SALINITY INVESTMENT FRAMEWORK
INTERIM REPORT – PHASE I

DEPARTMENT OF ENVIRONMENT
SALINITY AND LAND USE IMPACTS
SLUI 32
2003

Department of Environment

SALINITY INVESTMENT FRAMEWORK
INTERIM REPORT — PHASE I

prepared by

Resource Science Division
Department of Environment

DEPARTMENT OF ENVIRONMENT

SALINITY AND LAND USE IMPACTS

REPORT No SLUI 32

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Foreword

Managing salinity is a huge job that will continue for decades. However, our resources in terms of money, people, and time are limited. These resources to counter salinity are contributed by individuals, community groups, governments and private organisations.

If we are to do the best for current and future generations, we need to invest these resources wisely to save our most important natural assets. Like anyone on a limited budget, we need to make sure we are spending our time and money effectively, and on the most essential items.

We need a consistent, practical way of setting priorities to determine which of our prized natural assets are most at risk and could feasibly be restored, or saved from the effects of salinity.

This is where the Salinity Investment Framework comes in. This framework is a new way of determining natural resource management (NRM) spending priorities to help manage salinity.

For some time, allocation of public funds into salinity management has been problematic. There is so much to do and resources are limited. Communities have been looking for guidance about how to proceed. Individual landholders want to know how their efforts contribute to local or regional outcomes.

In 2002, the Minister for the Environment, Dr Judy Edwards, accepted a recommendation from the (then) State Salinity Council to commission a project to develop a process for determining how priorities can be set for investment of resources in salinity management — termed the Salinity Investment Framework. The general aim is to ensure that public investment is directed to projects with the best potential to protect assets of high public value that are at threat from salinity.

The project has received government funding and has been managed by the Salinity Investment Framework Steering Committee, which comprises senior government and community people with specialist salinity knowledge.

This report describes the work done to date in turning a concept into a sound process that will help focus our investment in salinity management. However, it is still a work in progress. For these reasons, it is termed an ‘Interim Report’.

Further work will include determining the feasibility of protecting assets of high public value, the priority to be placed on developing technologies for salinity management, and how the process can operate at regional and local scales.

On behalf of the Salinity Investment Framework Steering Committee, I thank the many people in government agencies, community groups, universities and private organisations who have contributed to the work reported here. In particular, I thank the Avon communities and the Avon Catchment Council for their willingness to be involved in the process and for their contributions to the work.

I encourage people to get involved in the continuing work in investment planning at state, regional and local scales. This is important work for us all.

I commend the report to you.

Rachel Siewert
Chairperson, Salinity Investment Framework Steering Committee
Member, Natural Resource Management Council
October 2003

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Executive summary

Background

Development of the Salinity Investment Framework (SIF) was commissioned by the State Salinity Council to guide public investment in salinity management initiatives at state, regional and catchment levels. The aim of the SIF is to ensure that public investment is directed to projects with the best potential to protect assets of high public value that are at threat from salinity.

In March 2002, a Notice of Intent was signed by the Hon Judy Edwards (Minister for the Environment and Heritage), Mr Alex Campbell (Chairman of the State Salinity Council), Mrs Barbara Morrell (Chair of the Avon Catchment Council) and Mr Robert Atkins (Acting Director for Regional Operations of the Department of Environment). The Notice of Intent outlined the outcomes expected from application of the Salinity Investment Framework to the state (South West Agricultural Zone) and the Avon natural resource management (NRM) region.

To create a Salinity Investment Framework at state and region scales $366 000 was allocated by government, from the Alinta Gas Fund, to undertake a project to develop:

- a priority listing of projects for the Avon NRM region
- a documented SIF process that works
- an evaluation of the process as applied during the trial
- a set of guidelines on how to implement the process
- criteria used in the analysis to make a decision
- details of information sets needed to make decisions
- skills required by the people involved
- the approximate cost of implementing the process.

Development of the Salinity Investment Framework — Phase I

Considerable progress has been made towards achieving the SIF outcomes. Achievements to date are as follows.

- A Salinity Investment Framework Steering Committee to manage the process has been established. The Committee comprises senior officers from responsible agencies and representatives from the Avon Catchment Council. The Steering Committee is chaired by Rachel Siewert, a Member of the Natural Resource Management Council, and Coordinator of the Conservation Council of WA.

- An over-arching process for identification of high-importance assets based on value and threat information has been developed, and applied across the state's agricultural areas. This has also been used by the Senior Officers Group to identify high-importance assets in a Natural Resource Management context across Western Australia (Sections 3 to 5).

- There are individual processes for identifying high-importance assets at threat from salinity within the following classes:

  – Biodiversity
  – Water resources
  – Agricultural land
  – Rural infrastructure
  – Social assets

For each of the above asset classes, broad groups of high-importance assets have been identified at a state (South West Agricultural Zone) level.

- There is a strong multi-agency and community-based team with an appreciation of the challenging nature of the task at hand and a strong commitment to producing a tool to help achieve accreditation of Regional Plans.
- The Avon Catchment Council have committed to use similar processes in identifying strategic directions for investment through the NRM Strategy being prepared for the Avon Region.

Conclusions from Phase I

The project teams responsible for implementing the Salinity Investment Framework process offer the following conclusions for consideration by government and the Natural Resource Management Council.

1. The SIF process developed through this project should be adopted by government and community groups as a means of establishing priorities for investment in natural resource management. The essential aspects about 'assets' that are addressed through the process are:
    - asset significance or **value** to humans
    - the **goal** or goals for the asset
    - level of **threat** based on the scale of potential damage and time scale of impacts
    - scale of intervention, feasibility of asset protection and cost-effectiveness (**feasibility** — the ability to do something for an asset).
2. The SIF process is intended to be applicable at all spatial and decision-making scales. While the outputs from this project (to date) are directed at addressing state NRM goals, the logic and method for defining assets of importance are acceptable and can be undertaken at local/subregional scale, based on goals established at those levels.
3. State and Commonwealth agencies are involved in accrediting regional NRM strategies. The accreditation process requires regional groups to demonstrate a valid process for setting priorities for investment. The full array of threats to natural resources will be considered in these strategies. The SIF methodology is a suitable process for setting priorities. State and Commonwealth agencies should urge its use, suitably adapted for the specific needs at regional, subregional, shire and catchment scale use.
4. Government agencies (Departments of Agriculture, Conservation and Land Management, and Environment) need to provide assistance to the regional NRM groups from state agencies in implementing the SIF process. Assistance is required in developing the process and preparing regional-scale descriptions of the agricultural, infrastructure, social, water and biodiversity resources that can be used as information to guide the process. In addition, assistance is required on the feasibility of proposed actions and to address hypothetical questions that may be thrown up by the process.
5. The SIF process represents a different way of developing priorities and determining strategies from those used in NRM in recent years. Regional and local communities have had limited contact to date, and are being asked to endorse and use these approaches. Interpretation for those using the process at different scales is required. State-level assets need to be reviewed for their validity by regional NRM groups.
6. Priority setting using the SIF process should consider three categories of asset. These are biophysical (biodiversity, water resources), economic (agricultural land, rural infrastructure) and social ('social wealth' or 'social capital') assets.

7. Feasibility information is an important ingredient in determining investment priorities. However, collecting this information in detail for all assets is resource demanding. The proposed method developed by the SIF project will employ a filter that focuses assessment for feasibility information on those assets considered important through a value–threat assessment. Feasibility assessment on protection of these important assets will use selected criteria and be based on expert panel judgements.
8. Separate processes have been used to establish priorities within the asset classes of biodiversity, water resources, agricultural land and rural infrastructure. These processes have been managed independently to date. New processes will be required to handle spatial aggregation of different assets, and to allocate priorities between classes (e.g. between biodiversity and water assets).
9. The SIF methodology currently focuses on individual assets and their goals for recovery, containment or adaptation. The intent of the process is to identify targets for direct intervention using public funds to protect specific assets from salinity. The *State Salinity Strategy* (Government of WA 2000) also promotes the importance of indirect investment into land use and management practices, termed here 'industry development'. These practices will improve the social and economic benefits flowing from actions taken to protect assets from salinity. Determining how priorities are set for industry development, and the relative investment in direct, and indirect, intervention will be a task for the next phase of the work.
10. Further development and review of the methodology and outputs is required. Priority setting is a continuing process that must be reviewed with new knowledge and technical information. Either re-allocation of existing funds, or allocation of new funds, will be needed to continue the development and application of the SIF methodology.

Recommendations from Phase I of the project

1. The SIF process developed in Phase I of this project should be adopted by government and promoted to community groups to assist in setting priorities for investment.
2. The Government should provide additional resources to state agencies and regional groups to implement the SIF process.
3. The Government should support review and further development of the SIF process beyond the life of the current project, and address wider NRM applications.

Recommendations for Phase II of the project

The Steering Committee recommends that the second phase of the SIF project be pursued. Proposed products from Phase II will include:

- a method for identifying assets of high-importance at a regional level
- a method for collecting feasibility information on high-importance assets at state and regional scales
- a process for deciding priority and importance between asset classes
- a process for determining the appropriate level of investment in industry development at state scale
- a process for making a final investment decision at the regional scale
- a list of investment priorities for the state
- a list of investment priorities for the Avon Region.

1 Introduction

This report documents the development and implementation of a framework for guiding investment into the management of salinity across the South West Agricultural Zone, with regional application in the Avon catchment. The framework is designed to be suitable for use in all regions.

The salinity situation

The State Salinity Strategy 2000 includes goals to:

- Reduce the rate of degradation of agricultural and public land and, where practical, recover, rehabilitate or manage salt-affected land
- Protect and restore key water resources to ensure salinity levels are kept to a level that permits safe, potable water supplies in perpetuity
- Protect and restore high-value wet lands and natural vegetation, and maintain natural (biological and physical) diversity within the region
- Provide communities with the capacity to address salinity issues and to manage the changes brought about by salinity
- Protect infrastructure affected by salinity (Government of Western Australia, 2000).

These are not simple tasks, particularly as current hydrological understanding indicates that larger areas are at risk of salinity than previously believed, which will affect even more productive agricultural land, biodiversity, rural towns, roads and railways than previously feared.

Current Land Monitor estimates are that approximately 1 million ha (5.5%) of the South West Agricultural Zone are already salt-affected. Of this, 776 000 ha is agricultural land. This area is predicted to rise to 5.4 million ha (29% of the landscape) by equilibrium assuming no management intervention. Eighty per cent (4.3 million ha) of this area is agricultural land. For most catchments, changes in land use will not have any significant impact for at least 20 years (National Land and Water Resources Audit 2001; Short & McConnell 2001). A continued decline in most natural resources is inevitable in the short to medium term, although early action will slow the rate of decline and potentially protect important assets.

For biodiversity alone the changes will be enormous, with most or all of the existing wetland, dampland and woodland communities in the lower parts of catchments, and outside the higher rainfall areas, affected by salinity without intervention. There will be a much increased flood risk with flood peaks and flows two to four times higher than at present for the same amount of rainfall. Unfortunately, profitable farming systems that control salinity are generally not available at the scale required to address these threats. Without proven systems that are both effective for managing salinity, and profitable, farmers are not willing to change their current ways of farming.

The clear conclusion is that both public and private investment into salinity management need to be increased above current levels for a significant period of time, and be targeted into actions that generate maximum returns for that investment. It follows that a rigorous and transparent process is needed to determine priorities for the allocation of the limited funds as they become available.

The investigations to date show that the potential net benefits of public funding will not be uniform across the state, or even across the regions. The highest benefit, and therefore the most important in terms of 'direct support' public investment, will come from protecting assets of high public value and supporting the community's economic and social capacity to manage the impacts of salinity. These are also likely to be the highest priority for action. Where direct funding by government is not cost-effective for the state community, 'indirect' forms of assistance (in particular, public funding of industry development) are required.

1.1 A clear position on salinity and its management

Salinity: A New Balance, the report of the Salinity Taskforce (Frost et al,. 2001), established a new, more focused position on salinity and its management. The three main actions that Government will commit to are set out in the introduction to the Government's Response to the Salinity Taskforce's Report:

1. Protection of outstanding **public assets** (biodiversity, water resources, infrastructure) from the consequences of salinity and other forms of resource degradation
2. Investment in, and support for, major actions on **private land** by developing new technologies and new industries (e.g. new perennial plants, commercial farm forestry, engineering solutions)
3. Support and incentives for planning, coordination and implementation of smaller on-ground works on **private land**.

These commitments build on the approach set out in *State Salinity Strategy 2000*, in particular the recognition of the three over-arching management goals of **Recovery, Containment** and **Adaptation** (Government of WA 1996; Government of WA 2000)

A vision for the outcomes from salinity management in Western Australia is essential to set clear direction for action.

The Salinity Taskforce (Frost et al. 2001) recommended that the vision should include, as far as possible:

- identification of areas with high water tables with the potential to become saline
- a network of natural systems, including high priority conservation areas and remnant native vegetation on private lands
- lands suitable for agro-forestry (with two objectives of commercial returns and lowering water tables)
- lands where other new agricultural practices will be needed to reduce water tables
- saline land which could be used for productive and nature conservation purposes
- areas where restructuring may be needed for agricultural or conservation purposes
- employment growth and regional development.

These aspects of vision provided a satisfactory context for the application of an investment framework. In addition they provided an indication for the magnitude and time-scale of the task of managing salinity in Western Australia.

1.2 Developing an investing framework

In Australia, the cost of repairing resource degradation has been estimated to be of the order of $65 billion over ten years (Black and Burton 2002). Governments and natural resource management groups appreciate that the public investment available will be limited. Around the country there has been a strong drive to develop accountable and strategic investment frameworks for NRM. These investment frameworks seek either to: (1) minimise resources necessary to achieve some given amount of environmental benefits, or (2) maximise the benefits from a given investment devoted to improving environmental quality.

On **the first point**, the Western Australian Government has strategically invested funds for the protection of a number of key public assets threatened by salinity, including recovery programs for five water resource recovery catchments, six natural diversity recovery catchments, and numerous rural towns. Note that work in natural diversity recovery catchments is also seeking to maximise benefits by using the recovery actions to protect other land uses as well as to test and develop solutions to salinity that are more widely applicable.

On **the second point**, the former State Salinity Council developed a set of principles for prioritising investment in salinity. The State Government has endorsed these principles in what is now termed the WA Salinity Investment Framework (SIF).

The SIF was developed to guide investment in salinity management initiatives at state, regional and catchment levels. The aim of the SIF is to ensure that public investment is directed to projects with the best potential to protect assets of high public value that are threatened by salinity.

The SIF represents a fundamental shift in NRM policy, for the following four reasons.

1. It shifts the emphasis in determining priorities from a *program approach* to an *asset approach*, by focusing most investment on protecting specific assets (e.g. the Muir–Unicup Wetland System), rather than distributing investment more thinly across a wider area via programs (e.g. funding for remnant vegetation in general).
2. It provides a logical approach in determining the importance attached to an asset, and the priority to be placed in investing in its protection[1].
3. It will allocate investment in protecting priority assets, with sufficient intervention to achieve the goal set for each asset item according to the value, the threat and the feasibility — the ability to achieve improvement.
4. The approach can be used for assets of very high-importance right down to the lowest level of importance, defining for each the goal, the effort required and the source of investment.

Setting priorities is not new — it is done in many walks of life to great effect. However, the NRM culture in rural Australia has traditionally been one of trying to distribute resources widely across the landscape. Therefore, implementing this new approach to salinity management clearly necessitates a transparent and rigorous prioritisation process. To achieve this end, the Salinity Investment Framework Steering Committee developed a methodology for prioritising investment of the limited funds available for salinity management between assets across all types (biodiversity, water resources, rural infrastructure, agricultural land and social assets).

1.3 The Salinity Investment Framework (SIF) Project

In March 2002, a Notice of Intent was signed by the Hon. Judy Edwards (Minister for the Environment and Heritage), Mr Alex Campbell (Chairman of the State Salinity Council), Mrs Barbara Morrell (Chair of the Avon Catchment Council) and Mr Robert Atkins (Acting Director for Regional Operations of the Department of Environment[2]). The Notice of Intent outlined the outcomes expected from application of the SIF to the state (South West Agricultural Region) and the Avon NRM Region.

- A priority listing of projects for the Avon NRM region
- A documented SIF process that actually works

[1] There is a difference between ‘importance’ and ‘priority’ in describing assets. Importance relates to the quality of the asset per se, and its need for protection. Priority allocates action in time — higher priority implies earlier action.

[2] Department of Environment is the new name for the agency which combines the functions of the former Department of Environmental Protection and the former Water and Rivers Commission.

- An evaluation of the process as applied during the trial
- A set of guidelines on how to implement the process
- A set of criteria used in the analysis to make decisions
- Details of information sets needed to make decisions
- Skills required by the people involved
- The approximate cost of implementing the process.

State Cabinet agreed to the development and application of the Salinity Investment Framework at the state-scale, and in the Avon NRM Region. Funds were allocated, with $116 000 for the former activity and $250 000 for the latter. The Department of Environment was identified as the accountable agency and was responsible for initiating and administering the project, and facilitating involvement of agency and other technical input. Other agencies involved in implementing this project include the Department of Conservation and Land Management (DCLM) and the Department of Agricultrue (DoA). Non-government organisations involved are the Avon Catchment Council and the Conservation Council of WA.

1.4 Project objectives and outcomes

The SIF Project objectives and outcomes were defined by the Steering Committee at a workshop in July 2002.

Community Level Outcome

High value public assets protected from damage caused by increasing salinity with tools in place to manage salinity on private land.

Community Level Objective

To target funds to achieve the greatest benefits from investment in salinity management for each dollar invested.

SIF Process Outcome 1

Private and public funding allocated to projects with the best potential to protect assets of high public value.

SIF Process Objective 1.1

To develop a prioritisation process, which is adopted by state and local government, regional groups, landholders and private industry, to guide funding to those projects with the best potential to protect assets of high public value.

Outputs of Objective 1.1

Documented Salinity Investment Framework Process that includes:

- details of information sets needed to make decisions
- criteria used in the analysis to make decisions
- a set of guidelines on how to implement the process
- description of skills required by the people involved
- approximate costs of implementing the process.

Documented case study of application of the SIF process which includes:

- identification of assets at risk from salinisation for state and Avon region
- goals set and options established for assets within Avon region
- a priority listing of assets for the Avon region
- an evaluation of the process as applied in the trial
- approximate cost of implementing the process at Avon region level.

1.5 Project management

1.5.1 The Steering Committee

A Steering Committee from the NRM Council (previously the State Salinity Council) oversaw both applications (state and region). The committee included two representatives from the Council, Rachel Siewert (Chair) and Neil Young, and Don Crawford (Executive Officer, NRM Council). Barbara Morrell (Chair of the Avon Catchment Council) represented the Regional Groups. Dr David Pannell provided expertise as a resource economist and because of his extensive work on prioritising investment for salinity management (Pannell 2001). The three agencies involved were represented by John Ruprecht (Manager Salinity and Land Use Impacts, DoE), Dr Bob Nulsen (Manager, Natural Resources, DoA) and Ken Wallace[3] (Regional Manager Wheatbelt, DCLM). Dr Michael Burton and Jonelle Black of the University of Western Australia were advisers to the committee. The Executive Officer for the Steering Committee was Tim Sparks (Team Leader Salinity, Department of Environment). Damien McAlinden and Louise Stelfox (DoE) were the Project Managers[4].

The Steering Committee was supported by a Joint Agency Working Group who scoped the methodology for the Salinity Investment Framework. This group included Damien Shepherd and Janette Hill-Tonkin[5] (DoA), Charlie Nicholson, Ben Carr and Megan Hillier (DCLM), and Peter Muirden and Damien McAlinden (DoE). Implementation of the project at state and Avon regional scales was supported by technical working groups in the Departments of Agriculture, Conservation and Land Management, and Environment.

1.5.2 The Project Teams

Two Project Teams were established to coordinate both levels of application of the SIF.

- The **State Project Application Group,** chaired by John Ruprecht, comprised Bob Nulsen (DoA) and Ken Wallace (DCLM), supported by officers from those agencies. This group prepared a state SIF Application Plan to detail the work to be completed, prepare detailed budget allocations and attend to any Working Agreements that were needed.
- The **Avon Project Application Group,** chaired by Barbara Morrell, (Chair of the Avon Catchment Council (ACC)), comprised Wayne Clarke (ACC), Colin Stacey (ACC) Ted Rowley (ACC), Martin Revell (DoE), Ken Wallace (replaced later by Brett Beecham) (DCLM), Cecilia McConnell (DoA), Jonelle Black (UWA) and Damien McAlinden (DoE). John Ruprecht and Tim Sparks were ex officio members to ensure effective liaison and reporting between the two groups.

3 Ken Wallace is now Manager, Natural Resources Branch with DCLM.

4 Janette Hill-Tonkin (DoA) and Charlie Nicholson (DCLM) acted as deputies for Bob Nulsen and Ken Wallace respectively on the Steering Committee and the State Project Application Group.

5 Ross Kingwell and Richard George also contributed for the DoA.

The Avon Project Application Group was responsible for developing the Application Plan which set out the requirements and working arrangements for the Avon Region SIF application, including any Working Agreements needed.

1.6 This report

Section 2 outlines the principles and processes in the Salinity Investment Framework and describes the overall methodology applied for each asset class.

Section 3 presents the processes used in defining important biodiversity assets.

Section 4 presents the processes used in defining important water resource assets.

Section 5 presents the processes used in analysing salinity impacts on agricultural land and rural infrastructure and determining options for management.

Section 6 summarises the social assets of importance.

Section 7 presents a discussion of progress to date, and highlights some issues to be addressed.

Section 8 provides an outline of further work to be completed in Phase II of the SIF project.

A **Glossary** of some important terms used in the report is presented at the rear of this document.

The Appendices contain supporting material, and present processes and assets for biodiversity, water resources, agricultural land and rural infrastructure, and social assets.

2 Setting priorities for investment in salinity management — the approach

Clear goal setting is an important initial step in setting priorities to identify the most appropriate type of investment of public funds for tackling salinity. Consideration of the **three responses** set out in the *State Salinity Strategy 2000* of **Recovery**, **Containment** and **Adaptation** provides guidance to developing this goal. These three responses were first defined in *Salinity: A Situation Statement for Western Australia* (Government of WA 1996).

A lack of clarity about which of these three broad types of response is required in each situation has in the past hampered the design of projects, assessment of the project for possible public funding, the determination of cost-sharing arrangements and, inevitably, the achievement of targeted outcomes.

2.1 Managing assets impacted by salinity — definitions, principles and processes

2.1.1 Defining assets, threats and feasibility

The Salinity Investment Framework is centred on an appreciation of the biophysical and socio-economic assets that are present in an area and which may be impacted to various degrees by salinity. The term ***'asset'*** indicates an item of value. For the purposes of the SIF, an asset can occur in three forms.

In the purest form, an 'asset item' is a discrete physical, biological or human-made entity. Examples are a rock outcrop with indigenous heritage value, a single species, or a building with an historical value.

An asset can also be considered as a location or site with single or multiple values. Examples include water resource and natural diversity recovery catchments, rural towns, areas of significance to indigenous people, and areas of bushland.

Assets can also be non-tangible qualities with values. Examples include the skills that a community group can apply to managing salinity, the technology able to be applied in managing salinity, and indigenous songlines extending over large areas.[6]

Definitions of 'asset hierarchies' as used in this report are presented in the Glossary.

'Asset value' in implementing the SIF process can be described in economic, social and environmental terms. Each of the processes for identifying important assets in each asset class describes value differently. Discussion about an asset item's value also leads to a better understanding of what is most important at a local community, regional or state scale.

'Threat' in the case of salinity, identifies the severity of potential impact from salinity and the urgency required for any action to recover, contain or adapt to the threat. The key question is 'How much of the asset's value will be affected and when will this happen if it has not already?'

For any given asset item, the process of setting specific goals for action is based on the asset item's ***value***, combined with an understanding of the hydrological situation and predicted scenario (the ***threat***), and the known ability to influence that scenario through intervention (the ***feasibility***). This term simply means the ability to do something for an asset, which requires consideration of goals, management options, costs, other threats, and social and technical capacity.

[6] In this report, the terms 'asset' and 'asset item' are used interchangeably to ensure that all three ways in which an asset can occur are recognised.

Analysis of these three characteristics will assist in deciding whether the ***specific goal*** for the asset should be aimed at recovery, containment or adaptation. This requires addressing questions including:

- 'What are we prepared to spend to recover, contain and/or adapt that asset and its value?'
- 'What is required to attain a goal for an asset?'
- 'Is that option economically viable, technically feasible and socially acceptable?'
- 'How much should be invested directly in targeted works on-ground versus investment in developing new technologies?'

The principles and steps developed by the State Salinity Council to guide the development of an Investment Framework for asset management are presented.

2.1.2 Principles

Eight principles which underpin the priority setting were developed by the State Salinity Council after considerable public and community consultation and participation.

1. The top-priority public investments are those which generate the greatest public benefits per dollar of public investment.
2. Direct financial assistance to land-holders to undertake salinity action should be strategic and should not exceed the public benefits that result.
3. Where the priority is high and the net public benefits are sufficient, Government should be prepared to take strong action to ensure protection of the asset.
4. Where the public priority is low but there are extensive private assets at risk, public investment should be aimed at industry development.
5. Inevitably, a targeted investment strategy in salinity management will result in unequal distribution of investment across the state.
6. Government must fulfil its statutory obligations for land, natural resources and functions (such as research) when it sets its priorities for investment in salinity action.
7. The process required for priority setting will involve continuing learning and need constant feedback.
8. Setting priorities must proceed even when there is only limited or imperfect information on prevailing environmental, social and economic circumstances.

2.1.3 The process of setting priorities — six steps

The principles can be applied in a six-step process for setting priorities. Figure 2.1 is a simplified outline of these steps.

1. Set broad objectives and goals. For example, the state has set goals for water quality in the *State Water Quality Strategy* and for salinity management in the *State Salinity Strategy*.
2. Assess assets, values and threats.
3. Assess feasibility for intervention, based on technical, social and economic factors.
4. Set specific goals for action. These will be more detailed than those established in step 1, and will apply to smaller areas. At the simplest level, the goal for an asset will be either recovery, containment or adaptation.
5. Set priorities for action for protecting assets, by locating all assets on a timescale for action.
6. Take action on the higher priority assets.

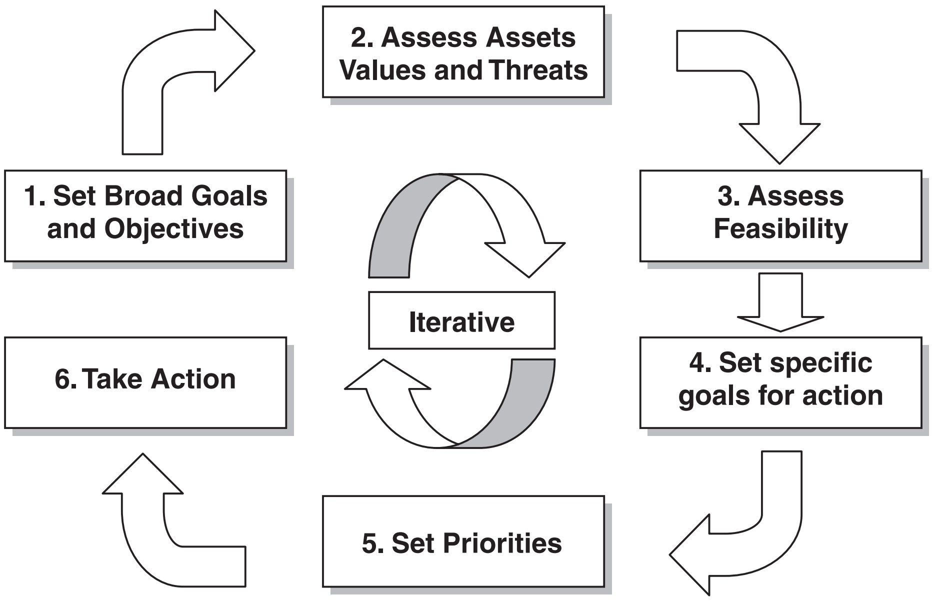

Figure 2.1 Diagrammatic representation of the State Salinity Council's six-step process for making investment decisions

2.1.4 Relating goals, asset importance and priorities for action at state, regional and local scales

A critical factor that the SIF project has acknowledged is the scale at which the assessment or priority setting takes place, whether at national, state, regional or local scales.

The value attached to an asset item can vary according to who is making the assessment, and the general goals that they have for that asset class or type. In the SIF context, there are at least three 'communities of interest' involved in establishing values for assets — the state community; regional and subregional communities; and local, subcatchment and shire communities. These three communities may have different valuations for the same asset item depending on the goals and objectives they have established for the asset class to which the item belongs. For example, an asset item (e.g. a piece of remnant vegetation) may be very significant to a local community having a goal of conserving all remnant bushland within the shire. However, the discrete piece of bushland may not be as important for contributing to the state goal for biodiversity conservation.

Communities operating at different scales and relying on different goals and objectives will value assets differently. This will have implications for the nature of information required, how social and economic aspects are addressed, and the way stakeholders are involved.

The SIF project is developing a process that is robust enough to be adaptable in its application across different scales. The generic features of the process — for example, defining goals, values and threats — is intended to be applicable at different scales, although modifications will be required according to the specific situation. An example of how asset valuation differs between the three scales of decision-making is presented in Table 2.1. It is important to recognise that asset valuation assessed at one scale is not superior or more important than asset valuation undertaken at another scale; because they are being assessed against different goals and objectives.

The different assessments shown in Table 2.1 need to 'inform' each other in developing an investment plan that addresses priority needs at all scales in the most cost-effective manner. Building effective inter-relationships between asset valuations at different scales will require excellent communication and collaborative work across the three scales. The Regional NRM Groups will have a critical role in coordinating and facilitating this process.

Table 2.1 Asset assessment at different scales

Scale	Community of interest for goals and values	Representative organisations for community	Sources of investment	Examples of important assets
State	Whole state community	Government agencies NRM Council	Mainly public	• Natural diversity and water resource recovery catchments • Representative landscapes for biodiversity conservation • Agricultural productivity at soil–landscape zone scale • Main roads and rail • Rural towns
Region	Whole regional community	Regional NRM Groups Subregional groups Special interest groups	Mixed public and private	• Bushland areas known to have regionally significant biodiversity values • Agricultural productivity within soil–landscape zones • Saltlakes used for recreation (e.g. water skiing) • Heritage trails • Regional indigenous heritage
Local	Whole local community	Catchment groups Special interest groups Shire councils LCDCs	Mixed private and public	• All bushland within the area • Local roads • Important local species • Heritage buildings within local towns • Local swimming hole • Local water supplies

In this report, initial value and threat assessments to achieve state goals were completed by agencies using relevant datasets required for work at that scale, as described in Sections 3 to 6 and in the appendices. A checking of these agency assessments for 'state-level' assets was then attempted through the Avon workshop series. In Section 7, initial comparisons between state level and Avon regional level assessments are presented, followed by a description in Section 8 of how this work will be continued in the Avon region.

2.2 Developing a methodology

2.2.1 A simple conceptual model

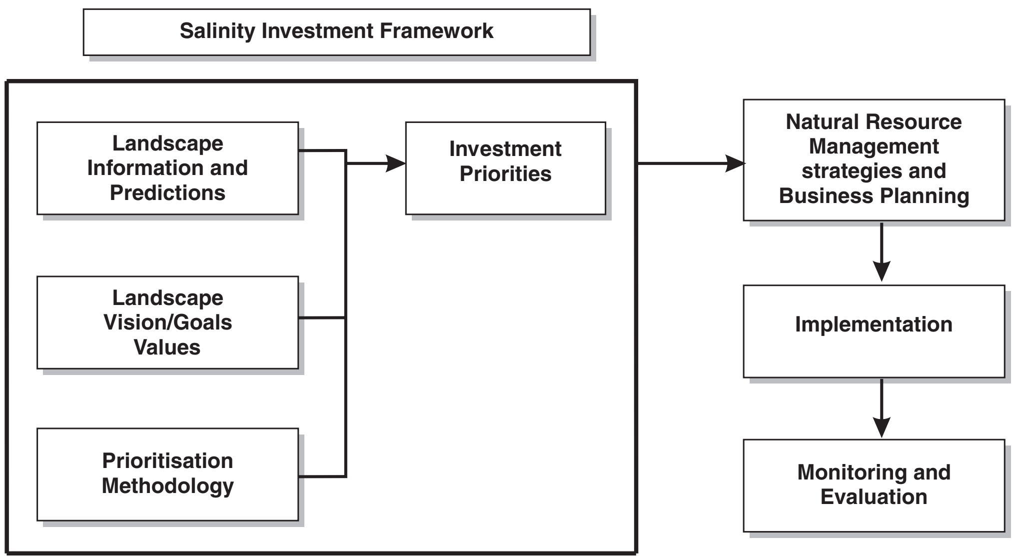

Figure 2.2 Salinity Investment Framework contextual model

The intention of the SIF project was to develop a framework to identify investment priorities that as well as being applied for salinity management would also be used in developing Natural Resource Management strategies, investment strategies and in business planning. Figure 2.2 presents the conceptual model of the Salinity Investment Framework adopted by the Steering Committee for implementation (Hamilton 2002).

2.2.2 Determining asset value, threat and feasibility

Figure 2.3 illustrates how consideration of these three characteristics can lead to identification of priorities for action for different assets. Asset items (e.g. discrete wetlands) can be ranked on one axis for their value, and on the second axis for the degree of threat measured by the extent and timing of salinity impact. On the third axis, the feasibility — the ability to address the threat — can be ranked.

Obviously those assets with the highest value that are the most threatened, but where the threat can be successfully managed (cost effective, technically feasible and socially acceptable), will be the highest priority for action — in particular for public investment. Those assets of low value, that are facing low threat and where the ability to do something about that threat is low will be the lowest priority for public investment.

However, in between these extreme options, there is no standard formula or approach for assigning priorities. For example, a high-value asset that is highly threatened and has only moderate feasibility may represent the best investment if objectives include both protection of high-value public assets and development of new technologies to improve our ability to combat salinity. Indeed, such an approach is likely to yield the best long-term public outcomes, rather than retreating to doing only those things that are most feasible.

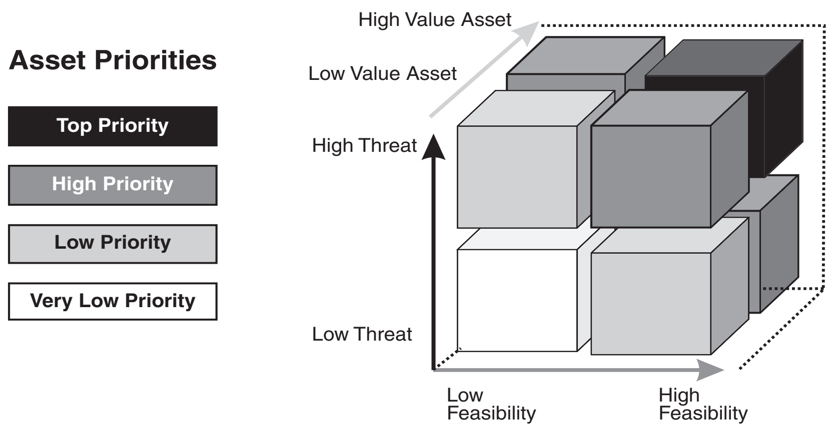

Figure 2.3 How SIF sets asset priorities according to their value, threat and feasibility

2.2.2.1 Measuring asset value

Assets are valued because they assist people to achieve goals. For example, rare flora have high value because they contribute to the goal of conserving biodiversity. Again, rural town infrastructure has value for the public and private services it supports. The value of an asset is what makes the asset important. In determining the relative value of an asset, it needs first to be acknowledged that there are firm quantitative measures for economic values, but none for describing social and environmental values in economic terms, although other quantitative measures for these values can be developed. The method chosen for expressing values depends on the goal for the asset class. If the asset can be valued in economic terms, as for example in the case of road infrastructure and agricultural productivity, then values should be assessed in financial terms. If the asset value can be expressed in other quantity and quality terms, as for example in the conservation of biodiversity, values should be expressed in the most suitable quantity terms (e.g. for biodiversity, criteria such as number of species, area of vegetation type may be used), or a combination of both. Assets with values that are expressed solely in qualitative measures, such as community capacity or cultural heritage, will require use of qualitative social research tools (e.g. rapid rural appraisal).

Developing a consistent description for asset value across the various categories (social, environmental, and economic) is not possible beyond categorisation into 'high', 'medium' and 'low' value as shown in Figure 2.4. These categories have been developed separately for the different asset classes by the agencies assessing them for their contribution to state goals (See Sections 3 to 6).

The value of an asset item can also be considered in combination with assets in close proximity (multiple values), as discussed in Sections 2.4.1 and 7.4.

2.2.2.2 Measuring threat from salinity

Threat contains dimensions of both severity and time. To illustrate the difference between these dimensions, there is evidence that some valley floors in wheatbelt areas will be totally impacted by salinity, but that the impact may not be apparent for over 50 years. Conversely, a relatively small section of the township of Morawa is being affected by saline water from a hillside seepage now, but the extent of impact is not predicted to increase over time (Rural Towns Program, pers., comm., 2002).

The left-hand column of Figure 2.4 separates assets into three groups depending on their threat from salinity (high, medium or low). To improve the consistency of comparisons between asset classes it is important that threat assessments are somewhat similar across the classes. Sections 3 to 5 introduce the methods for measuring salinity threat to assets within each asset class. The three broadly defined threat groups are:

High: imminent (< 2020)

Medium: 2020–2050

Low: > 2075 or asset significantly impacted now but not expected to deteriorate further

2.2.2.3 Feasibility

Determining the feasibility of a salinity management option for an asset item requires a number of important aspects to be considered:

- How much will the management option cost?
- Is it technically feasible?
- Will the option achieve the goal?
- How long will it take for the goal to be achieved?
- Will the option be implemented or be supported by surrounding land managers?
- What are the other threats to the asset (weed invasion, eutrophication, erosion etc)?

However, collecting this information for all assets will require substantial resource input. The proposed method developed in the SIF project employs a filter that focuses assessment of feasibility on those assets considered most important. The filter uses information on both the value of an asset and the degree of threat from salinity to identify its level of importance for further investigations on feasibility.

2.2.3 Value–threat matrix

Using the value and threat information, asset items can be arranged into the value–threat matrix. The value–threat matrix helps to identify high-importance groups or tiers of assets for further feasibility investigations. Three tiers of assets are defined within the value–threat matrix (Fig. 2.4) below. Each tier will require varying levels of investigations.

State Assets/Region Assets		Value		
		High	Medium	Low
Threat	**High** Existing and/or near (< 2020) and substantial	1st Tier		
	Medium Intermediate time (2020–2075) and/or not significant threat		2nd Tier	
	Low Long term (> 2075) or already impacted significantly			3rd Tier

Figure 2.4 Value versus threat matrix and the three asset tiers

The value–threat matrix defines three tiers of asset items, described as follows:

1st Tier: Includes asset items or groups of items of high value and at high threat from salinity

2nd Tier: Includes asset items or groups of items of high value at medium threat, and items of medium value at high threat from salinity, and asset items of medium value at medium threat

3rd Tier: Those remaining asset items or groups of items that include low value and/or low threat.

Should an asset item's allocation within any of the tiers be contested, 'reprocessing' the asset, through the matrix or spatial analysis can prove or disprove this contention. Reprocessing an asset item should acknowledge any available new information.

In summary, the value–threat matrix:

- provides a simple and transparent approach to identifying a group of high-importance assets for further assessment on feasibility.
- reduces the workload by ensuring that detailed studies for feasibility are completed on assets with high public value or of highest priority.
- identifies assets, and then priority groups of assets which require community participation.
- can be applied at state, region and local scales (employing the relevant goals).
- incorporates multi-agency information in identifying priority groups of assets.

2.3 Implementation — asset classes and information sources

2.3.1 Deciding asset classes

The SIF Steering Committee developed the asset classes and responsibilities for developing rules for identifying important assets for further investigation into feasibility, as shown below. Early in the SIF project, it was identified that the key difference between state and regional applications would be that the regional communities will address social assets as a separate asset class (APAG minutes, 15 July 2002). Both the Avon Action Group and the SIF Steering Committee decided to postpone dealing with social assets until the participants in the Avon workshops had been able to express their views.

- **Biodiversity:** DCLM (Section 3). *Identification of Important Biodiversity Assets — South West Agricultural Region* (Wallace, et al., in prep.).
- **Water Resources:** DoE (Section 4). *Identification of Important Water Resource Assets — South West Agricultural Region* (McAlinden, in prep.).
- **Agricultural land and rural infrastructure:** DoA (Section 5). *Agricultural Land and Infrastructure* (George and Kingwell, in prep).
- **Social assets:** Salinity Investment Framework Steering Committee and Avon Catchment Council (Section 6). *Social assets* (URS 2003a).

2.3.2 Information for assessing asset values and threats

Application of the principles and processes requires sufficient information and understanding of the land, social and economic systems that are being considered, their values and the threats to those values. Data available to the SIF Steering Committee at the commencement of the work were derived from a number of sources including:

- Land Monitor outputs
- National Land and Water Resources Audit outputs
- Water Resource Recovery Catchment investigations and actions
- Biological Survey of the Wheatbelt (DCLM)
- Databases of threatened species and communities
- Rural Towns Program investigations and actions
- Rapid Catchment Appraisal outputs
- State Waterways Needs Assessment
- Draft state Sustainability Strategy
- Draft Regional Development Policy.

Implementation of the process presented in Figure 2.1 has varied according to asset type. Each method endeavoured to follow the six-step process, with work completed for Steps 1 and 2 for all asset classes. Independently, each of the processes concluded that to complete all steps on each asset identified would be extremely resource demanding. In Step 3, salinity management options need to be explored, that is, the *feasibility* needs to be assessed. In Step 4, feasibility information should be used in setting specific goals for the important assets, these being to recover, contain, adapt or do nothing.

2.3.3 Obtaining regional views

To allow an opportunity for community contribution to the development and application of the SIF at both the state scale (South West Agricultural Zone) and at regional scale in the Avon River Catchment a series of workshops was held in the Avon Region. Section 7 summarises briefly the outputs of these workshops in terms of asset valuations. The following reports describe the two series of workshops and their outputs in more detail:

- WA Salinity Investment in the Avon Catchment. Subregional priorities (URS 2002)
- Implementing the Salinity Investment Framework in the Avon Region — A Position Paper (URS, 2003)

2.3.4 The workshops

Four separate workshops were held in October 2002. These were held in the towns shown in the three subregions that make up the Avon Basin (Fig. 2.5).

- Yilgarn subregion (Merredin) — 15 people.
- Lockhart subregion (Lake Grace) — 10 people.
- Avon-Mortlock subregion (Northam) — 9 people.
- Regional overview (Northam) — 20 people.

The aims of each workshop were to work with subregional communities, using their local knowledge to:

- identify *assets* of value at this scale
- set *goals* for assets identified, and define the components of the salinity *threat* to these assets
- Provide a community ranking of the threats to the assets as a function of *capacity* of the community to deal with them and the scale and urgency of the threat.

A final workshop was held in April 2003 in Kellerberrin. Participants from the four original workshops and a number of other individuals were invited to attend. The purpose of this workshop was to encourage comment on the process to date at a state and regional scale, and to seek advice on how to proceed further at a regional scale.

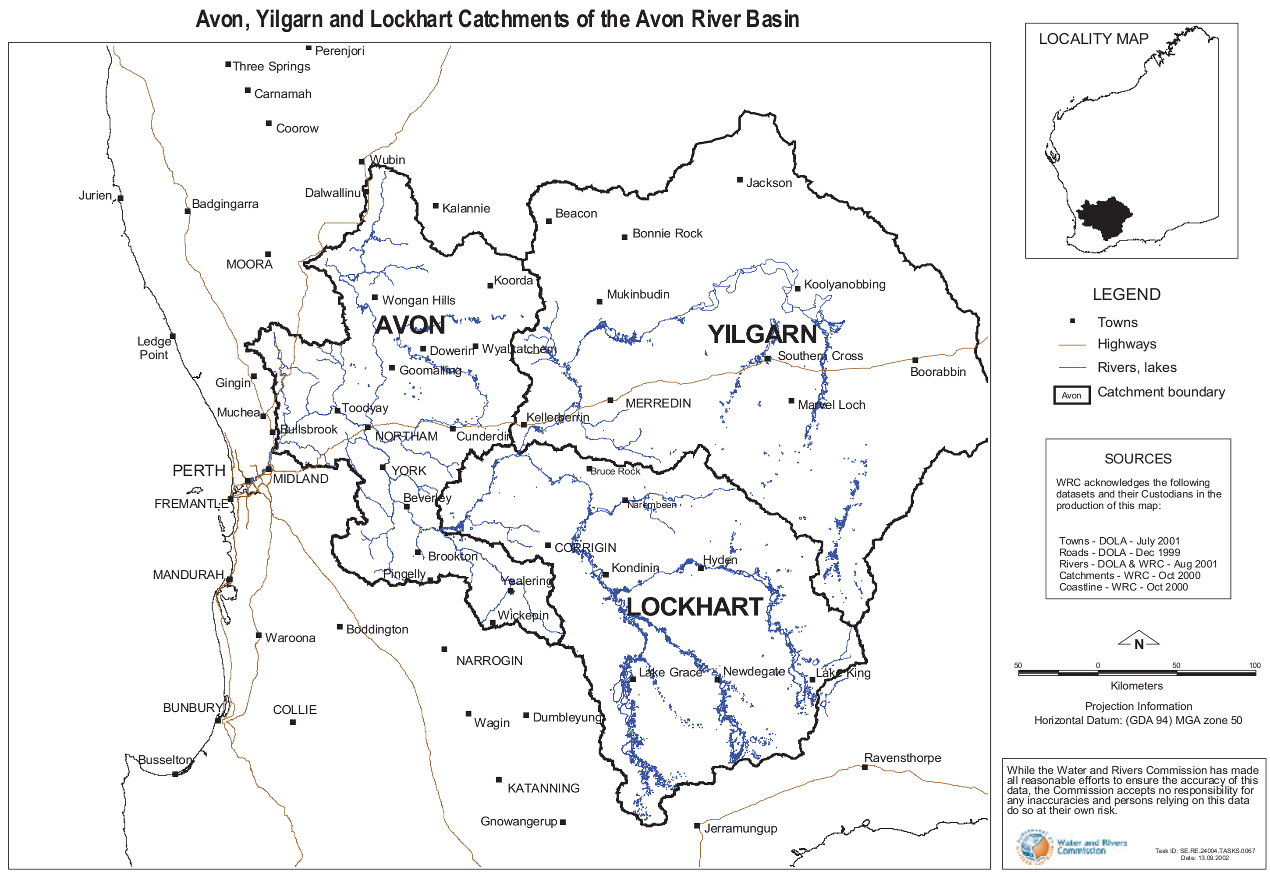

Figure 2.5 Subregions in the Avon Catchment

2.4 Further actions required

2.4.1 Multiple values and spatial analysis — the 'pizza approach'

The SIF methodology assesses individual asset items for their value and threat within each asset class. The separate asset–threat processes do not consider the relationship between asset items from different asset classes, even where these asset items may be in close proximity. For example, a piece of remnant vegetation of moderate value could be located in close proximity to a townsite that has a small area of infrastructure threatened by salinity. Individually, these two asset items may not attract a high priority. Collectively, the combined total value of the asset items will have higher value. There is potential for one management option to result in multiple benefits and consequently a much larger return on investment.

However, the goals for different assets, and the values they represent, may differ considerably. The validity of making cross-asset calculations needs to be seriously considered. Despite this, it is useful to consider the combined values and threats of groups of assets from different classes located in close proximity within the landscape.

Spatial analysis (the so-called 'pizza approach') will provide one method for assessing assets in close proximity across different classes. The SIF Steering Committee has conducted initial investigations into using spatial analysis for assessing multiple values and management option interaction. Further work is required before this methodology can be finalised. The first pass in these investigations will require overlay of asset datasets in a Geographical Information System. Any area of the landscape with values from two or more asset classes in close proximity will be identified. Their combined values and threat from salinity will be described in high, medium and low terms. Methods for managing the salinity threats to them will also be assessed.

Refining and implementing the spatial methodology for considering multiple values will be an important task in the second phase of the SIF project.

Despite considerable investigations, the SIF Steering Committee has yet to be shown where there has been an effective, applied priority setting process that integrates across disparate asset classes and items. Unless a cost-effective method of applying a standard set of quantifiable criteria across disparate asset items can be developed, integration of asset values will remain a highly subjective process.

2.4.2 Feasibility information

Using the three tiers identified above, the highest priority for collecting information on relative feasibility will be for those asset items in the first tier, followed by those in the second tier and then those in the third. More detailed assessments will be required for the first tier asset items in comparison with those assets within the third tier. An indicative assessment of information that should be collected to help determine if any action for an asset is achievable includes the criteria described in Table 2.1.

Further work is required in developing a methodology for each asset class to capture this information. Additionally, it will be very costly to assess feasibility. It is likely that further ranking will occur amongst Tier 1 assets before detailed investigations are undertaken.

Assessments of feasibility will result in some first tier asset items (high value-high threat) becoming low priority for investment, on the basis that the threat cannot be addressed within operational constraints. However, such valuations may change with improved knowledge and technology, or increased resources for salinity investment.

Completing the feasibility investigations on each asset item, and placing these items on the third axis in Figure 2.3, will finalise the priority to be given to the individual asset items. This may lead to some significant changes in the ranking based on threat-value alone. For example high value–low threat assets (third tier in Figure 2.4) may have a high level of feasibility and thus could attract a higher priority for investment.

Table 2.2 Indicative information requirements to help determine the success of any action for an asset

Criteria (indicative points only)	**Points to consider** (indicative points only)
Acceptability	• Has the Salinity Investment Framework identified the asset or assets as having a high level of importance? • Does the goal (recover, contain or adapt) for the asset have widespread community support? • Will the management option to achieve this goal have broader community and land-holders' support? • Highlight local government and regional organisation involvement if any.
Dependability	• Considering both technical feasibility and social capacity what is the probability that the management option will achieve the goal for the asset?
Investment return	• What is the expected cost of implementing the management option? • Are there contributing partners and funding contributions (time, works undertaken by the landholders etc)? • Where investment will result in extensive private benefit, is there an appropriate balance between government and community resourcing? • For projects greater than $1 million, does a cost-effectiveness analysis indicate this program will be the most efficient approach to deliver the positive returns to investment? • Does the program address multiple issues and have complementary effects for other programs?
Precaution	• Is the program important to avoid serious or irreversible outcomes? • Are there likely to be thresholds where impacts rapidly increase? • How quickly do we need to act to avoid greater impacts? • Is there any chance of unintended consequences causing negative impacts?
Timeliness	• Is the program necessary for addressing prerequisite issues? • Does this program require other actions to be taken before it can be successful? • Will this program prevent impacts from occurring or from increasing? • Will rates of change of impact severity increase over time? • How long will it take to successfully address the issue and deliver the outcomes?
Monitoring and evaluation	• An appropriate evaluation and monitoring method should be developed that demonstrates achievement or non-achievement of goals for assets.

2.4.3 Completing the work of state, regional and local scales

To date, the SIF project has focused on developing a prioritisation methodology and then applying it at a state scale (South West Agricultural Zone). The process has been introduced to regional communities in a series of workshops in the Avon Basin (see Section 2.3.3). Information from these workshops has contributed to the methodology. Workshops have also helped in the identification of certain asset characteristics. Regional and local community involvement will assist the validation of the state level assessment.

Further work in progressing implementation of the methodology to meet regional needs will be undertaken by the Avon Catchment Council during the second phase of the project.

2.4.4 Making an investment decision

The methodology for making the final investment decision is yet to be completed. After the method for collecting the feasibility information (above) is complete, this will be the next most important task. Two approaches are being considered.

In Appendix 1 a multiple-criteria analysis (MCA) tool that will offer an appropriate support to the Salinity Investment Framework is described. All further work on collecting data will need to consider any data requirements that a multiple-criteria analysis approach might demand.

An alternative approach will be to use reference groups to finalise priorities for potential investment. In establishing reference groups, the priorities at a given scale need to be considered. For example, state priorities will need to be set by a reference group that is able to 'speak' on behalf of the whole state community. Regional reference groups will be able to speak on behalf of regional communities in defining priorities at that scale. In establishing such a methodology, it needs to be very clear who is making decisions on behalf of whom.

Using the criteria outlined in Table 2.1, brief reports may be submitted to relevant groups and the state for assessment for potential investment.

2.4.5 Public investment into private assets

Private land that has been cleared for agriculture is called 'agricultural land'. The DoA has used this definition in their analysis in Section 5. Agricultural land is a private asset. The SIF principles (Section 2.1.2) state that where there are extensive private assets at risk public funding should be targeted at industry development and capacity building.

Natural habitats (terrestrial and aquatic) contain most of the biodiversity and water assets of public value. Where these are on private land they are still contributing to public values. The SIF principles state that investment in natural habitat on private land can be undertaken to enhance those public values.

It has been recommended that industry development and capacity building is assessed in relation to protecting valuable agricultural land, and improving agricultural practice in a way that protects public assets. The state SIF Steering Committee needs to present a set of recommendations for development of new industries and capacity building in relation to each of the zones identified by the DoA. It will be necessary to take into consideration the need to protect public assets from agricultural land use as well as the importance of protecting high-value agricultural land. It is likely that industry development to protect public assets across the agricultural zone will also deliver the industries required to protect agricultural land use. Whilst acknowledging the need to protect valuable agricultural land, it is unlikely that this approach would support new industries that have a negative impact on broader environmental, economic or social values.

Enhancement of the social assets is seen as being critical in delivering capacity to address the threat posed by salinity to all asset types such as biodiversity and land. The descriptions of the social assets in Appendix 5 provide valuable guidance and data in identifying the key priorities for industry development and capacity building.

2.4.6 Managing public resource allocation at state scale

State and Commonwealth governments will oversee the investment of public funds into regional natural resource management. In assessing Regional Plans for Investment, the Natural Resource Management Council and the State Investment Committee will use a resource allocation framework to recommend distribution of funds across five meta-programs.

1. Capacity building
- Governance
- Knowledge and skills
- Values and culture
- Networks and organisations
- Economic resources
- Community well-being

2. Biophysical assets
- Biodiversity protection and enhancement
- Water quality protection and enhancement
- Infrastructure
- Agricultural land/productivity
- Coastal and marine

3. New technology
- Farming systems
- Engineering options
- Integrated demonstrations

4. Industry development
- Targeted forest establishment
- New farming systems (e.g. perennial grasslands within the normal rotations)
- Productive use of saline land and water

5. Monitoring and evaluation
- Data and information management
- Target setting and monitoring design

Within the context of the Salinity Investment Framework, targeted works on-ground or 'direct investment' will be used to protect priority assets within the Biophysical assets program, for example, pumping of saline water from beneath Toolibin Lake (natural diversity recovery catchment) and pumping from beneath Katanning and Corrigin (Rural Towns Program). Direct investment in the social assets will occur through capacity building, by leadership training, training communities to make their own investment decisions, and through supporting learning networks, such as the Lucerne Growers' Association, Salt Land Pastures Association and Master Treegrowers Association. 'Indirect investments' will take place through the other three meta-programs (New technology, Industry development and Monitoring and evaluation). A task of the Natural Resource Management Council and the State Investment Committee will be to recommend overall balance in the total state investment package. Similarly at regional scale, the regional groups will be targeting and tracking the distribution of investment across these programs.

2.5 Summary

When considering any form of investment there are four essential aspects that should be considered:

- Asset significance or **value** to humans
- The **goal** or goals for the asset
- Level of **threat** based on the scale of potential damage and time scale of impacts
- Scale of intervention, feasibility of asset protection and cost-effectiveness (**feasibility** — the ability to do something for an asset).

The value–threat matrix:

- is a relatively simple and transparent approach to identify groups of high-importance assets for further assessment on feasibility
- reduces the workload by ensuring that detailed studies for feasibility are completed on assets with high public value that are facing higher threats
- needs to be informed by the views of appropriate communities of interest

- can be applied at state, region and local scales (employing the relevant goals)
- incorporates multi-agency information in identifying priority groups of assets.

Feasibility information is an important ingredient in determining investment priorities. However, collecting this information for all assets is resource demanding. The proposed method developed by the SIF project has employed a filter that focuses assessment for feasibility information on those assets considered important through a value–threat assessment.

Further work will:

- expand on the spatial overlay approach to consider multiple values of assets from different classes located within close proximity
- develop a methodology for assessing feasibility for each asset class at both the state and region scales
- design a tool to guide final investment decisions
- further develop the value–threat matrix at regional scale using regional goals and perspectives
- build interaction between asset assessment at different scales to ensure all community goals and objectives are achieved.

3 Biodiversity assets — South West Agricultural Region

3.1 Introduction

A much more detailed account of this Section is provided in Appendix 2.

The definition of biodiversity in *The National Strategy for the Conservation of Australia's Biological Diversity* (Commonwealth Department of Environment, Sport and Territories 1996) — a document that has been endorsed by the Commonwealth and all Australian state governments is:

'the variety of life forms — the different plants, animals and microorganisms, the genes they contain, and the ecosystems of which they form a part.'

However, for the purposes of the SIF process, 'biodiversity' was defined more narrowly as:

'All living things — plants, animals, bacteria, amoeba, and so on — that occur naturally in the state.'

Using this narrower definition recognises the following as important elements of biodiversity:

- Genetic diversity
- Species diversity
- Diversity of natural assemblages of living things (such as communities, or the living components of a specific ecosystem)
- Structural diversity of the above three components

The explanation for this approach is given in Appendix 2.

3.2 The process

The method used to identify key biodiversity assets is consistent with the process outlined in Section 2.1.3. A broad goal has been used to identify the relevant assets and their current values. The method has also dealt with viability/risk analysis in regards to salinity. However, a more comprehensive viability analysis is planned provided there is sufficient interest in pursuing further the methods described below.

3.2.1 The goal

The biodiversity goal for the SIF is:

'To protect, conserve and, where necessary and possible, restore Western Australia's natural biodiversity'.

This goal is consistent with the Salinity Strategy goal. During the development of the SIF and other similar work, the pivotal nature of a goal in defining assets was underlined. The goal should reflect the human values it seeks to address.

3.2.2 Value

The biodiversity goal adopted focuses primarily on delivering the human values related to:

- Opportunity values

- Ecosystem service values
- Amenity values
- Scientific and educational values
- Recreation values (but restricted to passive recreation, such as picnicking and bird watching, as these are most compatible with conserving biodiversity)
- Spiritual/moral/philosophical values.

3.2.3 Assets

The three key biodiversity asset types are:

- Rare[7] species
- Rare communities (of plants and animals)
- Areas that provide good representative samples of biodiversity.

The SIF project group working on biodiversity agreed that these assets make the greatest contribution to achieving the biodiversity goal provided above.

In the case of rare species and communities, there are already well-documented processes for ranking their importance for biodiversity conservation. These have been used in the SIF process.

However, exactly what in the South West Agricultural Zone constitutes a representative sample of biodiversity is more difficult to define (see Appendix 2 for a discussion of this issue). For the Salinity Investment Framework, it was decided that the most important representative samples exist at the landscape scale. As discussed in Appendix 2, the following is the most important list of representative landscapes at this point in time;

i) Landscapes over 10 000 ha that have 25% or more of their area in natural habitats

ii) Natural diversity recovery catchments and landscapes already selected on the basis of their importance for biodiversity and high level of threat from salinity

iii) Potential natural diversity recovery catchments. Also landscapes selected on the basis of their importance for biodiversity and high level of threat from salinity.

In the case of (i), the landscapes selected were ranked according to:

- amount of native vegetation remaining
- counts of rare/threatened species and threatened ecological communities (used as a measure of biological diversity — with the greater the number of these, the more biodiverse the local area is likely to be)
- measures of wetland importance (Ramsar, Nationally Important Wetlands, etc.).

In the case of (ii) and (iii), the ranking process was undertaken by an expert panel of scientists.

In summary, the three asset types described above of rare species, rare communities and representative landscapes contribute the most towards conserving biodiversity[8]. Therefore, these three types were selected for this analysis as the biodiversity assets that will make the greatest contribution to achieving the biodiversity goal provided above. To rank these types of assets we used criteria based on the attributes of rareness,

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[7] As used here, the term rare follows the general meaning of uncommon, rather than the statutory meaning in the *Wildlife Conservation Act 1950*.

[8] As might be expected, a skim through how biodiversity conservation priorities have been developed historically is consistent with these three assets providing the most important contribution to conserving biodiversity.

‘specialness’ (in the sense of icon species, living assemblages that reflect biodiversity hotspots or endemism, Gondwanan relics, etc.) and representativeness. Rarity and representativeness were the particular asset attributes used in this work to rank assets — ‘specialness’ is a concept that needs to be further developed in relation to evaluating other asset types.

From the work in this project and elsewhere, it was also clear that a more comprehensive list of assets is required, and this will be a topic for further development and refinement in future years.

3.2.4 Threat

3.2.4.1 Rare species and communities

Rare species and communities are assessed using standard procedures (Appendix 2). Where the threats are sufficiently high, rare species and communities are accorded varying levels of threatened status. Salinity threat is not a criterion applied uniformly across populations of threatened species and communities. Therefore, to assess the salinity risk to populations and communities, geographical information systems were used to intersect salinity risk as defined from Land Monitor, with the locations of rare species and communities. The output is threatened species and communities that are at risk from salinity. See Appendix 2 for a more comprehensive description of the methods used and the map produced as an output.

In setting priorities within this group of assets, it would be essential to first:

1. rank the threatened species and communities for action in line with how endangered they are (see Attachment 1 to Appendix 2)
2. undertake a field assessment (or preferably obtain local advice) concerning the salinity risk to the subset of species determined from (1) above. This is necessary to confirm the level of threat from salinity. The Land Monitor data used to calculate salinity risk does not provide information concerning local hydrogeology. For example, while a plant population may occur in a valley floor threatened by salinity, the plant itself may only occur on low, sandy dunes within valley floors and as such not be threatened by salinity. This level of discrimination is not available from Land Monitor.

3.2.4.2 Representative landscapes

Using the methods described above, and as presented in Appendix 2, representative landscapes were derived and rated in relation to their biodiversity importance and their level of threat from salinity. This information was further subdivided into three groups, termed tiers in this work (see Fig. 2.4):

- **Tier 1:** those representative landscapes ranked highest (rank 1) for biodiversity importance that are also highly threatened by salinity;
- **Tier 2:** those representative landscapes ranked either second (rank 2) for biodiversity importance, or moderately threatened by salinity, or both; and
- **Tier 3:** those representative landscapes ranked either third (rank 3) for biodiversity importance or with a low salinity threat, or both.

These tiers present a starting point for allocating funds to prioritised assets of public value. While it would be useful to have access to other information from risk analyses to provide more information on the viability of a particular landscape and the likelihood of management success, it was decided that Tier 1 assets should be those assessed further, as a matter of priority, for funding.

There are a number of other approaches. It might be argued, for example, that landscapes ranked 1 for biodiversity, and at either moderate or low threat from salinity, should be the priority target for funding given that success in their management is more likely. However, this would effectively condemn Tier 1

South West Biodiversity Assets		Biodiversity Value		
		Rank 1	**Rank 2**	**Rank 3**
Salinity Threat	High	Lake Warden	66	3
		Kojonup–Beaufort–Carrolup River Flats	86	2
		Buntine–Marchagee	70	20
		Muir–Unicup	64	8
		NE of Stirling Ranges (Anderson Lake to Corackerup Nature Reserve)	57	12
		Magenta Area	60	15
		Lake Bryde	41	28
		Dunn Rock/Lake King Chain	19	30
		Moore River System	44	32
		Drummond	45	56
		Boyup Brook–SE Collie Area	19	18
		Yinniebatharra System and Hutt Lagon	44	17
		Upper Lort River (possibly including Pyramid Lake)	45	26
		Headwaters of the Fitzgerald River	21	29
		Kondinin Salt Marsh	81	
		Toolibin Lake	24	
		Chinocup System	51	
		Coyrecup Nature Reserve	16	
		Mortlock River System (Northern Branch)	61	
		Lake Gore		
		Cowcowing Lake System		
		Kent Road Braided Saline Drainage System		
		Mollerin Lake System		
		Darkin Swamp/Dobbaderry Swamp System		
		91		
		94		
		80		
		46		
		67		
		92		
		82		
	Medium	13	39	7
		34	6	87
		47	27	10
		63	25	36
		75	35	37
		93	48	38
		95	76	5
			42	31
			74	
			23	
			58	
			72	
	Low	55	84	1
		54	33	4
		65	53	9
		71	43	14
		68	85	11
		89	52	
		88	77	
			40	
			90	
			22	
			49	
			62	
			50	
			83	
			73	
			59	
			69	

Figure 3.1 Value-threat matrix for one biodiversity asset (representative landscapes)

assets to a low probability of retaining the full range of their current biodiversity values. On the basis of current information and the broad goal provided above, it was not considered acceptable to take this step without further risk analyses. It was also accepted that working in some of the more highly threatened areas would be more likely to deliver a better understanding of managing salinity, including the development of new technologies.

It is therefore proposed that more detailed risk analyses be conducted for Tier 1 assets, and that they be ranked as priorities for investment in the light of this additional information. The outcome from further analyses is likely to be that particular landscapes are downgraded in priority, and others elevated.

The three tiers of landscape assets were mapped and developed within a geographic information system. The resulting list and map are shown in Figures 3.1 and 3.2, and in the full report in Appendix 2.

3.3 The outputs

3.3.1 High-importance assets

The full dataset of assets important in achieving goals at a state scale is presented in Appendix 2. In particular, the map produced of threatened species and communities is shown only in Appendix 2 (see Fig. 2.4 in Appendix 2). Figure 3.1 presents a matrix of representative landscapes allocated to the three tiers according to value and threat. Figure 3.2 presents the key representative landscapes in the agricultural areas identified using the process presented above.

3.3.2 General points

The biodiversity project group was confident that the methods and results described above provide a valuable framework and starting point for addressing the state goal for biodiversity conservation. Another conclusion of the project group was that it is important to maintain a funding stream to important biodiversity assets that are not identified through the process described above. This recognises that the priority setting process described here focuses on what contributes the most to biodiversity conservation, and not on all the assets required to meet the state biodiversity conservation goal. Important changes required to greatly improve the current system in this regard relate to the following.

- Better defining and describing assets. While the three main types of biodiversity asset (i.e. rare species, rare communities, and representative landscapes) used in this analysis are likely to contribute most to biodiversity conservation, there are many other assets that are essential to achieve the broad goal, and many of these asset items are remnants of natural environments.
- Ensuring that the value of all lands, including Crown lands, are adequately recognised in funding allocations. There is a risk, for example, that privately owned natural environments will be provided with government funds for management ahead of more important Crown land. This would not be consistent with meeting the broad conservation goal stated at the outset.
- Developing improved methods for ranking natural environments for biodiversity conservation. This will involve, in particular, methods that integrate criteria for assessing areas of natural vegetation, wetlands, rock outcrops, caves and other important categories of natural environment. The qualities of rareness, specialness and representativeness are likely to provide the criteria for evaluation, with specialness being of particular importance.
- As far as practicable, allocating resources across the biodiversity priority areas in a way that best meets the broad goal of biodiversity conservation.

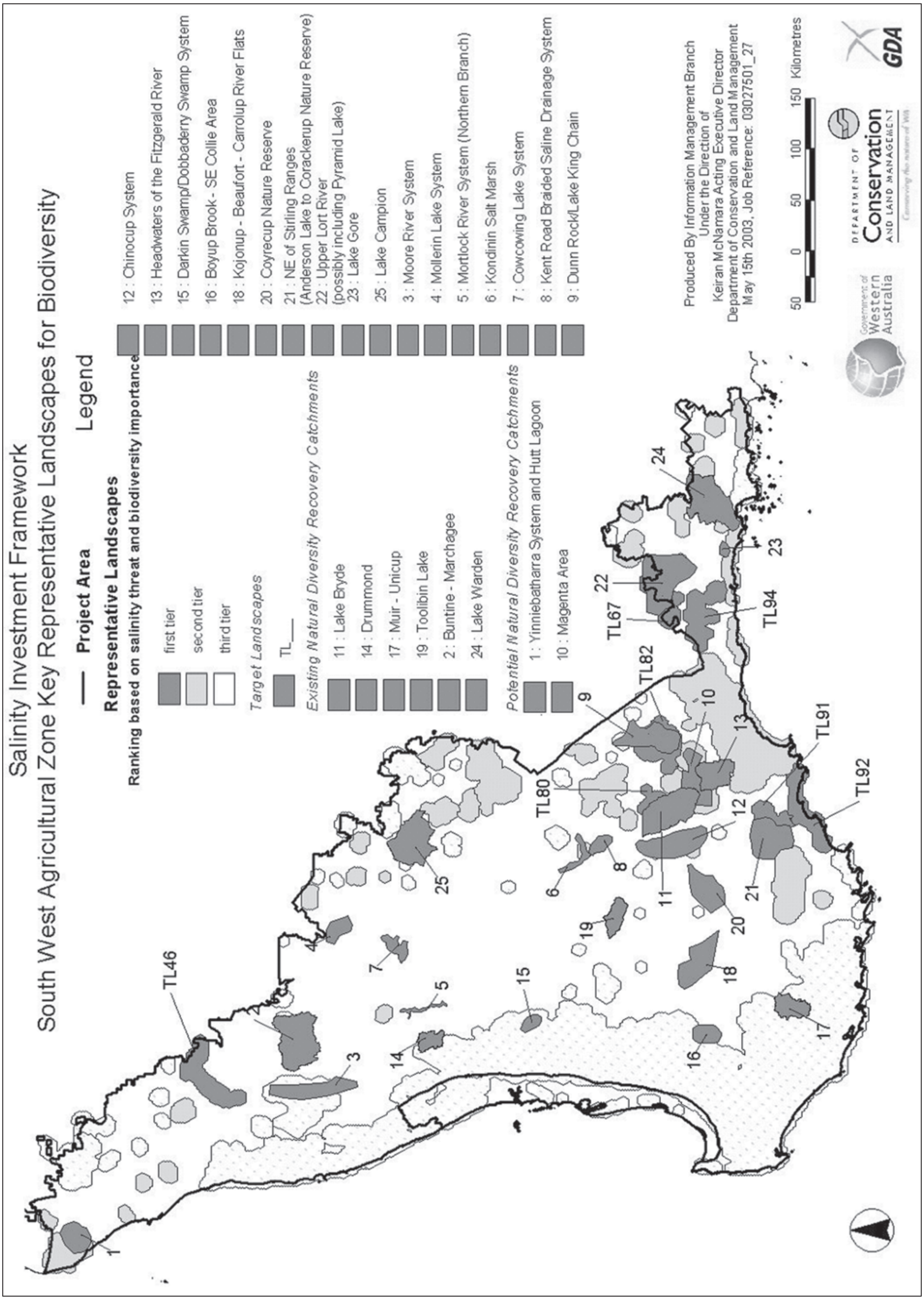

Figure 3.2 South West Zone Key Representative Landscapes for Biodiversity

3.4 Recommendations

The State Project Application Group recommends that:

1. Biodiversity assets identified in the SIF are checked, and that assets of perceived equal or greater importance can be identified by interested members of the Avon regional community. For state funds, the Minister for Environment holds the ultimate authority and responsibility for deciding priority assets. Currently, we are developing with stakeholders methods to more effectively engage the Avon regional community.

2. Work continues to improve methods for describing and ranking biodiversity assets, particularly with respect to the full range of human values covered by the broad goal.

3. A high priority is given to developing a methodology and criteria that integrate priority setting across all landscape types (for example, natural diversity recovery catchments, among others). This is consistent with existing recommendations in the DCLM's review of its salinity programs (Wallace 2001).

4. Priority setting processes for natural environments are developed for assets not included within the priority types proposed above of rare species, rare communities, and representative landscapes (see Section 3.3.2).

5. The greater part of State Government salinity funds for biodiversity conservation is allocated in 2003–04 to the priorities (threatened species, threatened communities, and Tier 1 representative landscapes) identified by this document. Given that the recovery of few additional landscapes can be started in any one financial year, the allocation of funds will depend on additional criteria and risk assessment to rank Tier 1 representative landscapes in order of priority for action. In the case of threatened species and communities, those that are critically endangered and threatened by salinity are the recommended priority for action. (Note, there are technical issues that need to be resolved before the threatened species and communities data can be fully integrated with Land Monitor data.)

6. Depending on the final outcome of SIF work with the Avon Catchment Council, results from this work are extended to other regional NRM groups.

Priority setting is a continuing process to be reviewed on the basis of new knowledge and technical information. Some of the above recommendations reflect the need to begin the process of review now, both of this methodology and of the allocation of specific priorities. Either reallocation of existing funds, or allocation of new funds, will be needed to develop and implement SIF processes.

4 Water resources

4.1 Introduction

The methodology for identifying high-importance water resource assets is consistent with that identified in Section 2.1.3. It was built upon the approach developed by WRC (2002a) to identify waterway management priorities in Western Australia. The approach was based on the State Waterways Needs Assessment methodology, which utilised stakeholders and water resource experts in collecting information on waterways and determining priorities for management.

The method developed for the water resource asset class involved a guided expert panel to assess a range of different attributes for the various water resource asset items. The expert panels were given access to published and spatial data when scoring criteria. The expert panels were then given an opportunity to review the results.

4.2 The process

The process for classifying water resource assets collected more than just value and threat information for each asset. A full description of the process can be found in McAlinden, et al. (in prep).

4.2.1 The goal

The water resource asset goal focused on delivering human values related to environmental, social and economic outcomes. Water resource assets were divided into two subclasses: water supply and waterscape (wetlands and waterways). Hence, two broad goals have been developed for the water resource asset class.

1. Protect, manage and restore present and future water supplies from the impacts of salinity.
2. Protect, conserve and restore significant waterscapes (wetland and waterway ecosystems) from the impacts of salinity.

4.2.2 The value

The expert panels were given an opportunity to identify assets after an initial list was provided as a starting point. The expert panels were presented with water assets identified in:

- legislation
- international, national and state policies and agreements
- state reports and investigations.

Generally, most water resource assets have more than one associated value. It was considered important to acknowledge and score these multiple values. Values were grouped into three broad categories — economic, social and environmental. Each of these categories is further explained in '*Identification of Important Water Resource Assets — South West Agricultural Region* (McAlinden et al. (in prep).

The expert panels were asked to score the specific assets using a scale of **1** to **5**, or **unknown**.

1 = None, the attribute does not contribute to the value of the asset.

2 = Minor, the attribute contributes to the asset at a local level.

3 = Moderate, the attribute contributes to the value of the asset at a local and regional scale.

4 = Important, the attribute contributes to the value of the asset at local, regional and state scale.

5 = Significant, attribute contributes to the value of the asset at a local, regional, state and national level.

Unknown, unable to answer.

After scoring each value (economic, social and environment) independently, the expert panel was asked to score an asset's overall value considering all categories. The scale for overall value was the same as that described for environment, social and economic values above. The score was either the highest scoring subvalue (if it was considered to be that important) or an average of all three (if they could not be separated). A maximum of 20 points could be obtained by combining all four scores for value. A score of one was equivalent to a value of zero thus scores of one were converted to zero.

For presentation in the value–threat matrix low, medium and high values were defined using the scores defined above.

Score	Value
1–9	Low
10–14	Medium
15–20	High

4.2.3 Threat

Referring to the value scores obtained from the section above, the expert panel then made an assessment of the threat from salinity to the asset. The expert panels were asked to score the salinity threat using the following threat scale.

1 = None there is no threat on the value from salinity or the value is already significantly affected by salinity and not expected to get any worse.

2 = Minor salinity threat is likely to occur in 75 years or more.

3 = Moderate salinity impacts will occur in 20 to 75 years.

4 = Severe salinity threat will occur over within 20 years.

5 = Extreme impact is imminent and substantial and will occur within the next 5 years.

Unknown = unable to answer the question.

In their deliberations on threat the expert panels had access to spatial datasets including:

- *Prediction of areas at risk of salinity*
- *Stream salinity trend data*
- *Stream salinity classification for the southwest of Western Australia*
- *Catchment boundaries and stream data*
- *Remnant vegetation*
- *Groundwater trend data*
- *Rainfall isohyets for Western Australia*

Three broad groups of threat were then defined so that the information could be presented in the value–threat matrix shown in Figure 2.4. The five scores defined above were allocated to the three threat groups.

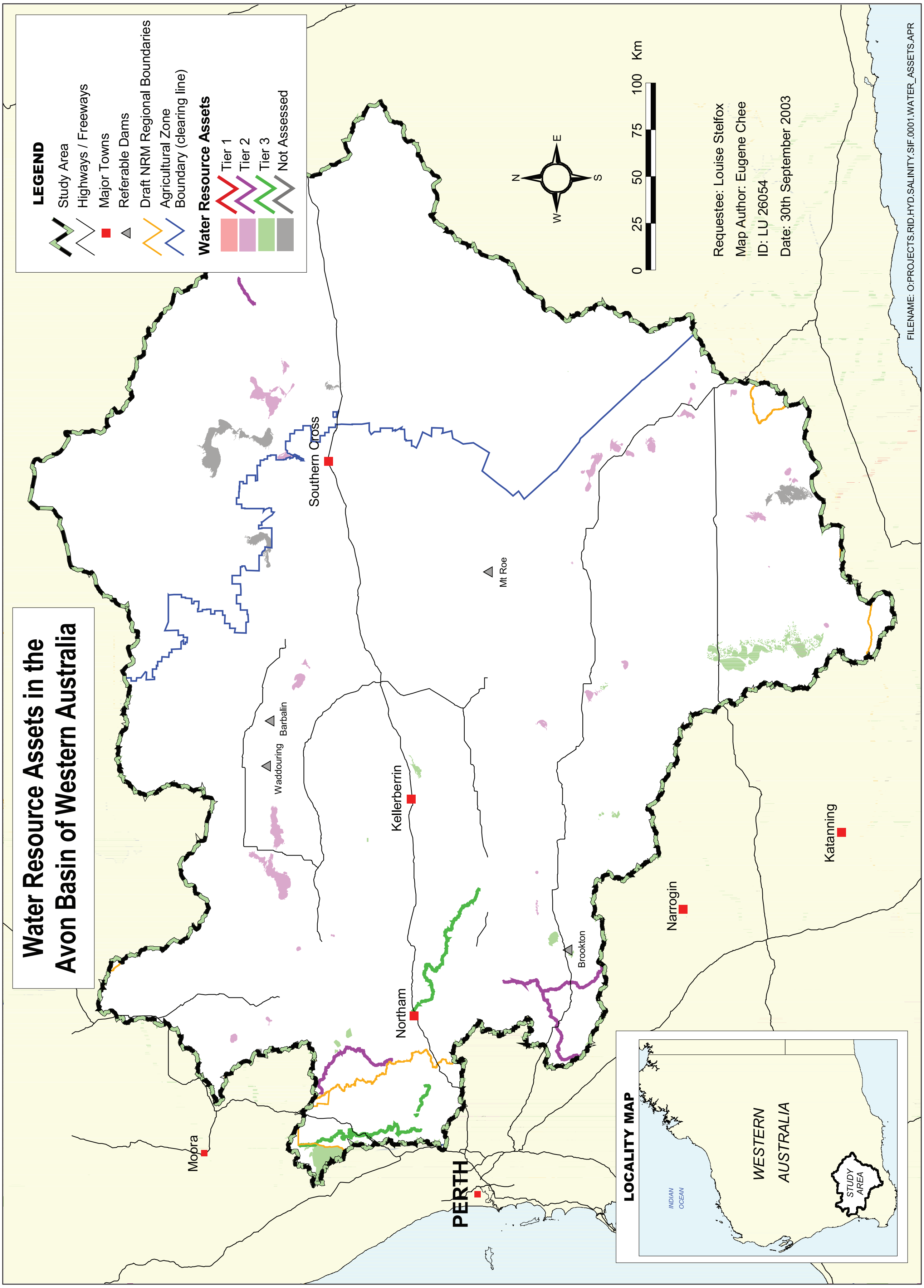

Figure 4.1 The state defined assets that fall within the Avon Basin

Score	Threat	Description
1–2	**Low**	Threat is long term, will occur after 2075, or the asset is already significantly impacted.
3	**Medium**	Intermediate time and/or not that greater extent. Impacts will occur between 2020 and 2075.
4–5	**High**	Existing and/or near and substantial. Threat will occur by the year 2020.

4.3 The outputs

4.3.1 High-importance assets

Appendix 3 lists water supply waterscape and waterscape assets identified across the South West Agricultural Zone. These have been allocated to the three tiers (shown in Fig. 2.4) as defined by the expert panels. Appendix 3 also lists those assets identified within the Avon Basin according to their relevant tiers as defined by the expert panels. Figure 4.1 shows the state-defined assets that fall within the Avon catchment.

4.3.2 General points

This process has been developed by the Department of Environment (formerly the Water and Rivers Commission) for the identification of important asset items at a state level within the South West Agricultural Zone. Representation on expert panels has been limited to officers within the Department of Environment. Prior to any investment decisions, a wider audience including community representatives should review the information contained in this report. It is important to note that success of the expert panel is dependent on participation of people with broad knowledge of a range of assets rather than detailed knowledge of a small number of individual assets.

The list of assets developed through this process to meet state goals will be different from those identified at a regional scale to achieve regional goals. A process needs to be created or adapted to deal with those asset items considered important at a regional and local scale.

This state assessment was based on the knowledge of the expert panels, the published reports and spatial information available at the time. The assessment should be reviewed as new information becomes available.

The tier ranking of assets identified in Appendix 3 does not represent a final priority ranking for investment. Further information on feasibility is required before investment decisions can be finalised. Information on threats other than salinity, separate goals for specific assets, management options, economic viability, technical feasibility and social acceptability information collected through the expert panel will provide a good starting point for further investigations into feasibility.

4.4 Recommendations

Recommendations from the water resources project group to the SIF Steering Committee:

1. This process and its results should undergo review by the community or representatives from the community.
2. As new information on asset value and salinity threat becomes available it should be incorporated into this process and results modified accordingly.
3. The results of this report do not represent a final priority ranking for investment. Further investigations on feasibility should be completed.
4. The assets identified by this report represent a state perspective. Assets not identified by this report are also important, although a different process should be developed to rank them.

5 Agricultural land and rural infrastructure

5.1 Introduction

The outputs from this assessment of salinity impacts on agricultural land[9] and rural infrastructure are:

- a spatial representation of areas of land and infrastructure currently affected (AOCLP) and at risk (AHAVF)
- value at risk (where possible)
- technically feasible treatments
- probability of adoption of those options
- economic analysis.

5.2 The process

5.2.1 Assessment of the extent and trends in salinity of agricultural land

Land Monitor (a satellite-based assessment and mapping program of salinity, topography and vegetation extent and change; <www.landmonitor.wa.gov.au>) and National Land and Water Resources Audit (NLWRA, <www.nlwra.gov.au>) datasets were compiled and an assessment made of the impact of salinity on agriculture and infrastructure related assets.

5.2.2 Townsite infrastructure

Rural Towns Program salinity data were assessed to determine the urgency and degree of risk in towns according to population and time to impact of salinity on infrastructure. This was based on data gathered in the Community Bores Project (a series of comprehensive groundwater studies covering 38 towns), short and longer-term groundwater trends, salinity prediction modelling and economic analysis tools as required. Priorities for investment were based on the town's population (as a guide to infrastructure value and risk) and time to risk (as a guide to urgency).

An Economic Impacts of Salinity on Townsite Infrastructure study (URS, 2001), was undertaken by the DoA in 2001. The assessment, which included a cost-benefit analysis, was conducted on six representative towns to quantify the economic impacts of salinity on townsite infrastructure with considerably more precision than a simple index. The intention is to complete the economic assessment for the remaining 32 towns in the Rural Towns Program to permit a more accurate ranking of townsite salinity risk.

5.2.3 Road and rail

The lengths of road assets at risk were classified according to classes used in the NLWRA and as provided by Main Roads WA. Four classes of road were assessed: highways, main, local and unclassified roads. Of these classes, all but unclassified roads have a clear definition and could be easily mapped. Unclassified

[9] As presented in the Glossary, 'agricultural land' refers to those specific areas of the landscape that are able to be used for agricultural production. In the case of a single farm, the agricultural land only includes the hectares that are cleared for annual crop and pasture production.

roads include some unsealed shire roads, but also include roads within public land, and so-called unmade roads on private land. Differing classes of railway assets were neither provided nor assessed. Lengths of assets that pass through areas classified as currently affected (AOCLP) or at risk (AHAVF), were calculated

5.2.4 Treatments options

An assessment of the range of options for salinity management was undertaken for each of the soil–landscape zones. The options assessed include engineering and plant-based practices, or systems of practices that already exist, which will deliver the maximum impact on the extent and severity of saline land. The matrix of generic options nominated for each of the soil–landscape zones is provided in Appendix 4.

To assess the area of land currently affected by salinity and at risk in each zone, three datasets were collected and collated in terms of the three goal-based criteria defined in the State Salinity Action Plan (2000): Recovery, Containment and Adaptation.

1. Timing of salinity

The average time required for a zone to reach hydraulic equilibrium (when water levels in areas of risk cease to rise) was assessed on the basis of available raw data. This was based on analysis prepared for the National Land and Water Resources Audit (Short and McConnell, 2000), and includes average depth to groundwater and rate of rise. The assessment also considered available numeric modelling to determine when the systems would come to effective equilibrium[9] in terms of the area at risk of salinity.

Rating scale — Urgency

0 No significant problems from salinity
1 Most potential salinity after 2075
2 Most potential salinity after 2030 and before 2075
3 Most potential salinity after 2020 and before 2030
4 Most potential salinity after 2010 and before 2020
5 Most potential salinity at or before 2010

2. Technical feasibility

Technical feasibility (TF) is a measure of the availability and capacity of salinity management options to recover, contain or allow adaptation of salt-affected land or those at risk. The factors are largely qualitative, but are based on available published data and supported by assessments of each of the regional hydrologists. In particular, the technical factors are based on the average response of the entire zone, not a specific part.

It must therefore be noted that whereas it was considered that with unlimited money and time it is technically possible to reclaim nearly all areas of dryland salinity, in practice, the technical feasibility is constrained by an array of factors. The principal factors taken into consideration are represented below as key questions.

- Is the practice or series of practices possible according to the physical conditions of the soil–landscape zone?
- Is the practice appropriate across most of the zone?
- Will implementation of the practice lead to impact within a reasonable timeframe?
- Has the practice been modelled or demonstrated to be effective in that zone?

[9] Effective equilibrium means that although groundwater levels may continue to rise in elevated areas, the area of discharge has come to equilibrium. This implies the rate of discharge per unit area may continue to increase after this point. It may take from as little as a few years to millennia for salt to come to equilibrium.

- Are there major offsite issues or downstream impacts that would prevent development.

Rating scale — Technical feasibility

0 Not applicable
1 Very Low (0.1)
2 Low (0.175)
3 Moderate (0.375)
4 Good (0.625)
5 Excellent (> 0.75)

Technical factors are thus a spatially averaged indication of effectiveness and exist within the context of our current scientific knowledge of the impact of salinity management options. They can be assessed under current technical criteria (e.g. TF1a) or using factors expected to be developed over time (e.g. TF1b). The factors used in this analysis are generic and must be reviewed when applied to specific cases (local scale), and reviewed over time (as knowledge builds).

3. Probability of adoption

The probability of adoption was also based on soil–landscape zones, results of the '… effectiveness and adoptability…' surveys undertaken as part of the National Land and Water Resources Audit (McConnell 2001) and the hydrologists' current assessment of the likelihood/probability of an option or suite of options being adopted.

As with technical feasibility, the adoption of practices or systems is dependent on a wide array of issues. The principal issues are represented below as key questions:

- Is the practice viable and affordable (cost effective)?
- Can the practice be easily adopted (advice, support, regulations etc)?
- Does the practice fit within the context of the current farming systems?
- Does the practice or system fit with the skills and aspirations of the farm owner?
- Are there major offsite issues or downstream impacts that would prevent adoption?

Details of the rating methods used and the determination of areas of impact are shown in Appendix 4.

5.2.5 Infrastructure

Rural towns

The 38 rural towns in the Rural Towns Program (RTP) were analysed. Rates of groundwater rise were calculated from existing datasets or from bores nearby, and a time to impact established. The extent of current salinity and town areas at risk was derived from the Land Monitor datasets. However, the datasets provided proved to be inaccurate at the scale required. The actual area of townsite salinity was small when compared with broadacre farming areas, water catchment areas and regions of high biodiversity value. Until all townsites at risk from salinity have been analysed in terms of the economic impact, a surrogate relationship has been defined to enable an estimate to be made of the risk to towns and of the priority for investment.

Roads

Department of Main Roads' estimates of repair and maintenance costs (Jerome Goh 2002, pers. comm.) and road classification system were used to assess the costs of salinity on roads. Roads were classified into four groups (highways, main roads, local and unclassified roads). The length of roads in each class was assessed with the areas of AOCLP and AHAVF. Only the raw[11] Land Monitor data were used to estimate lengths affected or at risk.

Railways

The length of railways assessed to be in areas classified as currently affected (AOCLP) or at risk (AHAVF) were calculated. Raw Land Monitor data were used. The costs of management were determined by methods documented in RTP studies (URS, 2001) which defined the two critical depth indicators (watertable as < 1.5 m and < 0.5 m). The costs in each class were assessed.

5.2.6 Economic analyses

Assessment of the benefits to agricultural land of the salinity investments utilised the estimated impact of adopting technically feasible practices provided by regional hydrologists. The benefits are the present value of a forecast stream of additional profits (and losses avoided) of farm businesses on each of the three land classes (R, C, A) in each zone.

The net profits from management of the land classes (e.g. recovery area) in the soil–landscape zones depend on the rate of change in the areas of these land classes prior to equilibrium, and on the profit difference between land practices on these areas, made possible by salinity investment compared with land practices when no salinity investment occurs. For example, on lands affected by salinity, now and in the future, farmers could generate additional profit due to the current findings for improved management of saline land. Much greater profits would be possible on lands that would otherwise become saline were it not for public investment in salinity management. Also on lands that are salt-affected, yet which are recovered due to public investment, larger gains in profitability will be experienced.

The estimation of these benefits from salinity management depends on describing a flow of farm profits through time, then expressing this flow in present value terms. The formula for deriving those benefits is not simple as it must allow for discounting, different profit flows depending on land class types, areas and rates of change in areas, zonal location, intervals to hydrological equilibrium or steady-state conditions, and in-perpetuity benefits.

5.3 The outputs

5.3.1 High-importance assets

Appendix 4 presents the full outputs from the analysis. Figures 5.1 to 5.3 locate the soil–landscape zones within a value–threat matrices for land value, calculated according to productive ability and market demand, and road value.

5.3.2 General points

The following main conclusions can be drawn from this analysis.

1. Salinity either currently affects or threatens large areas of agricultural land and many sites containing high-value infrastructure.

2. Most of the benefits (and losses avoided) for farmers from the adoption of factors assessed in this review stem from the containment of salinity. Benefits from recovery of salt-affected areas are imputed to be higher than those for the improved management of saline areas, although this dependent on actual costs of recovery.

[11] Land Monitor data used in this analysis was that provided to the DoA in late 2002, and did not include the final analysis for the Dumbleyung and Jackson scenes. It was considered that this would not significantly influence the results of this analysis.

Value Vs. Threat		**Value of Land (PV Gross Benefit)**		
		High (> $20m)	**Medium ($10–20m)**	**Low (< $10m)**
Threat to Land (Years)	Imminent < 20 years **(high threat)**	Warren-Denmark Dandaragan Western Darling Range Bassendean	Jerramungup Plain	Chapman Stirling Range Coastal Dune Pinjarra Plain
	20–75 years **(medium threat)**	Esperance Sandplain S. Rejuvenated Drainage Eastern Darling Range North Rejuvenated Drainage North Ancient Drainage SW Ancient Drainage	Pallinup Plain SE Ancient Drainage	Irwin River Albany Sandplain Lockier Ravensthorpe Pt Gregory Coastal Arrowsmith Kalbarri Victoria Plateau
	> 75 years or asset significantly affected **(low threat)**	Nil	Nil	Salmon Gums Southern Cross

Figure 5.1 Value of land (PV of gross benefit)

Value Vs. Threat		**Value of Land (PV Gross Benefit)**		
		High (> $100/ha)	**Medium ($50–100/ha)**	**Low (< $50/ha)**
Threat to Land (Years)	Imminent < 20 years **(high threat)**	Warren-Denmark (195) Bassendean (161) Western Darling Range (119)	Dandaragan (71) Stirling Range (58)	Chapman (31) Jerramungup Plain (36) Coastal Dune (0) Pinjarra Plain (0)
	20–75 years **(medium threat)**	Nil	Esperance Sandplain (92) Eastern Darling Range (58) S. Rejuvenated Drainage (57)	Pallinup Plain (49) North Rejuvenated Drainage (40) SW Ancient Drainage (17) Ravensthorpe (14) Lockier (11) Irwin River (11) North Ancient Drainage (8) SE Ancient Drainage (8) Pt Gregory Coastal (6) Albany Sandplain (3) Arrowsmith (0) Victoria Plateau (0) Kalbarri (0)
	> 75 years or asset significantly affected **(low threat)**	Nil	Nil	Salmon Gums (4) Southern Cross (2)

Figure 5.2 Value of land ($/ha)

Value Vs. Threat		Value of Land (PV Gross Benefit)		
		High (> $10m)	**Medium ($5–10m)**	**Low (< $5m)**
Threat to Land (Years)	Imminent < 20 years **(high threat)**	Warren-Denmark	Western Darling Range	Chapman Stirling Range Jerramungup Plain Dandaragan Pinjarra Plain Coastal Dune
	20–75 years **(medium threat)**	Nil	Albany Sandplain Esperance Sandplain Victoria Plateau	Pallinup Lockier Ravensthorpe Kalbarri Pt Gregory Coastal Arrowsmith
	> 75 years or asset significantly affected **(low threat)**	Nil	Salmon Gums	Southern Cross

Figure 5.3 Value of rural roads

3. There is a high degree of variability between the zones where benefits were incurred (or losses avoided), with many eastern zones having a lower return on investment than those to the west. Net return per hectare needs to be considered along with return per zone.
4. Improving either the technical feasibility or adoption greatly boosts the potential returns on investment in many zones.
5. Further analysis of the economics is warranted as this analysis was undertaken only at regional scale and was related to agriculture and infrastructure alone. A transparent analytical tool is required that allows further sensitivity analysis to be undertaken, and regional variations better accounted for.

5.4 Recommendations

Additional benefits from salinity management that are not included in this report are on-farm public benefits (e.g. biodiversity benefits of remnant vegetation) and off-farm public benefits (e.g. social aspects, water quality), as well as some further off-farm private and public benefits such as protection of rural towns. As a result, the outcomes of this study need to be reviewed alongside those of DoE and DCLM.

This analysis also needs to be complemented by an analysis of the additional ‘flow on’ impacts of salinity management, in particular in downstream processing (agribusiness, food, manufacturing), employment and regional development. Land management in areas at risk of salinity must be seen in a wider context than ‘salinity only’ investment considered here.

In particular, account needs to be given of the benefits that may flow from the adoption of salinity management practices on other NRM issues (e.g. waterlogging, acidification, and erosion).

6 Social assets

6.1 Introduction

The Steering Committee decided that, at the state scale, social assets needed to be considered alongside the biophysical and economic assets identified in Sections 3 to 5, but was keen to get input from the Regional Workshops (described in Section 2.3.3) on this non-tangible category.

The Regional Workshops gave specific attention to the social assets. All four workshops were able to define social assets in the context of salinity threats and management, and in three of the four workshops these assets were seen as being highest priority as targets for investment in salinity management.

The regional communities' definitions of social assets revolved around the critical populations in rural communities, the quality of communications, internal and external networks, levels of service provision for farm businesses, knowledge and skills in agricultural management, health and education services and the pivotal role of recreational pursuits in maintaining a sense of community. Cultural and spiritual assets received attention — both those based on natural features of the landscape and those derived from built infrastructure. In particular, indigenous heritage is receiving attention and is being recognised for its importance.

Overall, the view was that the impact of salinity as an additional force on trends affecting social and socio-economic assets was seen as marginal. Other forces such as declining terms of trade, improved communications and the replacement of labour by technology are far larger influences, for better and for worse, on how the region functions. However, maintaining and strengthening the ability of the social and socio-economic assets — broadly described as the community's capacity — to manage salinity impacts was seen as being of very high priority for salinity investment.

The conclusion from the first Regional Workshops was that social assets needed to be included as a distinctive asset class — broadly defined as the 'social wealth' or 'social capital' available at state, regional and local scales to address salinity threats. Enhancement of the social assets is seen as being critical in delivering capacity to address the threat posed by salinity to all asset types — such as biodiversity and land. The State SIF Steering Committee decided to develop a series of social asset categories for inclusion in the state framework.

6.2 The process

The SIF Steering Committee established a subcommittee to use the outcomes from the Regional Workshops and define social assets for consideration in the state and regional priority setting processes. The subcommittee addressed the following points.

- What are the social and socio-economic assets that are relevant in salinity management?
- What is the condition of these social and socio-economic assets — how well are they able to deal with salinity issues?
- How can the state SIF process deal with social and socio-economic assets?

The subcommittee also referred to available literature on social assets. *Focus on the Future — the WA State Sustainability Strategy*, a draft consultation paper has as its goal for 'Sustainability and community' — 'Support communities to fully participate in achieving a sustainable future' (Government of WA 2002, p. 164). The draft *Regional Policy Statement* includes strategies aimed at supporting communities involved in natural resource management (Department of Local Government and Regional Development 2003).

Many recent so-called 'triple-bottom line' reports have attempted to define, describe and measure social assets. The Australia Institute <www.tai.org.au> defines categories of 'human capital' and 'social capital' that deal in part with how a community behaves and performs. *Minnesota Milestones* <www.mnplan.state.mn.us> and *Tasmania Together* are examples of the many state/local reports that value social capital through goals and indicators for categories such as sense of community, volunteerism, and support for each other.

Commitment to investment in social assets is contained in the resource allocation framework developed by the Natural Resource Management Council and the State Investment Committee (see Section 2.4.6), which identifies 'Capacity Building' as one of the five programs through which investment will be directed.

6.3 The outputs

The Salinity Investment Framework Steering Committee commissioned an investigation of relevant social assets to be considered in the SIF process at state and regional scales. The following sections are taken from '*Defining social assets for the Salinity Investment Framework*' (URS 2003b). A full copy of this report is presented in Appendix 5.

6.3.1 High-importance assets

The report prepared by URS (2003b) presents types and items for the social and socio-economic assets, together with aspirational goals, rules for allocating priorities, and data sources. Although considered originally in the context of salinity threats and management, the assets are presented within the wider context of NRM. The social assets are summarised in Table 6.1. Detailed descriptions are provided in the full report.

Table 6.1 Social assets

Asset type	Asset items
Knowledge and skills	Knowledge and skills available
	Ability to grow knowledge and skills
	Robustness and availability
Values/culture	NRM values
	Sense of place, cultural heritage
	Robustness, persistence, resilience and availability
Community well-being	Community health
	Cohesiveness
Networks/organisations	NRM values
	Quality of social interaction
	Information flow
	Learning capacity
Economic resources	Investment available from businesses reliant on natural resources
	Investment available from sources not reliant on the natural resources
Governance capacity	Governance capacity

6.3.2 General points

An assumption made in this analysis is that 'social assets' are in alignment with underlying NRM values as reflected in goals and strategies. Social assets are not absolute assets, they are not 'value-free'. They need to be considered in the context of their NRM relevance and for the contribution they can make to salinity management. For example, 'cultural values' as a social asset can have more or less desirable characteristics in respect of NRM goals. Examples of less desirable underlying cultural values may be strongly held prejudices against participative and inclusive processes for establishing community goals and objectives. Conversely, cultural values that include an encouragement of new ideas or a willingness to embrace change are more desirable characteristics in relation to NRM goals. Another, simpler example is where one view held is that saline land is useless and ruined, whereas another view will be that saline land has potential for saltland grazing. Finally, community commitment to values that include a long-term view of landscape productivity and biodiversity protection will support more appropriate investment and management than values that emphasise short-term profit maximisation.

6.4 Recommendations

The social assets subcommittee recommended the following to the SIF Steering Committee:

1. The first Regional Workshops in the Avon concluded that social assets needed to be included as a distinctive asset class — broadly defined as the 'social wealth' or 'social capital' available at state, regional and local scales to address salinity threats.
2. Enhancement of the social assets is seen as being critical in delivering capacity to address the threat posed by salinity to all asset types — such as biodiversity and agricultural land.
3. The descriptions of the social assets will provide guidance and data to the SIF Steering Committee in identifying the key priorities for industry development and capacity building through the NRM Resource Allocation Framework.

7 Discussion

7.1 Progress through Phase 1

Considerable progress has been made towards achieving the SIF outcomes. Achievements to date are as follows.

- A Salinity Investment Framework Steering Committee to manage the process has been established. The Committee comprises senior officers from responsible agencies and representatives from the Avon Catchment Council. The Steering Committee is chaired by Rachel Siewert, a Member of the Natural Resource Management Council, and Coordinator of the Conservation Council of WA.
- An over-arching process for identification of high-importance assets based on value and threat information has been developed, and applied across the state's agricultural areas. This has also been used by the Senior Officers Group to identify high-importance assets in a Natural Resource Management context across Western Australia (Sections 3 to 5).
- There are individual processes for identifying high-importance assets at threat from salinity within the following classes:
  - – Biodiversity
  - – Water resources
  - – Agricultural land
  - – Rural infrastructure
  - – Social assets

For each of the above asset classes, broad groups of high-importance assets have been identified at a state (South West Agricultural Zone) level.

- There is a strong multi-agency and community-based team with an appreciation of the challenging nature of the task at hand and a strong commitment to producing a tool to help achieve accreditation of Regional Plans.
- The Avon Catchment Council have committed to use similar processes in identifying strategic directions for investment through the NRM Strategy being prepared for the Avon Region.

7.2 Comparing outputs from state and Avon processes

Section 2.1.4 outlines the issues related to asset valuation by different communities of interest. Sections 3 to 6 document processes and outputs from asset valuations undertaken at state scale. The Avon regional workshops described in Section 2.3.3 began the task of valuing assets based on regional goals, and also provided critique on the state processes.

Table 7.1 provides a summary comparison of the outputs from the two processes. The presentation of regional outputs is drawn from the subregional workshops report (URS 2002).

At the state scale, the focus is on achieving the broad state goals that have been set by the whole Western Australian community. For biodiversity and water categories, individual areas and places are being identified that will contribute best to achieving the state goals. For agricultural land, the economic costs of repairing, or preventing or managing salinity have been estimated at broad landscape scale, with suggestions for how this might develop into 'best-bet' recommendations for management and investment into industry

Table 7.1 Comparing state and regional assets

Asset Class	State outputs	Regional outputs
Agricultural land	Land values and productivity at soil–landscape zone scale used to determine best land use/ management strategy. Avon region included across two regions. Agricultural land assessed for its market value in four classes • Not impacted by salinity • Salt spotted • Poorer saline grazing land • Bare salt lands Importance of industry development	Very high value attached to: • Most productive agricultural land (20–30%) • Other agricultural land (70–80%) • Saline land
Biodiversity	Key assets are: • rare ecological communities • rare species • high priority representative landscapes, including significant wetlands.	High value attached to: • remnant bushland of all sizes • granite rock outcrops
Water	Definition of: • important public potable water supplies • wetlands of international/national/ state significance • wild rivers, high quality riparian vegetation	High value attached to: • granite catchments • public potable water supplies • private water supplies • wetlands of all sizes • some types of salt lakes • drainage lines/river systems
Infrastructure	• ranking of towns by population and level of risk from rising groundwater levels • costs determined for maintaining road and rail infrastructure	High value attached to: • towns • all classes of linear infrastructure • water-management infrastructure • infrastructure with heritage values
Social	Regional categories adopted and expanded — investment through NRM programs into • knowledge and skills • values/culture • community well-being • networks/organisations • economic resources • governance capacity	Very high value attached to: • community capacity (knowledge and skills, ability to manage change, financial security, viability) • natural heritage • built and cultural heritage • services and facilities • networks/organisations • financial security, viability

development. The same approach has been used for road and rail infrastructure, with rural towns ranked for importance according to their size and the degree of salinity threat.

At the regional scale, the focus is on achieving goals of importance to local, subregional and regional stakeholders. Through the workshops already held, asset classes and types have been defined, and a start has been made on setting specific goals and identifying some broad priorities. Agricultural land has been considered in three general classes — the most productive land (20–30%) that generates most (70–80%) of the economic return (e.g. broad wheatbelt valleys), the remainder of the farmed land, and the areas affected by salinity. Given the general scarcity of remnant bushland and wetlands in the Avon, regional communities are keen to see a high priority attached to their conservation, with particular note of some special environments, such as granite rock outcrops and salt lakes. Protection of rural infrastructures is important. Overall though, the highest priority is attached to ensuring that the social, community and economic capacity is supported and increased — a critical element in managing salinity.

As a result of the regional workshops' recommendations, the social and economic assets have been assessed and defined through the state-level process (as discussed in Section 6). As a result of recommendations from regional workshops, locations for European and indigenous heritage have already been captured and included as individual asset items.

7.3 Comparing asset classes

The asset classes fall into three main categories — biophysical (biodiversity, water resources), economic (agricultural land, infrastructure) and social (human and social capacity). Building a comprehensive framework that includes these asset classes will be important in deciding overall investment allocations. Some important considerations are:

- Each asset class has different values and threats, but it is possible to allocate these asset items into separate value–threat matrices and identify three tiers of priority.
- Some assets cannot have dollar values easily defined, particularly biodiversity and to some extent water resources. However, state goals for these assets allow the use of biological conservation principles and expert judgment to identify levels of importance.
- Agricultural land and rural infrastructure can be analysed for the economic value and cost of salinity impacts in determining appropriate strategies for managing salinity. Containment is likely to be the economically most sensible strategy for most of the agricultural land in the wheatbelt, with industry development the best use of public investment to achieve this aim. Strategies for rural infrastructure will vary according to specific situations.
- Investment in enhancing the social assets will proceed through a range of mechanisms. Building the networks and NRM values will emerge from the capacity building program in the state NRM allocation framework. Knowledge and skills development in salinity management will be funded through the industry development program in the framework. Outside NRM investment, programs in regional development will contribute to community well-being, and cohesiveness. Achieving further alignment between investments in this area can be facilitated at the regional scale.

7.4 Spatial aggregation across asset classes

Previous discussions document the separate processes used to establish priorities within the biophysical asset classes of biodiversity, water resources, productive agricultural land and rural infrastructure. These processes have been managed independently to date, although the spatial aggregation of items from different classes — the so-called 'pizza approach' — is being explored. This, or some other process, will be needed for direct comparison between asset classes, to allow for allocating priorities between classes (e.g. between biodiversity and water asset items) as well as within each class. This will be a task for the next phase of the work.

7.5 Integrating investment in industry development

The SIF methodology currently focuses on individual asset items and their priority for actions directed as recovery, containment and adaptation. The primary purpose is to identify targets for *direct* intervention using public funds to protect specific asset of public value from salinity — also termed as targeted on-ground works.

The *State Salinity Strategy* (Government of WA 2000) also highlights the importance of investment into land use and management practices, termed here 'industry development', that will improve the social and economic benefits flowing from actions taken to protect assets from salinity impacts. *Indirect* investment into industry development is required for two purposes.

- Where assets with mainly private values are endangered, the main role for public funds will be developing technologies and capacity to be used by the owners of these assets in managing the salinity threat.
- Where assets of high public value are at risk, and where the feasibility of direct intervention is low, indirect investment in industry development will 'lower the bar'. Industry development should provide a wider array of economically and socially rewarding actions to prevent or at least inhibit salinity impacts, resulting in these assets becoming more amenable to direct intervention in the future.

An example of industry development is the work being done in the oil mallee industry, which is aimed at generating new economic, social and environmental benefits from the establishment of oil mallees and processing plants in the wheatbelt. Another example is the investment in saltland pastures development, which aims to improve the economics of farming saline land.

An important decision at state and regional scales will be determining the ratio between investment in direct intervention in targeted on-ground works and indirect investment in industry development. Resource allocation for NRM will need to consider the balance between the two forms of investment at state scale (see Section 2.4.6) and at regional scale (see Section 8.2.2. for the Avon Catchment Council's approach). At another level of decision-making, it will be important to use feasibility information in determining how priorities are set for industry development. Further work in progressing these decision-making needs will be a task for Phase II of the project.

8 Progressing the Salinity Investment Framework

Throughout this report it has been highlighted that there is further work required to fully implement the Salinity Investment Framework process at state and regional scales. The following sections summarise the work to be completed in setting the state priorities in the second phase of the SIF project, and the implementation of the process at regional scale in the Avon Region by the Avon Catchment Council. Finally, recommendations for the SIF process are provided.

8.1 Phase 2 at state scale

The task has been more challenging than was appreciated at its inception. This has been acknowledged by all who have contributed to the process.

A second phase of the SIF project will develop the more detailed levels of information required and at the regional scale a priority listing of projects for the Avon NRM region will be identified. The process will be used to assist in setting priorities for all regional NRM strategies. Proposed products from Phase II will include:

- a method for identifying assets of high-importance at a regional level
- a method for collecting feasibility information on high-importance assets at state and regional scales
- a process for deciding priority and importance between asset classes
- a process for determining the appropriate level of investment in industry development at state scale
- a process for making a final investment decision at the regional scale
- a list of investment priorities for the state

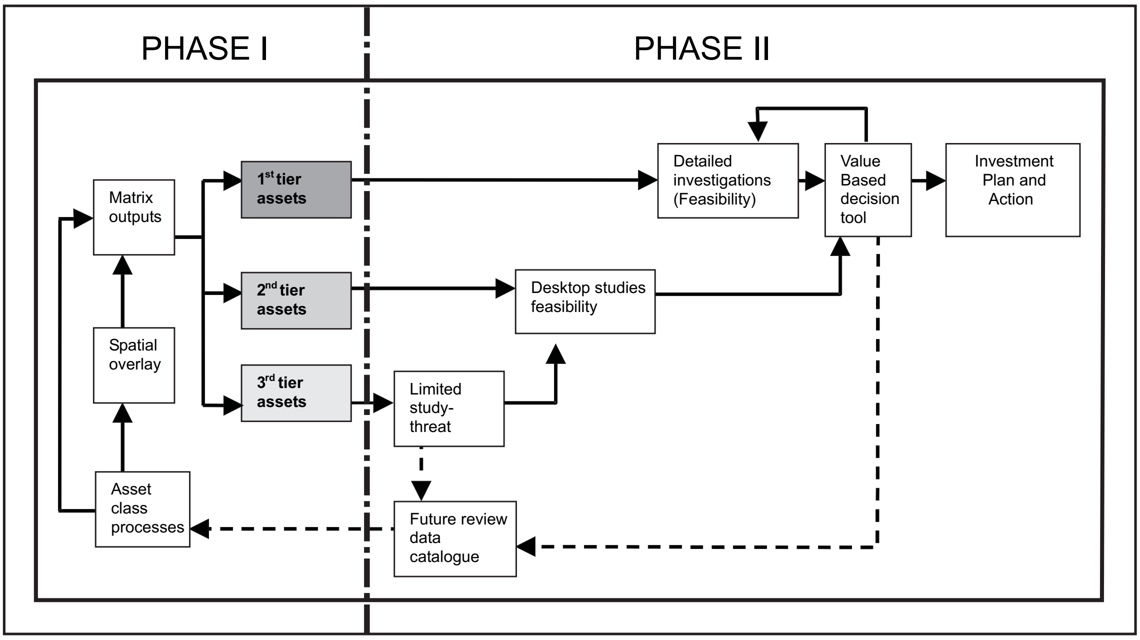

Figure 8.1 Diagrammatic representation of the Salinity Investment Framework, the work completed (Phase 1, except for spatial analysis) and further work required (Phase 2)

- a list of investment priorities for the Avon Region.

Figure 8.1 illustrates diagrammatically the process for identifying assets into three tiers and the relevant workload for each of these tiers through to final action.

8.1.1 Spatial overlay — integrating across asset classes

This approach needs further refinement in Phase II. Recommended further work includes:

- expanding on the spatial overlay approach to consider multiple values of assets from different classes located within close proximity
- developing a tool that guides final investment decisions
- apply the value–threat matrix to the Avon scale using regional goals and perspectives to identify high-importance assets at that scale.

8.1.2 Feasibility information

The collection and analysis of 'feasibility information' will use expert panels, which may include engineers, ecologists, hydrologists, social scientists, agricultural scientists, economists, and land managers. Similarly, guided questionnaires to community representatives with appropriate backgrounds in natural resource management may augment and cross validate the information gathering.

8.1.3 Decisions across asset classes

Implementation of a multi-criteria analysis (MCA) tool to help make decisions in investment allocation for the SIF has not been confirmed. Consideration of MCA data requirements should be made in all future work on the SIF project.

Failing the use of the MCA approach, another decision support tool should be developed that uses the value, threat, and feasibility information to identify priority assets. The capacity to compare between asset classes is a characteristic that needs to be considered in choosing the decision support tool.

8.1.4 Private assets and the social link

Enhancement of the social assets is seen as critical in delivering capacity to address the threat posed by salinity to all asset types — such as biodiversity and land. Industry development and capacity building need to be assessed in relation to protecting valuable agricultural land, and improving agricultural practice in a way that protects public assets. The descriptions of the social assets summarised in Section 6 provide valuable guidance and data to the SIF Steering Committee in identifying the key priorities for industry development and capacity building.

8.2 Developing the Avon regional process

The next important step is to develop or adapt the SIF processes to identify important assets at a regional scale.

The Draft Natural Resource Management Plan for the Avon River Basin released in 2000 contains a *Vision and Goals for natural resources*, which is sufficient to guide the process at whole-of-region scale. It has been recognised that the Avon goals include biodiversity, water, and land assets. The goals do not incorporate infrastructure and social issues. The ACC will investigate the development of goals related to these assets. Specific actions recommended for implementation in the Avon region are presented in the following sections.

Many of the subregional and local groups that will be engaged in the process will have developed visions, goals and objectives for their natural resources and communities as part of catchment planning activities. These may need to be reviewed for their continued relevance and compared with the state and Avon statements to look for overlaps and gaps.

8.2.1 Community views of the SIF process

Attendees at the final Avon workshop in Kellerberrin in April 2003 made the following points.

1. The Salinity Investment Framework (SIF) process being used at state scale covers asset classes of importance at both state and regional scales.
2. The logic and method for defining assets of importance are acceptable and could be undertaken at local subregional scale, based on goals established at those levels.
3. Regional and local communities would be keen to check outputs from the state process, and provide constructive critique.
4. There is confusion in how different people and entities are defining assets of private and public value.
5. There is a need for this work to be done for regional strategic NRM planning, although prioritising is not popular due to a desire for the widest distribution of funds possible.
6. Additional data and considerable on-ground assistance will be required to facilitate the process at different levels.
7. The level of community consultation had been inadequate prior to April 2003. The community had been asked to endorse and use approaches with which it had had little contact. The process needed to be extended from salinity through to all threats to natural resources.
8. Eventual investment decisions also need to consider the leveraging impact of small investments applied in the manner of NHT 1.

The Avon Catchment Council and state agencies involved are very grateful for the contribution all workshop participants have made in getting the process this far. The input and feedback at the regional workshops has provided important learning for how the project should develop. Their continued involvement is encouraged as the process unfolds further at subregional and catchment scales.

8.2.2 Next steps in implementing the process in the Avon Region

The Avon Catchment Council (ACC) is acting on these conclusions and is implementing the following processes.

- The State Salinity Investment Framework (SIF) methodology will guide the Avon SIF methodology for use at subregional, shire and catchment scale. The full array of threats to natural resources will be considered.
- The ACC needs to drive and facilitate the process in the region as part of its requirement in developing an accredited Regional NRM Strategy, and will provide assistance and support for subregional and local groups.
- The ACC has set up a team using Council and agency staff to implement the SIF methodology, with inclusion of two landcare coordinators and one local government representative
- The Team's first task will be to interpret the SIF principles/guidelines/criteria/steps for specific use in the Avon Region, followed by distribution to those involved. The subregional and local groups may also

need to adapt the process to address their specific situations and goals, and assistance will be provided to them.

- Assistance is being provided by state agencies (Departments of Agriculture, Conservation and Land Management, and Environment) in developing regional scale descriptions of the agricultural, water and biodiversity resources that can be used as information to guide the process. This information includes the hard copy data presented at the Kellerberrin Workshop, and electronic copies of these data.
- CSIRO Land and Water is providing advice in developing the description of the social assets highlighted in the original community workshops.
- The detailed outputs from the regional workshops need to be available to groups involved in the process.
- The ACC Team will provide clarity to participants on the definitions of: NRM at local, regional and state scale; ‘assets of high value’; ‘assets of public value’; and ‘assets of private value’.
- Assistance will be provided to groups in assessing different levels of technical feasibility and adoption rates as a way of fine-tuning the analysis of the value of agricultural lands.
- The Council has adopted as policy that the Regional Strategy will contain a commitment to direct the bulk of resources into directions highlighted through the SIF process, with a smaller proportion of the funds allocated to strategic directions determined using other methodologies.

8.3 Summary conclusions and recommendations

8.3.1 Conclusions from Phase 1

The project teams responsible for implementing the Salinity Investment Framework process offer the following conclusions for consideration by government and the Natural Resource Management Council.

1. The SIF process developed through this project should be adopted by government and community groups as a means of establishing priorities for investment in natural resource management. The essential aspects about ‘assets’ that are addressed through the process are:
   - asset significance or **value** to humans
   - the **goal** or goals for the asset
   - level of **threat** based on the scale of potential damage and time scale of impacts
   - scale of intervention, feasibility of asset protection and cost-effectiveness (**feasibility** — the ability to do something for an asset).
2. The SIF process is intended to be applicable at all spatial and decision-making scales. While the outputs from this project (to date) are directed at addressing state NRM goals, the logic and method for defining assets of importance are acceptable and can be undertaken at local/subregional scale, based on goals established at those levels.
3. State and Commonwealth agencies are involved in accrediting regional NRM strategies. The accreditation process requires regional groups to demonstrate a valid process for setting priorities for investment. The full array of threats to natural resources will be considered in these strategies. The SIF methodology is a suitable process for setting priorities. State and Commonwealth agencies should urge its use, suitably adapted for the specific needs at regional, subregional, shire and catchment scale use.
4. Government agencies (Departments of Agriculture, Conservation and Land Management, and Environment) need to provide assistance to the regional NRM groups from state agencies in implementing

the SIF process. Assistance is required in developing the process and preparing regional-scale descriptions of the agricultural, infrastructure, social, water and biodiversity resources that can be used as information to guide the process. In addition, assistance is required on the feasibility of proposed actions and to address hypothetical questions that may be thrown up by the process.

5. The SIF process represents a different way of developing priorities and determining strategies from those used in NRM in recent years. Regional and local communities have had limited contact to date, and are being asked to endorse and use these approaches. Interpretation for those using the process at different scales is required. State-level assets need to be reviewed for their validity by regional NRM groups.

6. Priority setting using the SIF process should consider three categories of asset. These are biophysical (biodiversity, water resources), economic (agricultural land, rural infrastructure) and social ('social wealth' or 'social capital') assets.

7. Feasibility information is an important ingredient in determining investment priorities. However, collecting this information in detail for all assets is resource demanding. The proposed method developed by the SIF project will employ a filter that focuses assessment for feasibility information on those assets considered important through a value–threat assessment. Feasibility assessment on protection of these important assets will use selected criteria and be based on expert panel judgements.

8. Separate processes have been used to establish priorities within the asset classes of biodiversity, water resources, agricultural land and rural infrastructure. These processes have been managed independently to date. New processes will be required to handle spatial aggregation of different assets, and to allocate priorities between classes (e.g. between biodiversity and water assets).

9. The SIF methodology currently focuses on individual assets and their goals for recovery, containment or adaptation. The intent of the process is to identify targets for direct intervention using public funds to protect specific assets from salinity. The *State Salinity Strategy* (Government of WA 2000) also promotes the importance of indirect investment into land use and management practices, termed here 'industry development'. These practices will improve the social and economic benefits flowing from actions taken to protect assets from salinity. Determining how priorities are set for industry development, and the relative investment in direct, and indirect, intervention will be a task for the next phase of the work.

10. Further development and review of the methodology and outputs is required. Priority setting is a continuing process that must be reviewed with new knowledge and technical information. Either re-allocation of existing funds, or allocation of new funds, will be needed to continue the development and application of the SIF methodology.

8.3.2 Recommendations from Phase 1 of the project

1. The SIF process developed in Phase I of this project should be adopted by government and promoted to community groups to assist in setting priorities for investment.

2. The Government should provide additional resources to state agencies and regional groups to implement the SIF process.

3. The Government should support review and further development of the SIF process beyond the life of the current project, and address wider NRM applications.

8.3.3 Recommendations for Phase 2 of the project

The Steering Committee recommends that the second phase of the SIF project be pursued. Proposed products from Phase II will include:

- a method for identifying assets of high-importance at a regional level
- a method for collecting feasibility information on high-importance assets at state and regional scales
- a process for deciding priority and importance between asset classes
- a process for determining the appropriate level of investment in industry development at state scale
- a process for making a final investment decision at the regional scale
- a list of investment priorities for the state
- a list of investment priorities for the Avon Region.

Appendix 1 — Decision-making tools and the Salinity Investment Framework

At the inception of this project a number of methodologies for collecting information and setting priorities in a natural resource management context existed. An important task of the Salinity Investment Framework project was to review their relevance to the Framework. An important product of the Salinity Investment Framework has been the report of Black and Burton (2002) which reviews a number of decision-making options. Their report to the SIF Steering Committee is summarised below.

1 A Review of decision-making tools

1.1 Introduction

This comprehensive review investigated the applicability of various prioritisation methodologies to the SIF. These methodologies are known collectively as decision support tools (i.e. structured techniques used to assess the relative desirability of a decision alternative within a wider set of alternatives).

Three categories of decision tools were considered.

1. Economic tools essentially follow the priorities of the market, in which values are derived directly or indirectly from a market or are assessed from the willingness of individuals to pay. Key characteristics of market values are that they are assumed to be derived from a process that reflects the maximisation of an individual's utility (or welfare), their budget constraints, and the resulting trade-offs between goods and services that are implicit in making choices. The central intent of the tool is to maximise economic efficiency.

2. Multiple-criteria analysis tools revolve around preferences of decision-makers. These tools try to consider simultaneously many conflicting criteria. Economic efficiency is not considered the only aim of the analysis, and many different objectives can be considered.

3. Deliberative tools are based principally on the inputs from, and decisions by, 'ordinary' people, rather than experts.

The theoretical underpinning of each of these tools is markedly different. Economic tools have a unified theoretical base in 'welfare economics'. The basic premise of welfare economics is to increase the well-being of the individuals who make up society. Each individual's welfare depends not only on the consumption of private goods and services provided by the government, but also on the quantities and qualities of non-market goods and services that flow from the environment (e.g. visual amenity). The decision process is generally linear, and there are limited opportunities for feedback.

Multiple-criteria analysis tools have their origins in operations research, which provides a scientific approach to decision-making by applying mathematical tools to obtain solutions. The decision process is iterative with opportunities for feedback on setting objectives, management alternatives, decision criteria and the weighting for each criterion.

Deliberative tools have their base in 'participatory democracy' which can be loosely described as rule by the people. The decision process is also iterative, but it differs in that it is dynamic and open.

1.2 Technical performance of representative decision tools

The technical performance of each tool is summarised in Table 1.1. The general conclusions that can be drawn from this summary are: (1) economic tools perform the best in terms of repeatability,

(2) multiple-criteria analysis tools offer the most transparent results, and (3) deliberative tools will generate the least ethical or moral objections.

Table 1.1 Technical performance of representative decision tools.

Feature	Economic tools	Multiple-criteria analysis tools	Deliberative tools
Theoretical underpinning	Welfare economics	Mathematics and operational research	Participatory democracy
Decision process	Linear *Discrete steps and limited opportunities for feedback.*	Iterative *Discrete steps with opportunities for feedback on objectives, alternatives, criteria and weighting.*	Iterative *Dynamic and open process.*
Final decision	Explicit *Decision fully detailed.*	Explicit *Decision fully detailed.*	Implicit *Internalises the spectrum of values and considerations.*
Repeatability *Where the results of one method can be replicated over a number of trials.*	Moderate–High *Sensitive to discounting rate.*	Moderate *Sensitive to design.*	Low *Sensitive to design and context.*
Validity of results	Variable *Criticism over non-market valuation techniques and discounting rates.*	Variable *Criticism over the subjectivity of weighting, and/or groups that generate them.*	Variable *Criticism over the representativeness of reference groups.*
Transparency *The reasons for making a particular decision are clear to all stakeholders.*	Low *Economic methods are not well understood by politicians or the public.*	Moderate–High *Ranking may be questioned if the decision matrix is concealed.*	Low *Difficult to document the nature of jury discussions.*
Ethical or moral concerns	High *Indifferent to who receives the benefits and who suffers the costs, it simply aggregates across them. Also impacts of discounting on future generations.*	Moderate *Subjectivity introduced in establishing weighting for the decision criteria.*	Low–Moderate *Open to strategic bias.*
Accommodation of risk and uncertainty	Low–Moderate *Statistical procedures for considering risky outcomes are well developed but rarely employed. May want to report a range of possible internal rates of return for a particular alternative.*	Low–Moderate *Risk can be accommodated in the decision by including it as a criterion.*	Low *Not generally considered in a systematic fashion.*

1.3 Practical performance of representative decision tools

General policy concerns

General policy concerns, in particular distribution and macroeconomic issues, were reviewed. A negative aspect of economic tools was revealed in that they do not adequately address distribution concerns. However, some may argue that it is more efficient to leave equity issues to the taxation and social welfare systems. We also rated the tools' performance against a set of key principles for effective NRM polices and programs (these were identified by Land and Water Australia). This analysis is captured in Table 1.2. It made clear that no tool completely satisfied all the principles for effective NRM, nor is one particular tool necessarily poor in all circumstances. Multiple-criteria analysis tools generally performed the best overall, and performed particularly well in the areas of goal development, capturing diverse values, accommodating various information sources, balancing outcomes and policy learning. Economic tools clearly out-performed the other tools in the allocation of roles and responsibilities.

Table 1.2 Performance of decision tools in relation to principles for effective NRM (as outlined in Land and Water Australia 2001).

To what extent can the decision tool be used to:	Economic tools	Multi-criteria analysis tools	Deliberative tools
Optimise environmental, social and economic benefits?	✔ *Optimises economic efficiency, but possibly falls short on social and environment elements*	✔✔ *Can accommodate conflicting objectives, so trade-offs between these elements are explicit.*	✔✔ *Rather than an 'optimal' result, a consensual outcome is desired.*
Ensure that some values are not consistently favoured over others — in particular that environmental values are not marginalised?	✔ *Difficulties in dealing with benefits and costs which are not valued in markets.*	✔✔✔ *Can accommodate environmental, economic and social issues.*	✔✔ *Participants have ability to directly express their values.*
Encourage the genuine and orderly participation of a wide range of stakeholders and interested parties?	✔ *No clear rules on setting boundaries for who counts when calculating costs and benefits*	✔✔✔ *Weighting can be elicited through a participatory approach.*	✔✔✔ *Jury will be selected to represent various elements of the relevant population.*
Ensure that different kinds of knowledge are fully taken into account?	✔ *Requires values to be expressed in monetary terms.*	✔✔✔ *Construction of the impacts matrix draws on wide range of knowledge and in various forms.*	✔✔ *Expert witnesses can be called upon to provide detail on particular issues.*
Facilitate clear and transparent agreement on the allocation of roles and responsibilities?	✔✔✔ *Costs and benefits clearly defined in analysis aiding formulation of cost-sharing arrangements.*	✔ *Not a necessary outcome of the analysis.*	✔ *Only will if the jury has been charged to do so.*
Develop an outcomes-based hierarchy of goals, objectives and plans, linked in a logical way?	✔ *Not a necessary component of the analysis. Link is provided by comparison to the base case or the 'do nothing' scenario.*	✔✔✔ *Especially the Analytic Hierarchy Method.*	✔ *Not a necessary component of the analysis.*
Apply the precautionary principle?	✔ *Debate over whether irreversible loss can be valued.*	✔✔✔ *Thresholds or criteria for risk can be built into procedure.*	✔✔ *Jury can be charged to do so.*
Operate at a bio-regional scale?	✔✔ *Issues on whose preferencesto include in non-market valuation.*	✔✔✔ *So long as this is part of setting the context for decision-makers.*	✔✔✔ *So long as this is part of setting the context for participants.*
Reflect the inherent complexity of NRM systems?	✔✔ *Putting all value dimensions into a single axiological scale can mask complexity.*	✔✔ *It relies on information to be presented in a way that can be usefully considered by decision-makers. This can lead to over-simplification.*	✔✔ *It relies on information to be presented in a way that can be usefully considered by decision-makers. This can lead to over-simplification.*
Use systems and techniques that contribute to enhanced adaptive management?	✔ *Does not adequately capturesocio-political concerns in the process so results are often ignored.*	✔✔✔ *Amenable to treating policy formulation as on ongoing process.*	✔✔✔ *Amenable to treating policy formulation as on ongoing process.*
Use systems that enhance 'policy learning' by individuals and within organisations?	✔ *Analysis lends itself to be 'ruled by experts'. Has been described as a 'black box' approach.*	✔✔✔ *The performance matrix unravels complexity of decision, clearly identifying trade-offs and complementarities.*	✔✔ *Deliberation involves reflective elements.*

✔ *Ticks reflect an ordinal ranking.*

Specific policy concerns

Specific policy concerns including the requirements for data and skills, and community perceptions were also examined. It is often mistakenly thought that multiple-criteria and deliberative tools require less information than economic tools. There may be less need for *consistency*, but the information requirements will be similar nevertheless. Furthermore, a greater emphasis on the *presentation* of the information will be necessary to aid the decision-making process. The sets of skills needed for the application of each tool vary. Multiple-criteria analysis tools probably require the most diverse set of skills as they involve analytic and participatory techniques. No conclusive evidence could be found that indicated which tool the community would favour.

Case studies

A number of applications of decision-making tools from within and outside Australia were also scrutinised with particular attention being paid to their success in achieving the desired outcomes. This proved to be very difficult as the specific circumstances and constraints of an application were seldom transparent in the documented processes. What could be elicited were any discouraging aspects of the tools. In summary, it was observed that:

(1) The *non-market valuation* or *benefits transfer* component of an economic tool is often challenged.

(2) The procedure for determining weights in the application of multiple-criteria analysis tools is variable.

(3) Deliberative tools are prone to problems relating to small group dynamics.

(4) There are opportunities to combine tools, substituting a negative component of one tool with a positive component of another.

2 Decision-making tools in the context of the SIF

Within the context of the SIF, the evaluation of the decision tools was guided by a number of explicit questions:

- Is the tool able to prioritise between economic, social and environmental public asset classes? (*meaning economic, social and environmental values*)
- Can the eight broad principles and six steps for setting investment priorities be incorporated?
- Does the tool include involvement of stakeholders?
- Is it applicable at various levels of detail (i.e. state, regional and subregional levels)?
- Does the tool require changes in the prioritisation methods employed by each agency to prioritise within each asset class?

All the tools were determined to satisfy these questions, however, their relative performances differed. The main points to note were:

(1) The diverse set of values in relation to asset protection are best captured by deliberative or multiple-criteria analysis tools.

(2) Economic tools provide the most relevant framework for considering costs and benefits, although these tools cannot accommodate information that has not been given a monetary value.

(3) So long as the costs of treatments are included in multiple-criteria and deliberative tools, then these tools can factor in economic objectives.

(4) Multiple-criteria analysis tools provide a structured and goal-orientated approach to prioritisation.

The reviewers concluded that the 'multiple-criteria analysis tool' demonstrated the best potential for prioritising investment under the SIF. Their view was formulated on its superior performance in the areas of goal specification, flexibility in information requirements, and transparency. The recommendations from the Review to the Steering Committee were as follows.

Recommendation 1: Multiple-criteria analysis tools provide a sound framework for complex decision-making problems. They are particularly suited to NRM because the tools: (1) distinguish a broad set of criteria used in NRM decisions, (2) can effectively identify trade-offs between conflicting objectives, and (3) deal adequately with non-monetary, qualitative and uncertain information. *A multiple-criteria analysis tool should be applied to the Salinity Investment Framework for prioritising investment.*

Recommendation 2: The main criticism levelled at multiple-criteria analysis tools is the arbitrary nature of their weighting systems. A logical progression in overcoming the problem is to incorporate either economic or deliberative techniques to generate the weights. *Leading researchers and practitioners in this new area should be consulted on the relative merits of deliberative multiple-criteria analysis and choice-weighted multiple-criteria analysis.*

Recommendation 3: Design is the most crucial stage in any application of the multiple-criteria tool, particularly with regard to: (1) structuring of objectives, (2) setting the management alternatives, (3) determining the decision criteria, (4) filling in the performance matrix, and (5) eliciting weights. *Clear guidelines should be prepared for the practical application of the multiple-criteria tool to the Salinity Investment Framework.*

3 Actions arising from the Review

In general, the SIF Steering Committee accepted the findings of the Review (Black and Burton, 2002). However, its application to the Salinity Investment Framework is yet to be finalised. For multiple-criteria analysis (MCA) to work effectively the required information has to be available. Obtaining *value* and *threat* information for an expansive suite of assets is relatively easy. However, obtaining information on the *feasibility* of any action for these different assets is more challenging. Furthermore the collection of information that conforms to the requirements of an MCA tool is yet to be investigated.

The SIF Steering Committee resolved that:

- Work done in implementing the Framework, including the collection of data on assets, needed to consider its usefulness in an MCA decision-making tool.
- The proposed second phase of the SIF project (discussed in Section 8) will develop a method for collecting feasibility information for assets identified as important. The SIF Steering Committee will then decide if an MCA model will be used to guide the final investment decisions.

4 Summary

- Multiple-criteria analysis tools provide a sound framework for complex decision-making problems. They are particularly suited to NRM because the tools: (1) identifys a broad set of criteria used in NRM decisions; (2) can effectively identify trade-offs between conflicting objectives, and (3) deal adequately with non-monetary, qualitative and uncertain information. *A multiple-criteria analysis tool should be applied to the Salinity Investment Framework for prioritising investment.*
- The main criticism levelled at multiple-criteria analysis tools is the arbitrary nature of their weighting systems. A logical progression in overcoming the problem is to incorporate either economic or deliberative techniques to generate the weights. *Leading researchers and practitioners in this new area should be consulted on the relative merits of deliberative multiple-criteria analysis and choice-weighted multiple-criteria analysis.*

- Design is the most crucial stage in any application of the multiple-criteria tool, particularly with regards to: (1) structuring of objectives; (2) setting the management alternatives; (3) determining the decision criteria; (4) filling in the performance matrix, and (5) eliciting weights. *Clear guidelines should be prepared for the practical application of the multiple-criteria tool to the Salinity Investment Framework*.
- Implementation of an MCA tool to help make decisions in investment allocation for the SIF has not been confirmed as of May 2003. Consideration of MCA data requirements should be made in all future work. The Steering Committee will decide on the use of MCA tools during the next phase of the overall project.

SALINITY INVESTMENT FRAMEWORK

Appendix 2
Identification and ranking of important biodiversity assets — South West Agricultural Region

Prepared by

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Acknowledgments
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Introduction

Background to the Salinity Investment Framework

The Salinity Investment Framework (SIF) was developed by the State Salinity Council to ensure that funding for salinity projects is distributed at state, regional and catchment scales to projects which best protect assets of high public value. To evolve the SIF into an effective operational tool it is being developed and tested at two scales: across the whole south west agricultural zone for assets of state significance; and within the Avon Basin for assets of regional significance.

The SIF established a six-step process for setting priorities:

1. Set broad objectives and goal
2. Assess assets and risks
3. Set specific goals for action
4. Assess options
5. Set priorities
6. Take action.

In this particular project we only dealt with steps (1) and (2).

The Department of Conservation and Land Management (CALM), as the key state agency for biodiversity conservation, is involved in both the state and regional level projects developing the SIF. This paper describes the method developed by the Department to identify biodiversity assets that are, at a state level, a high priority for public funding in relation to salinity management.

The state level component of the project aimed to identify the most important biodiversity assets within the south west agricultural zone *from the perspective of the state community*. This latter point needs some explanation.

During the project, problems arose because the various interests of local, regional, state and National communities have not always been recognised or articulated with regard to setting priorities among natural resource assets. That these interests will sometimes be consistent, and at other times compete, has also not always been recognised. It is important to emphasise that, as a state agency, CALM's responsibilities[12] are to the state community[13].

While the state level biodiversity conservation component of the SIF was developed, three related projects were also in progress. Firstly, a parallel project on the regional scale application of SIF is progressing with the Avon Catchment Council. This work will be reported separately. Secondly, planning work is underway to underpin CALM's Wheatbelt Regional Plan (Wallace et al. in draft). This work has contributed to the development of the biodiversity conservation component of SIF, and many of the matters described in the draft work are relevant to this document. Thirdly, regional planning on a draft set of targets for the Avon Catchment Council (see Wallace et al. 2002a) also provided an important opportunity to test and develop some of the ideas used in the SIF.

[12] These responsibilities are outlined in legislation and managed by a State Minister of the Crown.

[13] The term 'community' is used in many ways. By state community, we recognise citizens of Western Australia (people on the State Electoral Roll) and their children.

The strong interaction of the SIF work with other projects emphasises the importance of collaboration in developing effective priority-setting processes. Work to date has also confirmed the iterative nature of priority setting for biodiversity conservation. That is, the methods proposed here will change and develop with new knowledge and ideas.

As the project evolved, a number of fundamental questions were addressed to enable the development of a method for identifying and ranking important biodiversity assets in the south west agricultural zone. The two most critical issues were:

1. defining natural biodiversity
2. describing why natural biodiversity is important.

These two issues, and the geographic area for the project, are dealt with in the remainder of this section.

Geographic boundaries of project for biodiversity conservation

The analyses conducted for this project were restricted to the south west agricultural zone. It should be noted that, while state forest, nature reserves and national parks subject to the current forest management planning process, and the Swan Coastal Plain portion of the Perth Metropolitan Area were both included in this analysis, they will be excluded from further analyses and priority setting because:

1. they are already subject to a rigorous biodiversity conservation planning process involving significant resources
2. the Government has already made decisions concerning the future management of these areas.

Finally, it is important to emphasise that while the Department manages large areas of natural environments, mainly bushland and wetlands, in the south west agricultural zone, this priority setting process is designed to incorporate all biodiversity assets, irrespective of the tenure on which they occur.

What is biodiversity?

During the development of SIF it became apparent that there are a number of ways to define biodiversity. Because the definition of biodiversity defines what is to be managed and conserved, it is essential to be clear on how the term is used.

The definition of biodiversity in *The National Strategy for the Conservation of Australia's Biological Diversity* (Commonwealth of Australia 1996) — a document that has been endorsed by the Commonwealth and all Australian state governments — is:

> 'The variety of life forms: the different plants, animals and microorganisms, the genes they contain, and the ecosystems they form.' [Note that this definition is taken from the Glossary of the report — this differs slightly from the definition given in the introduction of the same report.]

However, in developing our investment framework we have not included the non-living parts of ecosystems in the definition of biodiversity, as they are not tangible, biological entities. To include abiotic components in the definition of biodiversity would have caused several problems.

Firstly, it is difficult to develop effective classification systems when different types of entities — in this case tangible biological entities and intangible processes — are included together. Secondly, defining biodiversity assets (see section below on Assessing Assets and Risk) is more appropriately linked to tangible entities. Thirdly, the most readily monitored outcomes of natural biodiversity conservation will be the persistence in natural (or near natural) environments of viable populations of living organisms. The latter point also reflects that there are circumstances under which ecosystem processes might be conserved, but all the native biota may not.

Thus in defining biodiversity assets, we recognised the following as important elements of biodiversity:

- Genetic diversity
- Species diversity
- Natural assemblages of living things (such as communities, or the living components of a specific ecosystem)
- Structural diversity of the above three components.

Adopting this approach, ecosystem processes are dealt with as elements that must be managed to conserve biodiversity assets. Thus ecosystem processes are critical (through threat analyses) for planning and implementing biodiversity conservation.

Note also that we only deal with natural biodiversity in this report, that is, native plants, animals and other wildlife. We excluded non-native plants and animals — such as cows, sheep, foxes, and cereal crops — from consideration. However, throughout the rest of this report, the term biodiversity is used as shorthand for natural biodiversity.

Why is biodiversity important?

During work on SIF and other planning projects, we found that it was essential to be clear on why biodiversity is important, as this has important implications for goal setting and the definition of assets. There are many ways for describing how conservation of biodiversity is critical to protecting an important range of human needs. The structure of human needs, or values, used in this project is briefly summarised in Table 2.1. This is one of many ways of classifying human values. Issues relating to these points are explained in more detail in Wallace et al. (in draft).

In this particular work, we have focused on identifying the biodiversity assets to meet human values related to:

- Opportunity values
- Ecosystem service values
- Amenity values
- Scientific and educational values
- Recreation values (but restricted to passive recreation, such as picnicking and birdwatching, as these are most compatible with conserving biodiversity)
- Spiritual/moral/philosophical values.

If these values are not adequately reflected in the broad goal and assets (see below), then it is essential to change one or more of: the values targeted, broad goal, or assets.

Table 2.1 Contributions of biodiversity to human values

Human Value	Examples of the contribution of natural biodiversity to human values in the agricultural area of south west WA
Consumptive use values	These include the values of natural products that are harvested for domestic use and that do not pass through a market. For example, farmers' use of on-farm timber from native vegetation for fencing, firewood, etc.
Productive use values	Are the values of natural products that are harvested commercially. Examples include timber harvesting, use of kangaroos for hides and pet meat, wildflower harvesting.
Opportunity values	The native flora and fauna of the south west are unique. The flora, in particular, is renowned internationally for its diversity. This diversity represents enormous potential for the development of new products, including industrial and medicinal products.
Ecosystem service values	Are those values that contribute to the maintenance of our environment and ensure that life can persist. For example, the role of wetlands and their native plants and animals in flood mitigation and nutrient stripping, the contribution of native vegetation to water use and erosion control, the role of native animals in pest control.
Amenity values (including aesthetics)	The amenity values of biodiversity in agricultural areas include pockets of bushland around houses and yards that provide shade, shelter from wind, and aesthetic values. Road verge vegetation provides important aesthetic values.
Scientific and educational values	For example, areas of native vegetation are essential if we want to understand our land and how it works. For our children to understand the future and how to manage for it, they need to understand the past. Many institutions use areas of natural lands for educational purposes. Another example is that native vegetation provides the only source of reference material if we wish to assess how agricultural practice has affected soil structure and other properties.
Recreation values	The enormous importance of natural environments for recreation and tourism is well known. Research links recreation in natural environments to both physical and mental health.
Spiritual/ philosophical/ moral values	While not an area that is often discussed, there are many ways in which natural environments are an important part of our spiritual and moral framework. In many areas, the strong association between communities and particular patches of bush, granite outcrops, or lakes often shows this. Also, there are many people who feel that other living things have the 'right' to persist — this reflects deeply held spiritual/philosophical/moral values.

Methods

This section deals with how we identified the most important biodiversity assets threatened by salinity. It is stressed that the aim of this work was to select the *most* important biodiversity assets that require *urgent* management with respect to salinity — we have not aimed to describe and rank every important asset.

The method used to identify biodiversity assets is consistent with the process outlined in earlier documentation of the SIF. In particular, we have used a broad goal to identify the relevant assets. We have also dealt with viability/risk analysis in regards to salinity. However, a more comprehensive viability analysis can be undertaken provided there is sufficient interest in the methods described below.

Broad goal (Step 1[14])

The relevant goal in the *State Salinity Strategy* was taken as a starting point for the development of a broad goal. The relevant statement in the strategy is:

> 'To protect and restore high-value wetlands and natural vegetation, and maintain natural (biological and physical) diversity within the region.' (State Salinity Council 2000)

However, as this goal also includes physical diversity — such as rocks, hills and so on — as well as biodiversity, we used the following CALM goal that relates only to biodiversity.

> 'To protect, conserve and, where necessary and possible, restore Western Australia's natural biodiversity'. (Corporate Plan 2002–2005 Department of Conservation and Land Management)

This goal is consistent with the *Salinity Strategy* goal. During the development of SIF and other, similar work, the pivotal role of goal setting in the process of defining assets was reinforced. Also, it is important that the goal reflects the human values it seeks to address (see Table 2.1 and accompanying text).

Finally, for this work we aimed to apply the broad goal to the south west agricultural region, with a timescale of 50 years[15].

Assessing assets and risk (Step 2)

Assessing assets

Definition and description of assets

An asset is defined as 'a useful or valuable thing or person' (Concise Oxford English Dictionary). In this part of the SIF project, an asset is therefore a valuable thing in the context of the broad goal and values to humans of biodiversity described above. More specifically for this work, assets are biodiversity elements that occur at a specific site (can be at a range of scales) and are valuable to the state community. Given the broad goal used, and the wide range of human values attached to this goal, the sum total of biodiversity assets is taken to be every living individual of the state's biodiversity. It should also be noted that, in some cases, the scale of management required to conserve an asset is larger than the asset itself. For example, where a biodiversity asset is a living assemblage occurring in a wetland, the scale of management will generally be a catchment. Matters such as this have important implications for how assets are described and evaluated.

[14] Step numbers refer to those used in the Project Management Brief dated 19 June 2002.

[15] While longer would be desirable, 50 years represents the longest planning horizon we could be expected to sensibly consider to achieve the broad goal. However, this timescale is well within the return times of important natural cycles. Therefore, it would be desirable to plan over much longer periods — these issues were left to consideration of specific threats.

As this work is about establishing priorities for the investment of resources, the next question we asked is: What specific biodiversity assets do we need to protect, conserve and restore as priorities to meet the goal? In answering this question, we were conscious of the need to focus on specific biodiversity assets (living things valuable to humans), and deliberately excluded the environment[16] of biodiversity assets. In this sense, particular environments are needed to conserve particular biodiversity assets, but are not themselves the asset. (For a more complete explanation of this and related issues see Wallace et al. in draft.)

Also, it should be stressed that generating a list of asset categories will inevitably exclude elements of the state's biodiversity as defined above. That is, the listing of asset categories is effectively the first act of priority setting.

The draft list of biodiversity categories developed included a long list of things such as:

- Rare[17] native plants, animals and other organisms
- Rare ecological communities
- Representative samples of native plants and animals (including common species)
- Plants/animals at the limits of their natural range
- Uncommon genetic variants
- Unusual living assemblages
- 'Ancient' species
- Living natural assemblages that have high levels of biodiversity and/or endemism
- A living assemblage that represents a local ecotype.

From work to date it is apparent that a more comprehensive definition of biodiversity assets is required, and a consultant is currently working on this issue. For example, obvious gaps in the asset list include the need either to better reflect amenity and ecosystem service values or to acknowledge that they are two human values not fully represented by the broad goal and asset list. When these matters are examined, it is likely that additional criteria, such as replication of assets, will be included when assessing current importance as well as viability.

Despite the need for further work, the biodiversity asset categories above provided a useful basis for progression to the next stage of analysis

Evaluation of assets — current importance

Background

In this work we have deliberately separated questions about the current importance of an asset to goal achievement from questions concerning the long-term viability of that asset. While it is difficult to do this, it is important because:

- We must be clear on what are the really important assets, independent of viability. If important assets are recognised as unviable, they tend to be intuitively accorded low importance, irrespective of their actual importance. This may result in important assets being ignored, or accorded inappropriately low priority;

[16] In this context we propose that the terms 'environment' and 'habitat' are synonymous.

[17] The term 'rare' is generally used for something that is uncommon or unusual. This is the sense in which it is used here, and not the statutory meaning defined under the *Wildlife Conservation Act 1950*.

- Some factors affecting viability, such as lack of knowledge or socio-political support to supply resources, can rapidly and unexpectedly change. Being clear about current importance places managers in a much better position to take advantage of changing circumstances; and
- A well-constructed framework for valuing assets encourages criteria development and transparent processes. Separation of current importance from viability is an important element of such a framework.

Of the asset categories listed in the previous section, the three typically used in the past as drivers for biodiversity conservation are:

1. Rare species
2. Rare communities (of plants and animals)
3. Areas that provide good representative samples of biodiversity. In more recent times, this can be equated to the goal of developing a system of conservation areas that is comprehensive, adequate and representative. Given that the definitions of comprehensive and representative overlap (Conservation Commission of Western Australia 2002), and adequacy is about viability (treated in the next section), this asset in simple terms relates to representative samples that reflect the diversity of regional ecosystems, and the variability within them. However, effective networks of natural environments for conservation will necessarily include important biodiversity assets on freehold lands. In this regard the concept of a comprehensive, adequate, and representative reserve system is too limiting for SIF. Thus in this project we have focused on identifying important, representative samples of biodiversity wherever they occur.

These three asset categories, by and large, contribute the most towards conserving biodiversity[18]. Therefore these three categories were selected for this analysis as the biodiversity assets that will make the greatest contribution to achieving the biodiversity goal provided above. To rank these types of assets we considered criteria based on the attributes of rareness, specialness (in the sense of icon species, living assemblages that reflect biodiversity hotspots or endemism, Gondwanan relics, etc.) and representativeness. Rarity and representativeness were the particular asset attributes used in this work to rank assets — 'specialness' is a concept that needs to be further developed in relation to evaluating other asset types.

As asset types (1) to (3) do not fully represent the draft list of biodiversity assets, nor do they reflect other types of biodiversity assets that may be needed to meet the human values listed as important, work continues on defining assets. As noted above, a consultant is currently undertaking the initial work to better define and describe assets. This issue is also discussed again under the section below titled 'Other assets of biodiversity importance'.

Current importance — rare species and communities

In the case of rare species and communities, there are existing, well-documented processes for ranking their importance for biodiversity conservation (Attachment 1). While there are issues about better separating current importance from viability, the existing processes were accepted for the SIF as sound and useful. They are not considered further here.

Current importance — representative samples

With regard to the definition and ranking of representative samples, available processes are less clear. There has been considerable research on the topic (see, for example, Burgman and Lindenmayer 1998), and criteria have been developed in the case of Western Australian forests (Conservation Commission of Western Australia 2002). All of these methods require a level of biodiversity information that does not

[18] As might be expected, a skim through how biodiversity conservation priorities have been developed historically is consistent with these three assets providing the most important contribution to conserving biodiversity.

exist for most of the south west agricultural zone, although this situation will improve considerably when results from the recent biological surveys have been fully analysed (Keighery & Lyons 2001; Keighery 2002).

Until our knowledge improves, the project group developed the following process for identifying important representative samples of biodiversity within the south west agricultural region.

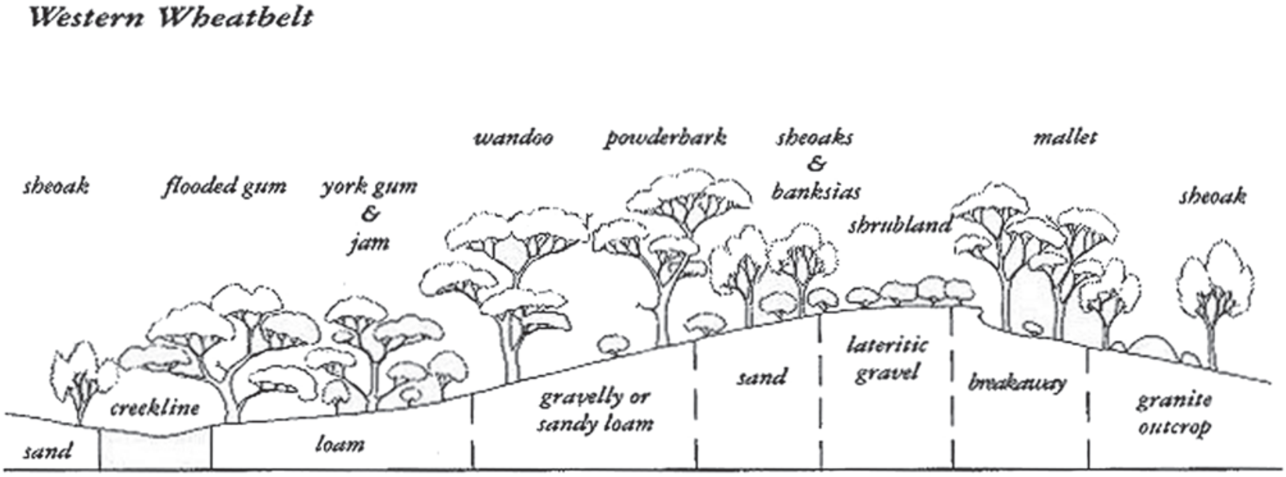

Figure 2.1 Idealised cross-section of wheatbelt landscape (taken from Bamford 1995, page 12)

Figure 2.1 shows an idealised cross-section of a wheatbelt landscape. While the figure shown is more typical of the western wheatbelt, a similar pattern is recognizable throughout most of the south west agricultural zone. At the very least, a representative sample of local biodiversity would need to sample the full range of soil–landform–vegetation types shown by this pattern. Not only does this diagram indicate the range of soil–landform–vegetation types that need to be sampled, it also emphasises the need to identify representative samples at landscape scales.

While the distance over which this landscape sequence is broadly repeated tends to be shorter in the west and south, and longer in the east and north, in the central wheatbelt it rarely occurs (in its full expression) inside 10 kilometers — that is, roughly 10 000 ha. (This assessment is based on rough measurements of several ridge-to-ridge distances along the Great Eastern Highway between Northam and Kellerberrin, with adjustments based on how many of the soil–landform–vegetation elements were missing.) Thus a minimum landscape-scale sample size should be 10 000 ha or more to provide a reasonable probability of sampling the full range of soil-landform-vegetation types.

At the same time, the high species turnover of plants between sites in the agricultural region (Burgman 1988; Brown 1989) means that, if one wants to sample living assemblages of plants (and presumably the related fauna), representative samples must occur within relatively short distances. Burgman calculated for his study site that this distance is 15 km. If this result is transferable elsewhere in the agricultural region, it suggests that, to sample assemblages of plants, sample sizes should be less than 18 000 ha (area of circle with a radius of 7.5 km is about 17 700 ha).

Given the preceding, it was felt that sampling the agricultural region using 10 000 ha polygons was a reasonable, first up basis for selecting representative samples of biodiversity in the region. This does not necessarily apply in other landscapes.

At the same time, in Figure 2.1 there are eight landform/soil components across the catena, each of which typically carries a particular range of vegetation and other habitat components. One could expect at least three major variations within each of these eight landform/soil units, thus giving 24 elements overall.

Assuming, conservatively, that one needs a minimum of 100 ha per element to capture species, genetic and structural diversity, one would need a minimum of 2 400 ha for each landscape unit of 10 000 ha to contain a representative sample of the biota. This equates to about 25% of the landscape unit, and, given the turnover and species diversity of wheatbelt landscapes, is a very conservative estimate.

This estimate is *very conservative,* and is based on a number of assumptions that are rarely met in reality. For example, it was assumed that remaining natural environments in each locality sample the full range of soil–landform–vegetation complexes. This assumption is rarely met in reality. Again, this serves to emphasize that the argument developed here is very conservative — generally much larger areas of natural environments are required at the landscape scale merely to adequately sample biodiversity, irrespective of the issue of viability.

Despite the limitations of the above approach, the project group considers that it provides a useful starting point until more information becomes available and the concepts used may then be further developed. Therefore, this method of identifying landscapes that are likely to contain important representative samples of biodiversity was used in the current project. These landscapes were named target landscapes; a subset of representative landscapes, and a description of how they were selected is given in Attachment 2.

Additionally, there are a number of landscapes that have been identified through past work as containing very important samples of wildlife. These areas include:

a. Natural diversity recovery catchments that have been formally endorsed and funded on the basis of their importance for biodiversity and high level of threat from salinity.

b. Potential natural diversity recovery catchments. These have been proposed by experts (Dr G Keighery and Mr M Lyons) on the basis of their importance for biodiversity and high level of threat from salinity.

Most of the areas identified in (a), and all of those in (b), are based on preliminary results from the recent biological survey of the agricultural area (Keighery & Lyons 2001; Keighery 2002). It is emphasised that the potential natural diversity recovery catchments may, following a more detailed analysis of their importance, be downgraded in rank. Thus it is critical to note that they are potential, *not proposed*, natural diversity recovery catchments.

It should also be noted that, while one would not normally amalgamate two datasets generated by different methods, it was important in this instance to combine the results from both processes. A high priority for further development of this work is to integrate both processes.

Thus, the final list of areas that we considered would provide good, representative samples of local biodiversity combined:

i. Landscapes > 10 000 ha that had 25% or more of their area in natural vegetation (area in natural environments would have been the preferred data set, but there are currently none available)

ii. Natural diversity recovery catchments

iii. Potential natural diversity recovery catchments

In the case of (i), the landscapes selected were ranked according to:

- amount of native vegetation remaining within their boundaries;
- counts of rare/threatened species and threatened ecological communities (used as a measure of biological diversity. The greater the number of these, the more biodiverse the local area is likely to be); and
- Measures of wetland importance (Ramsar, Nationally Important, etc.). This was the best mechanism available for assessing wetland environments.

A full description of the ranking process is given in Attachment 2. Note that attempts were made to use the data of Beard as upgraded by CALM and the Department of Agriculture (Beeston et al. 2002) to provide a better measure of diversity, however, no useful method could be developed in the time available.

In the case of (ii) and (iii), the ranking process was undertaken by Dr G Keighery and Mr M Lyons, research scientists with CALM (see also comments above).

It is emphasised again that while the criteria and methods described above provide a valuable starting point for priority setting, *they are inadequate in the longer term*. Considerably more work is required to develop a more complete method based on a range of criteria. Despite this, the project group is satisfied that the general framework is sound, and should be broadly applicable across bioregions with appropriate adjustments to criteria.

Assessing risk

Background

To undertake a risk assessment for the biodiversity assets defined above, the project group proposed to deal with three groups of issues that, taken together, measure the longer-term viability of assets:

a. *Existing biological and physical threats*: in this work, only the threat posed by salinity was assessed. However, there are many other important threats that affect the viability of assets, and some significantly interact with salinity. Thus, a more comprehensive threat analysis is required in developing priorities beyond those tackled in this paper. Specifically, this would pick up the range of threats listed in Attachment 3.

b. *Our knowledge and technical capacity to manage threats*: in many cases, we do not have the knowledge or technical capacity to manage particular threats. For example, while we have a general understanding of the development and management of salinity, we do not have sufficient knowledge of how revegetation interacts with salinity, nor do we have the technologies to cost-effectively manage discharge.

c. *Socio-political capacity to manage threats*: while in some cases we know how one might better tackle a particular threat, there may not be the local support, or the state level support, to apply the necessary resources. These are examples of socio-political issues. (Sometimes the solution to a socio-political issue is to change the knowledge or existing technology in a way that makes a known technological fix economically viable.)

In this particular work, only the risk of salinity was taken into consideration for the representative landscapes, and a less than complete range of threats in the case of rare species and communities. As noted above, this places limitations on this work, and (a) to (c) would all need to be addressed to develop a final list of priorities for landscapes.

Viability, salinity risk, rare species and communities

Rare species and communities were assessed using standard procedures (Attachment 1). Where the threats are sufficiently high, rare species and communities are accorded various levels of threatened status. To assess the salinity risk to threatened populations, GIS was used to intersect salinity risk as defined from Land Monitor, with the locations of threatened species and communities. The output is species and communities that are at risk from salinity. See Attachment 2 for more details.

Viability, salinity risk, representative landscapes

The salinity risk to representative landscapes was also assessed using Land Monitor salinity data within a GIS. Risk was quantified as the area of remaining vegetation within a representative landscape that was at risk of salinisation but not yet salt effected. See Attachment 2 for more details. Note that the high salinity risk to existing and proposed natural diversity recovery catchments was identified when they were assessed.

As noted previously, to improve the current work it would be essential to consider the full range of threats, to evaluate our technical capacity to manage threats, and to assess our socio-political capacity to implement management works. While salinity was the only threat considered in relation to the representative landscapes selected in this project, it should be noted that the 25% rule used in this work has been used elsewhere (Wallace et al. in draft) as a measure of viability in relation to the threat of 'insufficient resources to maintain viable populations' (see Attachment 3).

Other assets of biodiversity importance

The assets described above, namely rare species and communities, and representative landscapes, do not cover all the important assets that need to be protected, conserved or restored to meet the broad biodiversity conservation goal. However, they provide a valuable starting point, and are those assets that will contribute most to achieving the goal.

In the original documentation proposing the broad methods for assessing biodiversity conservation priorities (Wallace et al. 2002b), it was stated that:

> 'Given the limited human resources available for management, it is important to acknowledge that priority setting processes will result in many areas and biological assets not receiving a high priority ranking. This does not mean that they are unimportant for biodiversity conservation, but that either they are considered so resilient they currently need little management, or that they are not going to provide as large a conservation return for resources allocated as the selected priorities. In other cases sites may have so little probability of retaining their value in the longer term that they will not be considered for funding.
>
> However, as knowledge and technical capacity improve, or if additional resources are allocated to management, then the number of intensively managed biological assets may be expanded.
>
> Furthermore, it is important to allocate some resources to slowing the rate of biodiversity decline outside selected priorities. This acknowledges both the importance of many (non-priority) remnants of natural habitat to biodiversity conservation, and the value, from the viewpoint of socio-cultural change, of engaging a wide range of land managers in conservation activities.
>
> Thus it is important that some funds are allocated to areas outside the priorities selected from the process described below. Vehicles for such programs already exist in the work of Land for Wildlife and other state schemes and management by agencies, and further state and Commonwealth programs may be developed through natural resource management regional groups. Other organisations, such as World Wide Fund for Nature and Greening Australia (WA), may also provide programs.'

Later work served to emphasize, rather than diminish, these points. Therefore, the project group recommends that the state community should continue to support, through state agencies, the conservation of important natural environments outside the priority areas listed by the SIF. These not only include a wide range of existing conservation reserves and other Crown lands, but also natural environments on freehold land.

Important changes required to greatly improve the current system in this regard relate to:

- Better defining and describing assets. While the three asset categories used in this analysis are likely to contribute most to biodiversity conservation, there are *many other assets that are essential* to achieve the broad goal, and many of these asset types occur as remnants of natural environments;

- Ensuring that the value of all lands, including Crown lands, is adequately recognised in funding allocations. There is a risk, for example, that freehold natural environments will be provided with government funds for management ahead of more important Crown land. This would not be consistent with meeting the broad conservation goal stated at the outset;
- Developing improved methods for ranking natural environments for biodiversity conservation. This will involve, in particular, methods that integrate criteria for assessing areas of natural vegetation, wetlands, rock outcrops, caves and other important categories of natural environment. The qualities of rareness, specialness and representativeness are likely to again provide the criteria for evaluation, with specialness being of particular importance; and
- As far as practicable, allocating resources across the priority areas in a way that best meets the broad goal of biodiversity conservation.

Results

Representative landscapes

Using the methods described above and in Attachment 2, representative landscapes were derived and rated in relation to their biodiversity importance and their level of threat from salinity. This information was further subdivided into three groups — termed tiers in this work (Figure 2.2):

Tier 1: those representative landscapes ranked highest (rank 1) for biodiversity importance that are also highly threatened by salinity

Tier 2: those representative landscapes ranked either second (rank 2) for biodiversity importance, or moderately threatened by salinity, or both

Tier 3: those representative landscapes ranked either third (rank 3) for biodiversity importance or with a low salinity threat, or both.

These tiers then present a useful starting point for allocating funds to priority public assets of this asset type. While it would be useful to have access to other information from risk analyses to provide more information on the viability of a particular landscape and the likelihood of management success, it was decided from this work that Tier 1 assets should be those assessed further, as a matter of priority, for funding.

There are a number of alternative approaches. It might be argued, for example, that landscapes ranked 1 for biodiversity, and at either moderate or low threat from salinity, should be the priority target for funding given that success in their management is more likely. However, this would effectively condemn Tier 1 assets to a low probability of retaining the full range of their current biodiversity values. On the basis of current information and the broad goal provided above, it was not considered acceptable to take this step without further risk analysis. It was also accepted that working in some of the more highly threatened areas would be more likely to deliver a better understanding of managing salinity, including the development of new technologies.

It is therefore proposed that a more detailed risk analysis be conducted for Tier 1 assets, and that they be ranked as priorities for investment in the light of this additional information. However, it should be noted that the outcome from further analyses is likely to be that particular landscapes are downgraded in priority, and others elevated.

The three tiers of landscape assets were mapped and developed within a Geographic Information System, and the resulting map is shown in Figure 2.3.

Threatened species and communities

Threatened species and communities were assessed in relation to the threat of salinity as described in the Methods section above and Attachments 1 and 2. The resulting map is shown as Figure 2.4.

It is clear from the map that there are many threatened species and communities that are at risk from salinity. In setting priorities within this group of assets, it would be essential to first:

1. rank the threatened species and communities for action in line with how endangered they are (see Attachment 1)

South West Biodiversity Assets		Biodiversity Value		
		Rank 1	Rank 2	Rank 3
Salinity Threat	High	Lake Warden	66	3
		Kojonup–Beaufort–Carrolup River Flats	86	2
		Buntine–Marchagee	70	20
		Muir–Unicup	64	8
		NE of Stirling Ranges (Anderson Lake to Corackerup Nature Reserve)	57	12
		Magenta Area	60	15
		Lake Bryde	41	28
		Dunn Rock/Lake King Chain	19	30
		Moore River System	44	32
		Drummond	45	56
		Boyup Brook–SE Collie Area	19	18
		Yinniebatharra System and Hutt Lagon	44	17
		Upper Lort River (possibly including Pyramid Lake)	45	26
		Headwaters of the Fitzgerald River	21	29
		Kondinin Salt Marsh	81	
		Toolibin Lake	24	
		Chinocup System	51	
		Coyrecup Nature Reserve	16	
		Mortlock River System (Northern Branch)	61	
		Lake Gore		
		Cowcowing Lake System		
		Kent Road Braided Saline Drainage System		
		Mollerin Lake System		
		Darkin Swamp/Dobbaderry Swamp System		
		91		
		94		
		80		
		46		
		67		
		92		
		82		
	Medium	13	39	7
		34	6	87
		47	27	10
		63	25	36
		75	35	37
		93	48	38
		95	76	5
			42	31
			74	
			23	
			58	
			72	
	Low	55	84	1
		54	33	4
		65	53	9
		71	43	14
		68	85	11
		89	52	
		88	77	
			40	
			90	
			22	
			49	
			62	
			50	
			83	
			73	
			59	
			69	

Figure 2.2 Representative Landscape Assets — Biodiversity Rank vs Threat Analysis — Numbers refer to specific landscape units

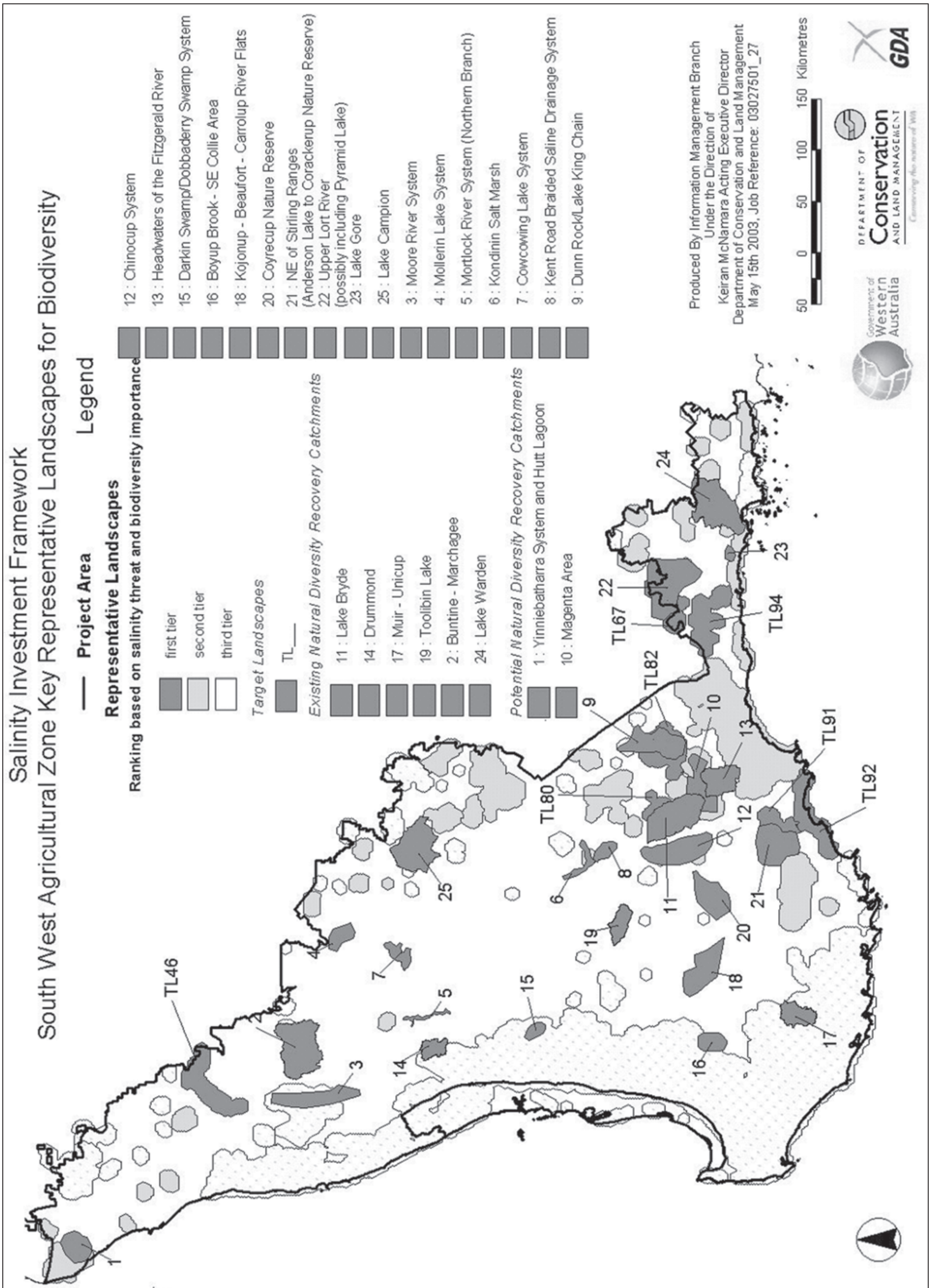

Figure 2.3 South West Zone Key Representative Landscapes for Biodiversity

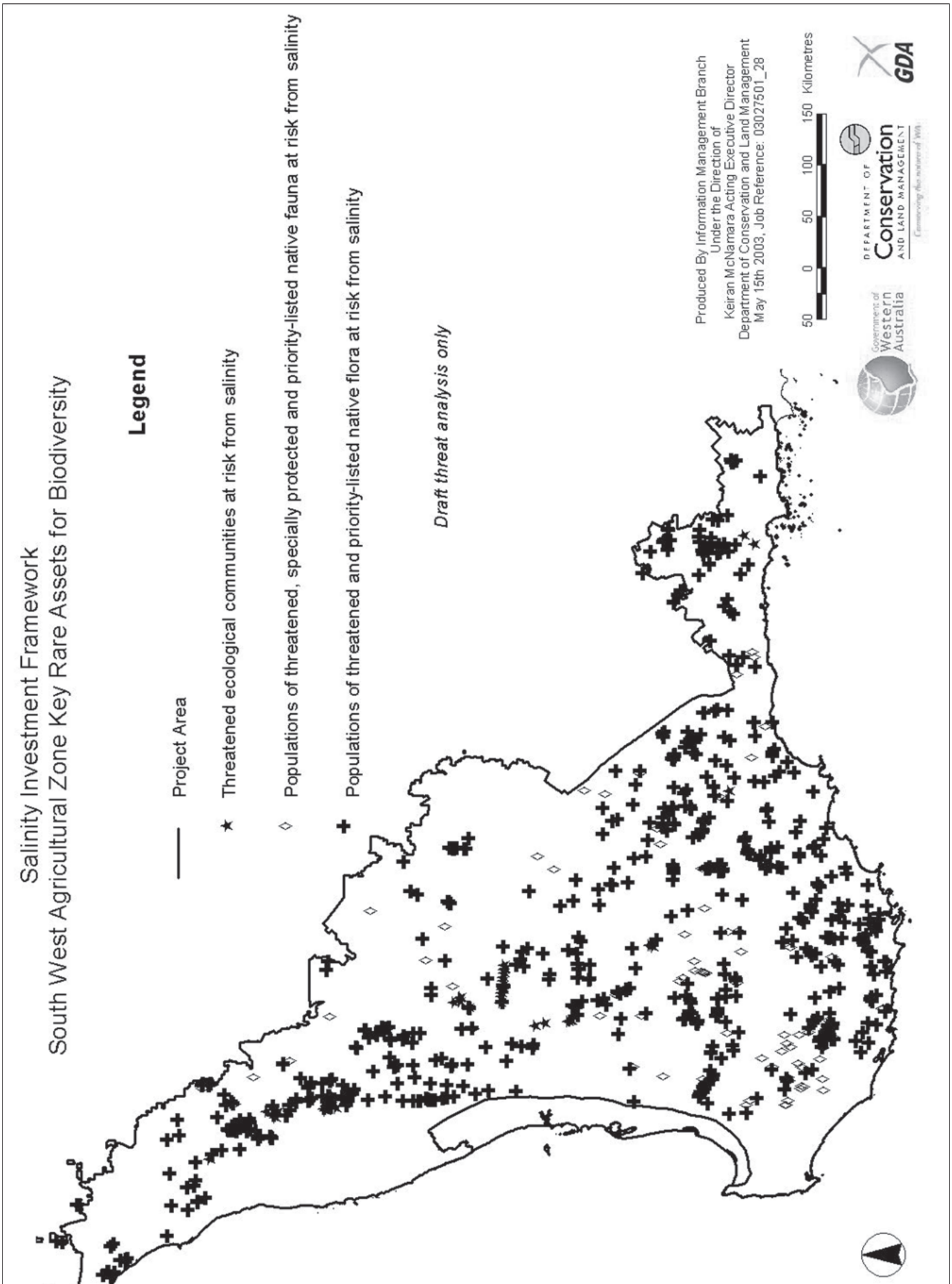

Figure 2.4 South West Zone Key Representative Landscapes for Biodiversity

2. undertake a field assessment (or preferably, obtain local advice) concerning the salinity risk to the subset of species determined from (1) above. This is necessary to confirm the level of threat from salinity. The Land Monitor data used to calculate salinity risk does not provide information concerning local hydrogeology. For example, while a plant population may occur in a valley floor threatened by salinity, the plant itself may only occur on low, sandy dunes within valley floors, and as such not be threatened by salinity. This level of discrimination is not available from Land Monitor.

Conclusions and recommendations

The methods and results described above have covered the first two steps of the six steps proposed in the Salinity Investment Framework. Additionally, in the case of risk assessment, only salinity (see Attachment 3) has been considered, and this has been considered using a broad scale analysis of salinity threat that does not take into consideration local topography, hydrology and other site characteristics.

Whether steps 3-6 of the Salinity Investment Framework are completed depends on the acceptance of the work to date. If the above process (with suitable amendment) is accepted, then steps 3-6 are necessarily applied at the level of specific, individual assets that are agreed to be of high priority for action. These steps require much more site-specific work and the application of considerable resources. Although ideally one would assess in detail the importance of all biodiversity assets, in reality this would be a poor allocation of resources. There are only sufficient funds to fully assess the most important and most threatened assets.

Conclusions

The project group is confident that the methods and results described above provide a useful framework and starting point for investing in biodiversity assets threatened by salinity. However, a range of issues must be addressed to improve the methods used. These issues include developing better, and more generic criteria for describing and ranking assets, and risk assessments that encompass the full range of threats. However, before embarking on this work, it is essential that stakeholders fully review the methods proposed here.

Recommendations

The project group recommends that:

1. Biodiversity assets identified in the SIF are checked and assets of equal or greater importance proposed by interested members of the Avon regional community as part of the project involving that region. For state funds, the Minister for the Environment holds the ultimate authority and responsibility for deciding priority assets. However, it is noted that there is a need to better engage the Avon regional community (work currently in progress).

2. Work continues to improve methods for describing and ranking biodiversity assets, particularly with respect to the full range of human values covered by the broad goal.

3. A high priority is given to developing a methodology and criteria that integrates priority setting across all landscape types (for example, natural diversity recovery catchments and other landscape types). This is consistent with existing recommendations in CALM's review of its salinity programs (Wallace 2001).

4. Priority setting processes for natural environments are developed for assets not included within the priority categories proposed above of rare species, rare communities, and representative landscapes.

5. The greater part of state government salinity funds for biodiversity conservation is allocated in 2003–04 to the priorities (threatened species, threatened communities, and Tier 1 representative landscapes) identified by this document. Given that the recovery of few additional landscapes can be started in any one financial year, the allocation of funds will depend on additional criteria and risk assessment to rank Tier 1 representative landscapes in order of priority for action. In the case of threatened

species and communities, those that are critically endangered *and* threatened by salinity are the recommended priority for action. (Note, there are technical issues that need to be resolved before the threatened species and communities data can be fully integrated with Land Monitor data.)

6. Depending on the final outcome of SIF work with the Avon Catchment Council, results from this work are extended to other regional NRM groups.

It should be emphasised that priority setting is a continuing process that must be reviewed on the basis of new knowledge and technical information. Some of the above recommendations reflect the need to begin now the process of review, both of this methodology and of the allocation of specific priorities. Either re-allocation of existing funds, or allocation of new funds, will be needed to develop and implement SIF processes.

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Attachment 1

Processes for selecting threatened and specially protected native species

[This Attachment was originally prepared for a document dealing with goals and targets in the Avon Region. A Subcommittee of the Avon Catchment Council prepared the document]

Under state legislation there are statutory mechanisms for formally listing various categories of threatened native flora and fauna. For listing of both flora and fauna the process is as follows.

1. A species or other taxon is nominated for listing. Any person or organisation may nominate a species for listing; however, certain information is required (see below).
2. Once a year, the schedules of threatened flora and fauna are considered by the WA Threatened Species Scientific Committee (TSSC). There is a public advertisement for membership of this committee which is appointed by the WA Minster for the Environment. At this meeting nominations for listing and de-listing of species are considered against specific criteria and a list of recommendations to amend the list prepared. The membership of the TSSC is given in Addendum 1.
3. Lists of recommended changes are sent to the Conservation Commission of WA for endorsement.
4. Lists of recommended changes are sent to the Corporate Executive of the Department of Conservation and Land Management for endorsement.
5. Lists of recommended changes are sent to the Minister for the Environment and Heritage for endorsement.
6. Lists, as amended, are published in the *Government Gazette*.

As an organisation, the Department of Conservation and Land Management has formal procedures for ranking threatened species against each other. Generally, management efforts focus on those that are critically endangered — the most at risk category.

Additionally, a large number of native flora are under consideration for listing as threatened, and other species are known to be rare but are not threatened. The Department lists flora within each of these groups under various categories of Priority Flora (Atkins 2001).

Criteria for selecting threatened flora

According to the policy of the Department of Conservation and Land Management, protected flora may be recommended for gazettal as declared rare flora (threatened species) if they satisfy the following criteria.

1. The taxon (species, subspecies or variety) is well-defined, readily identified and represented by a voucher specimen in a state or National Herbarium. It need not be formally described under conventions in the International Code of Botanical Nomenclature, but such a description should be undertaken as soon as possible after listing on the schedule.
2. It has been searched for thoroughly in the wild by competent botanists during the past five years in most likely habitats, according to guidelines approved by the Executive Director.
3. Searches have established that the plant in the wild is either:

   a. Rare; or

   b. In danger of extinction;

   c. Deemed to be threatened and in need of special protection; or

   d. Presumed extinct.

4. In the case of hybrids, or suspected hybrids:

   a. They must be a distinct entity, that is, the progeny are consistent within the agreed taxonomic limits for that taxon group;

   b. They must be [capable of being] self-perpetuating, that is, not reliant on the parent stock for replacement; and

   c. They are the product of a natural event, that is, both parents are naturally occurring and cross fertilisation was by natural means.

With the exception of one species — which is rare in WA but not in the eastern states — the state list should be identical to the Commonwealth list of threatened flora. In practice there are some differences due to delays in listing state changes on the Commonwealth list.

Criteria for selecting threatened and specially protected fauna

Threatened fauna

The Minister may declare animals (including fish and invertebrates) that are protected fauna under the Wildlife Conservation Act as threatened fauna. Currently all invertebrates except jewel beetles (family Buprestidae) and ants of the genus *Nothomyrmecia* have been declared not protected by Ministerial notice. If any invertebrate taxa not in these groups are to be declared as threatened fauna they will first need to be protected by removal from the provisions of the Ministerial notice.

A taxon may be recommended for declaration as threatened fauna by the Threatened Species Scientific Advisory Committee if it satisfies the following criteria.

1. The taxon is part of the indigenous fauna of Australia or its external territories, and is well defined in the taxonomic literature or, in the case of an undescribed or poorly defined taxon, it is represented by a voucher specimen in a state or National Museum or some other collection recognised by the Western Australian Museum as a proper repository for taxonomic material. It need not necessarily be formally described under conventions in the International Code of Zoological Nomenclature, but such a description is preferred and should be undertaken as soon as possible after listing on the schedule.

2. It has been established that the taxon in the wild is either:

   a. presumed to be extinct

   b. in imminent danger of or threatened with extinction, that is, it is likely to decrease in numbers and possibly become extinct if factors causing its decline continue to operate (includes taxa whose numbers have been reduced to a critically low level or whose habitats have been so drastically reduced that they are deemed to be in immediate danger of extinction, and taxa that are not yet rare but are under threat from serious adverse factors throughout their range)

   c. dependent on, or restricted to, habitats that are vulnerable and/or subject to factors that may cause its decline, or

   d. very uncommon, even if widespread.

The Committee may recommend taxa if it believes that they meet one or more of the above criteria, even if insufficient information exists to accurately establish their status at the time.

Taxa may also be declared by the Minister if they have been declared to be threatened by other Australian States or Territories (including taxa on the Official List of Endangered Vertebrates of Australia and its Island Territories adopted by the Council of Nature Conservation Ministers) or are classified as threatened in a treaty to which Australia is a party. Western Australia has agreed to list all species listed under Article M of the Japan–Australia Migratory Birds Agreement (JAMBA). These birds are those on the Official List of Endangered Vertebrates of Australia and its Island Territories that do not occur naturally in Western Australia.

The status of a threatened taxon in captivity has no bearing on the above criteria.

The Threatened Species Scientific Advisory Committee may recommend that a taxon be removed from the schedule of threatened fauna where:

i) recent zoological survey has shown that the taxon no longer meets the above criteria

ii) the taxon is no longer threatened because it has been adequately protected by habitat protection and its population numbers have increased beyond the danger point.

The Committee also prepares a ‘Reserve’ List including animal taxa:

a. that have recently been removed from the list of threatened fauna

b. that have a restricted distribution, are uncommon or are declining in range and/or abundance, but which do not meet the criteria for listing as threatened fauna

c. for which there is insufficient information for the Committee to make an assessment of their status.

The Reserve list is also reviewed at least every three years.

Specially protected fauna

The Schedule of Specially Protected Fauna is dealt with in the same way as the Schedule of Threatened Fauna. The criteria for addition to the schedule are the same, except for the addition of the criterion that it has been established that the taxon in the wild is either:

a. likely to be taken because of high commercial value and the standard penalty for taking is insufficient deterrent, or

b. uncommon, but not threatened at present, but is either of commercial or intrinsic value or is perceived to be damaging a commercial or hobby enterprise, and taking may lead to the taxon becoming threatened.

The Threatened Fauna Scientific Advisory Committee may recommend that taxa be removed from the schedule of specially protected fauna where:

a. recent zoological survey has shown that the taxon no longer meets the above criteria

b. the commercial or other incentive to take has disappeared or has been removed by some other means.

Addendum for Attachment 1

Membership list for the Threatened Species Scientific Committee

Chairman

Mr Keiran McNamara, Director of Nature Conservation, CALM

Members (Alphabetical order)

Member	Area of Expertise for Committee	Professional position
Dr Ken Atkins	Flora ecology and conservation management (especially threatened flora)	Principal Botanist, CALM Wildlife Branch
Dr Allan Burbidge	Avian fauna ecology, conservation and biogeography	Senior Research Scientist, CALM Science and Information Division
Dr Andrew Burbidge	Threatened species management (especially vertebrate animals), Chair of Commonwealth Endangered species Advisory Committee	Director, WA Threatened Species and Communities Unit, CALM
Dr David Coates	Flora conservation genetics and management	Principal Research Scientist, CALM Science and Information Division
Dr Mark Harvey	Invertebrate animal taxonomy and distribution	Curator of Arachnids, Western Australian Museum
Dr Stephen Hopper	Flora ecology and conservation management	Director, Kings Park and Botanic Garden
Dr Rick How	Vertebrate animal taxonomy and distribution	Curator of Biogeography and Ecology, Western Australian Museum
Assoc. Prof. Jonathon Majer	Invertebrate animal ecology and conservation	School of Environmental Biology, Curtin University of Technology and also Convenor of the Australian Entomological Society's Conservation Committee

Attachment 2

Implementing a methodology for priority setting for biodiversity conservation within the South West Agricultural Zone using a Geographic Information System (GIS)

Background

The methodology outlined here follows and further develops in part the target landscape methodology outlined in Wallace et al. (in draft).

Although documented here as a series of linear steps, the process is iterative and indeed steps may be run parallel or subsequent steps commenced before full completion of the preceding one.

Boundaries of the project area

Although identified in the preliminary process as areas for exclusion, the forested areas within the RFA boundary and those within the Perth Metropolitan Area have been carried through, within this initial South West Agricultural Zone analysis, to step 4. The boundaries are the coastline and the clearing line. The delineation of the project area boundary has implications on the ultimate location of resulting target landscapes; the process run over the same general area within differing project area boundaries will possibly result in different target landscapes or landscapes with differing external boundaries.

Step 1: Establishing a broad goal

This part of the process has already been discussed in this report in some detail and little further elaboration is required here. The importance of re-affirming and refining the initial goal cannot be over emphasised, when proceeding through subsequent steps.

Step 2: Identification of South West Agricultural Zone biodiversity assets

Representative landscapes have been defined here as being of two types:

- Type 1 — Areas with a minimum specified proportion of remaining native vegetation (target landscapes)

The definition of remaining native vegetation has been based in this process on the Department of Agriculture (DoA) vegetation extent dataset. Some modifications had already been made to this dataset to address perceived anomalies over areas of plantation, and subsequent to this, as part of this process, a one-hectare filter was applied to remove patches too small to provide significant habitat.

The minimum specified proportion within a 10 000 ha area varied spatially with a threshold of 40% being used along the more heavily vegetated coastal strip, and a threshold of 25% applied to the remaining fragmented portion of the project area. Some manual editing of internal boundaries occurred in larger landscapes to reduce the range of landscape sizes as a precursor to step 3.

Biodiversity assets defined in this manner are indicative areas of potential interest. The specific line boundary is based on the sampling units (hexagons). Their precise location would need to be determined through ground-truthing and broader discussion.

- Type 2 — Existing and potential natural diversity recovery catchments

Boundaries of existing Natural Diversity Recovery Catchments already held by the Department of Conservation and Land Management (CALM) were used, whilst boundaries for potential Natural Diversity Recovery Catchments were created for this process and are draft and indicative boundaries only.

Rare species and communities have been identified in this process using existing CALM databases for declared rare and priority flora (DRF), threatened fauna and threatened ecological communities (TEC).

This definition of biodiversity assets may not be appropriate to all scales of use nor at all spatial locations. Ongoing refinement is an inherent characteristic of the process and may include the addition or exclusion of existing asset types or the refinement of types such as the variation of target landscape parameters.

Information from the Wheatbelt Biological Survey and National Land and Water Resource Audit Bioregional Biodiversity Audit were not available for guiding the definition of biodiversity assets at this stage of the process (February 2003).

Step 3: Evaluation of assets — Current importance

The relative current biodiversity value of each representative landscape was determined as a numeric count in the following manner:

the area of remaining native vegetation within each landscape divided by x

\+

count of declared rare and priority flora species within each landscape multiplied by y

\+

count of threatened fauna within each landscape

\+

count of threatened ecological communities within each landscape multiplied by z

\+

count of Ramsar wetlands within each landscape

\+

count of nationally important wetlands within each landscape

\+

count of additional wetlands of interest identified by Stuart Halse (CALM) within each landscape,

\+

biodiversity importance measures derived from a preliminary analysis of data from the Wheatbelt Biological Survey.

Where

x = 1000 for assets with an area of remaining native vegetation < 100 000 ha
x = 10 000 for assets with an area of remaining native vegetation ≥ 100 000 and < 250 000 ha
x = 100 000 for assets with an area of remaining native vegetation ≥ 250 000 ha
y = 5 for critically endangered flora in the DRF database
y = 3 for endangered flora in the DRF database
y = 1 for vulnerable and un-ranked endangered flora in the DRF database
y = 0 for extinct rare flora in the DRF database
z = 5 for critically endangered communities in the TEC database
z = 4 for endangered communities in the TEC database
z = 3 for priority communities in the TEC database
z = 2 for vulnerable communities in the TEC database
z = 1 for lower risk communities in the TEC database
z = 0 for totally destroyed communities in the TEC database.

Established processes exist for the assessment of threatened species and communities as discussed already in this report.

It should be noted that this methodology for defining assets and the relative value of those assets is highly reliant on data availability and quality. Representative landscapes have been treated as being distinct even in instances where they are spatially coincident, and biodiversity assets located near one another may in combination be assigned quite different values than when treated separately. Additionally it does not currently include any measures of comprehensiveness, representativeness and adequacy (CAR), connectivity, fragmentation, general asset condition, and the impact of threats other than salinity on an assets value. However, it should be noted that the acceptance into the analysis of landscapes with 25 % or more of their area in natural vegetation is, itself, a measure of viability (see Wallace et al. in draft). Existing agency legislative responsibilities in relation to land management and priorities and programs have not been measured against or included in this current valuation methodology. Nor has the validity and rigour of the weighting schema in particular been tested within CALM.

Step 4: Evaluating salinity threat (risk assessment)

The salinity threat to each representative landscape and rare species and community was quantified using the Land Monitor salinity and salinity risk datasets. Within each representative landscape the area of remaining native vegetation at risk from salinisation and not already salt-affected has been calculated as a percentage of all the remaining native vegetation within that asset. Rare species and communities were classified as at risk of salinisation when they were coincident with the salinity risk dataset.

The Land Monitor data was used without modification and thus any calculation of risk is dependent on any limitations of this dataset in a particular location. Technical feasibility or the capacity to manage the threat were not considered, nor was the urgency or time to maximum impact.

Representative landscapes were grouped into the following classes as a means of incorporating them into the three-tiered value–threat matrix:

- Value classes

Rank 1 representative landscapes are those that have a value score of 100 or above. Rank 2 representative landscapes are those with a value score of between 10 and 99, whereas rank 3 representative landscapes are those with value scores between 0 and 9. In this manner, approximately 25% of all these assets fall within each of the high and low classes and 50% within the medium class.

- Risk classes

Representative landscapes at high risk have been defined as those with 11% or more of their remaining native vegetation at risk. Medium risk representative landscapes are those with between 5 and 10% at risk, and low risk representative landscapes as those with between 0 and 4% at risk. In this manner, approximately 25% of all these assets fall within each of the medium and low classes and 50% within the high class.

After applying this approach, any existing and potential natural diversity catchments that lay outside Tier 1 were, based on expert knowledge, placed into Tier 1. In future processes it is planned to develop and use better criteria for assessing biodiversity importance so that the entire process is quantitatively based.

All biodiversity assets identified using the methodology outlined here are by definition of high value, and thus tiering of representative landscapes is a means of initial prioritisation, and assets that do not fall within the high-value class at this stage are medium or low only in relation to a group of assets already defined as important.

As discussed above, the current threat analysis does not include timing of threat. It may not be appropriate for high-value representative landscapes to be in the third tier based purely on their having a relatively small area at risk from salinisation given that that risk may be imminent. Biodiversity asset urgency data at a scale that is relevant to the landscape or smaller asset is not currently available across the south west agricultural zone.

Additionally, and as mentioned above, the spatial relationships and interdependencies between the different types of landscapes were not considered in this analysis.

Attachment 3

Categories of threats

[Extract from Wallace et al. in draft — see references]

1. *Altered biogeochemical processes:* Management issues include:
   a. hydrological processes, particularly salinity and negative impacts of drainage
   b. nutrient cycles, including eutrophication
   c. carbon cycle and climate change.

2. *Impacts of introduced plants and animals:* Management issues include:
   a. weed eradication
   b. control of feral predators
   c. preventing the new introductions of damaging species
   d. grazing of remnants by stock.

3. *Impacts of problem native species:* Management issues include:
   a. explosion in numbers of some parrots, due to habitat change, resulting in grazing damage and competitive exclusion of some other native species
   b. defoliation by scarab beetles and other damage by excessive numbers of native herbivores.

4. *Impacts of disease:* Management issues include:
   a. dieback (*Phytophthora* spp)
   b. armillaria.

5. *Detrimental regimes of physical disturbance events:* Management issues include:
   a. fire regimes that lead to local extinction of one or more species;
   b. cyclones
   c. drought.

6. *Impacts of pollution:* Management issues include:
   a. herbicide use and direct impacts on plants, including effects of fungicides
   b. pesticide surfactants and impacts on vertebrate reproduction
   c. oil and other chemical spills.

7. *Impacts of competing land uses:* Management issues include:
   a. recreation management
   b. management of agricultural impacts
   c. management of consumptive uses (wildflower cutting, timber cutting, etc.)
   d. management of illegal activities
   e. management of mines and quarries on bushland.

8. *An unsympathetic culture:* Management issues include:

   a. attitudes to conservation;
   b. poor understanding of nature conservation values and their contribution to human quality of life.

9. *Insufficient resources to maintain viable populations:* The management issue here is:

   Ensuring that there are sufficient resources (see Table 1), if threats (1) to (8) inclusive are held constant, to allow viable populations of organisms to persist. This includes sufficient space for habitat replication so that disturbance regimes, see threat (5) above, may be managed. Revegetation to create buffers and corridors, habitat reconstruction, and regeneration of degraded areas are important management techniques in this context.

Appendix 3
Water resource assets at state scale

Identification of important water resource assets – South West Agricultural Region

Introduction

Water is one of our most important resources and potable water is in short supply. The Community treasures water resources as places to live near, for recreation, or to enjoy as places of serenity and beauty. Much of the state's biodiversity of plants and animals depend on healthy water resources for long-term survival.

Water resources are important for a number of other reasons, including:

- support a rich biodiversity — provide habitat and water for terrestrial and aquatic flora and fauna, and may provide refuges for fauna in times of drought
- provide life-supporting ecosystem services — supply water for flora and fauna, assist in the formation of soils, absorb pollutants, and maintain near-shore marine environments
- provide drinking and domestic water
- provide water for agricultural and industrial use, and for economic development generally
- provide settings for tourism
- provide locations for harbours, marinas and jetties (particularly in estuaries)
- provide recreation and other personal opportunities such as swimming, boating, picnicking, fishing, marroning, walking, and nature appreciation
- are a significant part of Aboriginal and European heritage
- provide distinctive landscape features and have aesthetic values
- provide an attractive setting for urban and residential development, and contribute to a locality's 'sense of place'.

In addition waterways:

- drain land and carry floodwaters
- have ecosystem linkage values — in substantially cleared areas they are often the only corridors for wildlife.

The salinity of many water resources (waterways, wetlands and groundwater) in the South West Agricultural Zone has increased significantly as a result of extensive clearing associated with farming practices in the wheatbelt. The salt load in some south-west streams has increased by more than five-fold over the past 50 years. Increasing salinity has and will continue to have an impact on waterway and wetland aquatic and terrestrial ecosystems. The full impact of salinity on riverine ecosystems is not well established, but includes a loss of fringing vegetation and decreased water quality. The future availability of fresh water for rural and urban areas in Western Australia is also at threat from salinity.

For all of the reasons listed above there is a need for water resources to be protected from the impacts of salinity. As identified by the State Salinity Council, any investment in water resources needs to be targeted to ensure that those resources with the highest public value are managed. To ensure appropriate targeting of investment in water resource management the following process was developed to identify high-importance water resource assets. This exercise has not identified the final priority ranking of assets for investment. However, it has resulted in a significant movement towards accomplishing this task.

The method for identifying high-importance water resource assets for the Salinity Investment Framework was developed by officers of the Department of Environment, who have the responsibility for managing the state's water resources. The methodology for identifying high-importance water resource assets follows the State Salinity Framework's six-step process for identifying priority assets (discussed in section 2.1.3).

This appendix describes the methodology used to identify high-importance water resource assets for the Salinity Investment Framework. The water resource asset class comprises two subclasses: water supplies and waterscapes (wetlands and waterways). The attributes of assets within these subclasses are defined, followed by an outline of the method used to derive value and salinity threat information for each asset.

Methods

The methodology for identifying high-importance water resource assets is based upon the approach developed by the Water and Rivers Commission (2002a) in the *State Wide Waterways Needs Assessment* for identifying waterway management priorities in Western Australia. The *State Waterways Needs Assessment* methodology utilised stakeholders and water resource experts in collecting information on waterways and determining priorities for management.

The method described here involved a guided expert panel to assess a range of different attributes for the various water resource assets. The expert panel was given access to published and spatial data when scoring criteria. Details on this spatial and published information were discussed against the criteria described in following sections. The expert panels were then given an opportunity to review the results.

Expert panels were formed in the Department of Environment's South Coast, South West, Peel–Kwinana, Swan Goldfields Agricultural and Mid-west Gascoyne Regions. Part or all of the jurisdictions of these Department of Environment Regions fall within the South West Agricultural Zone.

For the purpose of identifying the high-importance assets the expert panels were used firstly to identify assets and then collect information on their value and salinity threat. The expert panels were presented a series of criteria questions, which they were asked to score:

1. What and where are the water resource assets?

2. Why is the asset valuable (economic, social, environment)?

3. Is that value at risk from salinity?

These criteria questions are explained in more detail in the following sections.

The engagement of an expert panel offered an important opportunity to gather further information on water resource assets. To guide further investigations that will help identify investment priorities the expert panels were also presented the following criteria questions:

4. What is the current condition of the asset?

5. What are the other threats that will impact on the asset's value?

6. For protection of value what goal is required? R = recover, C = contain, A= adapt or N = nothing

7. How much will it cost to achieve the specific goal?

8. What is the capacity of the community and government agency to achieve this goal?

9. In terms of salinity investment, how would you rank the assets in your region at a state level?

The data collected for each of these extra criteria will provide a good starting point for further investigations into tractability of salinity management options to achieve specific goals for assets.

Broad goal

The Department of Environment's functions and powers are outlined in Part 3 of the *Water and Rivers Commission Act 1995*. As affirmed in the Legislative Assembly Second Reading Speech for the *Water Resources Commission Bill 1995*, the Department of Environment has

> 'a clear mandate to manage the state's 'water resources', which embrace all watercourses, lakes, wetlands, estuaries, rivers and aquifers and underground drainage, surface and surplus water, and to concentrate on the assessment, conservation, protection and management of those water resources and their environment.'

The Department of Environment has a statewide responsibility for advising on water resource management issues. Water resource issues may relate to wetlands, waterways and water supply protection and management including the restoration of degraded environments.

The broad nature of these responsibilities required that two broad goals be developed for the water resource asset class:

1. To protect, manage and restore present and future water supplies from the impacts of salinity

2. To protect, conserve and restore significant waterscapes (wetland and waterway ecosystems) from the impacts of salinity.

These two goals are closely linked to the second and third aims identified in the Western Australian Salinity Strategy (Government of WA 2000, page 10):

- To protect and restore key water resources to ensure salinity levels are kept to a level that permits safe, potable water supplies in perpetuity.

- To protect and restore high-value wetlands and natural vegetation, and maintain natural (biological and physical) diversity within the south-west region of Western Australia.

To acknowledge these vastly different goals and their related values the assets have been grouped into two subclasses:

1. Water supply class

2. Waterscapes (wetland and waterway ecosystems).

Assessing assets and risk

Description of asset

As discussed above there are two subclasses of water resource assets (water supply and waterscape). Although the expert panels were given the opportunity to identify assets within their regions, it was considered important to present a list of assets as a starting point. The water assets presented to the expert panels comprised assets identified in:

1. Legislation:
    - *Rights in Water and Irrigation Act 1914*

- *Waterways Conservation Act 1976*
- *Country Areas Water Supply Act 1947*
- *Metropolitan Water Supply, Sewerage and Drainage Act 1909*

2. International, National and State Policies and Agreements:
   - *Ramsar Agreement Wetlands*
   - *Japan and Australia Migratory Birds Agreement* (JAMBA)
   - *Chinese and Australia Migratory Birds Agreement* (CAMBA)
   - *Australian Nationally Significant Wetlands*
   - *Environmental Protection Policy Wetlands*
3. State reports and investigations:
   - *State Waterways Needs Assessment — P1 waterways*
   - *Wild Rivers*
   - *Fringing Vegetation Studies (excellent and good)*

There was no intention to limit water resource assessments to assets identified from these sources. The expert panels were given an opportunity to expand the list with assets that they considered important within their relevant regions.

As discussed in the previous step, assets were assigned to the following subclasses — water supply and waterscapes. The water supply subclass generally included:

- both current and proposed Public Drinking Water Source Areas and Recovery Catchments
- groundwater areas, irrigation districts and waterways proclaimed under the *Rights in Water and Irrigation Act 1914*
- local town water supplies not proclaimed under legislation
- Referrable Dams for drought relief, Water Corporation.

The waterscape subclass generally comprised:

- significant wetlands, including Ramsar, JAMBA, CAMBA and Environment Australia Significant wetlands.
- waterways identified in the Wild Rivers Report (Conservation Council WA, 1988; WRC, unpublished, 1999) and Priority 1 waterways from the State Waterways Needs Assessment (WRC, 2002).
- waterways proclaimed under the *Waterways Conservation Act 1976.*
- reaches of rivers identified as having pristine and good quality riparian vegetation (various WRC reports).

Focusing the assessment

The expert panels were then asked to identify the significance of each asset at a state, regional, and subregional level. Those assets considered to be of value at a state and regional level were retained for further analysis.

The SIF focus is within the South West Agricultural Zone. Therefore assets not within this area were removed from further assessment. The SIF focus is on salinity; therefore, using Land Monitor data, those assets falling outside the areas mapped as being at threat from salinity at equilibrium were removed from further assessment.

Separating those assets not affected by salinity from further assessment should not be misinterpreted to imply that they have a lesser value than assets continuing through this process. In some cases their value will be greater. It is important to make this distinction, as the key output of the SIF is to identify assets of high value at high threat from salinity. Assets not at threat from salinity will be addressed by other natural resource management processes and funding.

Evaluation of assets (current)

Value, as defined by the *Oxford Dictionary*, refers to '…worth, desirability, or utility, or the qualities on which these depend'. It is these 'qualities' on which the worth, desirability, or utility of water resources depend that are the focus of this section.

The two broad WRC (DoE) goals stated above, relate to assets with very different values. The water supply goal identifies assets that have an anthropocentric (human centred) value as these assets are developed and used primarily for industrial, agricultural and public drinking water purposes. Waterway and wetland assets are not only important for their water supplies but are also important for the ecological services that they provide. Examples of ecological services include: maintenance of atmospheric and water quality; provide flood control; genetic library maintenance; and support ecosystem food webs and nutrient cycles. Wetland and waterway assets are also important for their aesthetics, landscape, European and indigenous heritage and biodiversity values.

Most assets identified by this process will have a collection of values. For example, the Wellington catchment not only provides water for agriculture on the Swan Coastal Plain but it is also an important asset for local recreation. In the not too distant future this asset will contribute to public drinking water supplies. All of these activities relate to economic and social values. There are also unique landscapes, pristine tributaries and other waterscapes within this catchment that provide environmental values to the asset's 'overall value'. Any salinity management option that protects the quality of this water supply may also result in benefits to the asset's social and environmental values.

Protection and management of a waterway or wetland based on its landscape values may also result in other associated values being retained or enhanced. For example, protection of the lower reaches of the Blackwood River may impact positively on fisheries within the estuary, tourism and the local resident's lifestyles.

The introduction to this appendix outlines some of the many values associated with water resources. As outlined above, water resource assets may have more than one associated value. It was considered important to acknowledge and score these multiple values. Values were grouped into three broad categories — economic, social and environmental.

Economic values

Industries throughout Western Australia (e.g. agricultural, aquiculture, mining, fisheries, tourism etc.) derive a multitude of economic benefits from water resources. For example, direct benefits would include:

- provision of water to enable agricultural production and mineral processing to proceed
- provision of fresh water for drinking
- provision of settings for tourism
- provision of locations for harbours, marinas and jetties (particularly in estuaries)

Indirect economic benefits derived from water resources (specifically near waterways) would include:

- increases in stock health through a reduction in heat or cold stress due to windbreaks and shelter provided by riparian vegetation
- an increase in the capital value of land due to the picturesque outlook provided to any dwelling located beside the feature
- ability to drain the land and prevent loses of production to flooding and waterlogging.

Social values

Recreation: Water resources such as water supplies and waterscapes can provide pleasant surroundings that are popular for various recreational pursuits. Rivers and the riparian zone are an important recreational resource for fishing, swimming, bird watching, picnicking, boating walking, nature appreciation and other pursuits.

Spirituality and culture: Wetlands, rivers and foreshores are often places of spiritual and cultural significance. Traditional landowners may have strong spiritual attachments to watercourses. Wetlands, rivers and foreshores are also places of spiritual significance for non-indigenous communities.

Sense of Place: Provide an attractive setting for urban and residential development, and contribute to a locality's 'sense of place'.

Environmental values

Biodiversity: Biodiversity refers to the variety of genes, species and ecosystems, and is essential to human well-being in many ways. It underpins ecological processes that are vital to human health and survival and the continued evolution of life on Earth. Although biodiversity was considered in this value assessment, it was not the focus. The DCLM's assessment of biodiversity value is far more rigorous and robust.

Uniqueness: Some habitats and ecosystems are representative of environmental systems that are no longer widespread and are therefore considered unique.

Aesthetics: The river and riparian zone, or a vegetated public drinking water catchment or groundwater area, tend to dominate the local landscape and may also contribute significantly to the regional landscape and so are important to the aesthetic value of an area.

Ecological function: Water resources provide life-supporting ecosystem services such as:

- supplying water for flora and fauna
- assisting in the formation of soils
- absorbing pollutants, and maintaining near-shore marine environments

Waterways have ecosystem linkage values — in substantially cleared areas they are often the only corridors for wildlife and they provide:

- improved water quality due to a healthy riparian ecosystem
- decreased algal blooms and eutrophication due to the flushing effect of flooding.

Using the following scales, water resource assets were scored for their economic, social and environmental values described above:

1 = None, the attribute does not contribute to the value of the asset
2 = Minor, the attribute contributes to the asset at a local level
3 = Moderate, the attribute contributes to the value of the asset at a local and regional scale
4 = Important, the attribute contributes to the value of the asset at local, regional and state scale

5 = Significant, attribute contributes to the value of the asset at a local, regional, state and national level
Unknown = unable to answer

After scoring each value (economic, social and environment) independently, the expert panel was asked to score an asset's overall value considering all categories. The scale for overall value was the same as that described for environment, social and economic values above. The score was either the highest scoring subvalue (if it was considered to be that important) or an average of all three (if they could not be separated). A maximum of 20 points could be obtained by combining all four scores for value. A score of one was equivalent to a value of zero thus scores of one were converted to zero.

For presentation in the value–threat matrix low, medium and high values were defined:

Low value: score of 1–9
Medium value: score of 10–14
High value: score of 15–20

Evaluating salinity threat (risk assessment)

It is important to determine both the time until maximum impact and the extent of that impact on the asset's value. Those assets not at threat from salinity will have a lower priority than those assets of high public value with a high salinity threat.

Referring to the value scores obtained from the section above, the expert panel made an assessment of the asset value's threat from salinity. The expert panel were asked to score the salinity threat using the following threat scale:

1 = None, there is no threat to the value from salinity, or the value is already significantly impacted on by salinity and not expected to get any worse.
2 = Minor, salinity threat is likely to occur in 75 years or more
3 = Moderate, salinity impacts will occur in 20 to 75 years.
4 = Severe, salinity threat will occur over within 20 years.
5 = Extreme, impact is imminent and substantial and will occur within the next 5 years.
Unknown = unable to answer the question.

In their deliberations on threat, the expert panels had access to spatial datasets that included:

- ***Prediction of areas at risk of salinity*** (Dunne & Caccetta 2001): This is a spatial information set that describes the areas of the landscape expected to be saline when the new groundwater equilibrium is attained. The salinity risk predictions are based on analysis of landscape elevation, vegetation trends, ground-truthing and salinity risk predictions from expert hydrologists.
- ***Stream salinity trend data*** (WRC 2002b): Water and Rivers Commission, now DoE have extensive water quality monitoring systems across Western Australian rivers. Over time, salinity trend information in some surface waters has been described and mapped spatially for these features.
- ***Stream salinity classification for southwest Western Australia*** (Muirden, in prep.): Similar to the stream salinity trend data above, this information has been described spatially for certain rivers in the southwest Agricultural Zone.
- ***Catchment boundaries and stream data*:** This information was used to determine the asset's position in the landscape. Generally, the lower an asset sits in the landscape, the greater the potential threat from salinity.
- ***Remnant vegetation***: Appreciating the amount of remnant vegetation surrounding an asset helps define a salinity threat. A wetland positioned in the bottom of a catchment that has 90% vegetation cover is

less likely to have a salinity threat then a wetland position at the base of a catchment with 90% of the vegetation cleared. The *Prediction of Areas at Risk of Salinity* (Dunne & Caccetta 2001) data, described above, also illustrate the areas of remnant vegetation across the South West Agricultural Zone.

- ***Groundwater trend data*** (Short & McConnell 2001): Understanding the trend in groundwater levels around an asset helped to determine the time until, and the significance of, any salinity impact.
- ***Rainfall isohyets over Western Australia*** (WRC 1990): Generally, as rainfall decreases from west to east, across the wheatbelt, there is an increase in soil salt stores as a result of decreased flushing. Decreased flushing is also a consequence of flatter landscapes. The lower the gradient the harder it is for water to drain from the land. Assets within the eastern portion of the wheatbelt with lower rainfall and flatter landscapes will generally be at greater threat than assets located in the west.

Three broad groups of threat were then defined so that the information could be presented in the value–threat matrix.

The five scores defined above were allocated to the following threat groups.

High = score of 4–5, existing and/or near and substantial.
Threat will occur by the year 2020.

Medium = score of 3, intermediate time and/or not that greater extent.
Impacts will occur between 2020 and 2075.

Low = score of 1–2, threat is long term, will occur after 2075,
or the asset is already significantly impacted.

Results

Addendum 1 lists both waterscape and water supply assets identified across the South West Agricultural Zone according to their tiers as defined by the expert panels. Figure 3.1 below shows all assets identified by the expert panels across the South West Agricultural Zone.

Addendum 2 lists those assets identified within the Avon catchment in their relevant tiers as defined by the expert panels. Figure 3.2 below shows those state-defined assets that fall within the Avon catchment.

Conclusions

General

This process has been developed by the Department of Environment for the identification of important assets at a state level within the South West Agricultural Zone. Representation on expert panels has been limited to officers within the Department. Prior to any investment decision's a wider audience that includes community representation should review the results of this report. It is important to note that success of the expert panel is dependent on participation of people with broad knowledge of a range of assets rather than those with detailed knowledge of a small number of individual assets.

The assets identified by this report represent those considered important at a state scale within the South West Agricultural Zone that are at threat from salinity. The assets list will be different from that identified at a regional scale. The areas identified by this process represent those areas where we should begin with our efforts for managing water resources in the face of a salinity threat. The results should not be misinterpreted to suggest that areas not identified are unimportant and should be ignored. There should be a process developed to deal with those assets considered important at a regional and local scale.

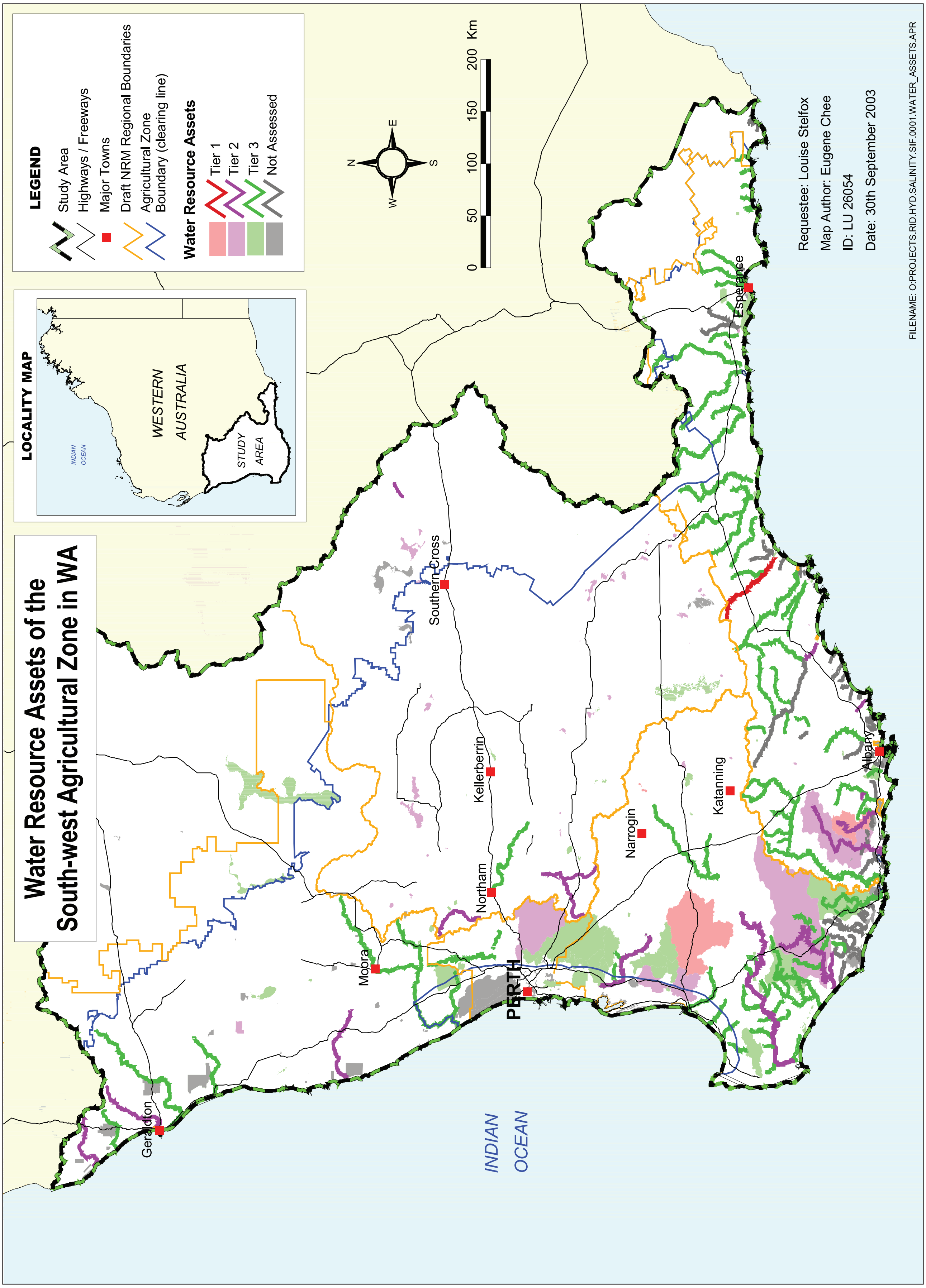

Figure 3.1 Water resource assets of South West Agricultural Zone

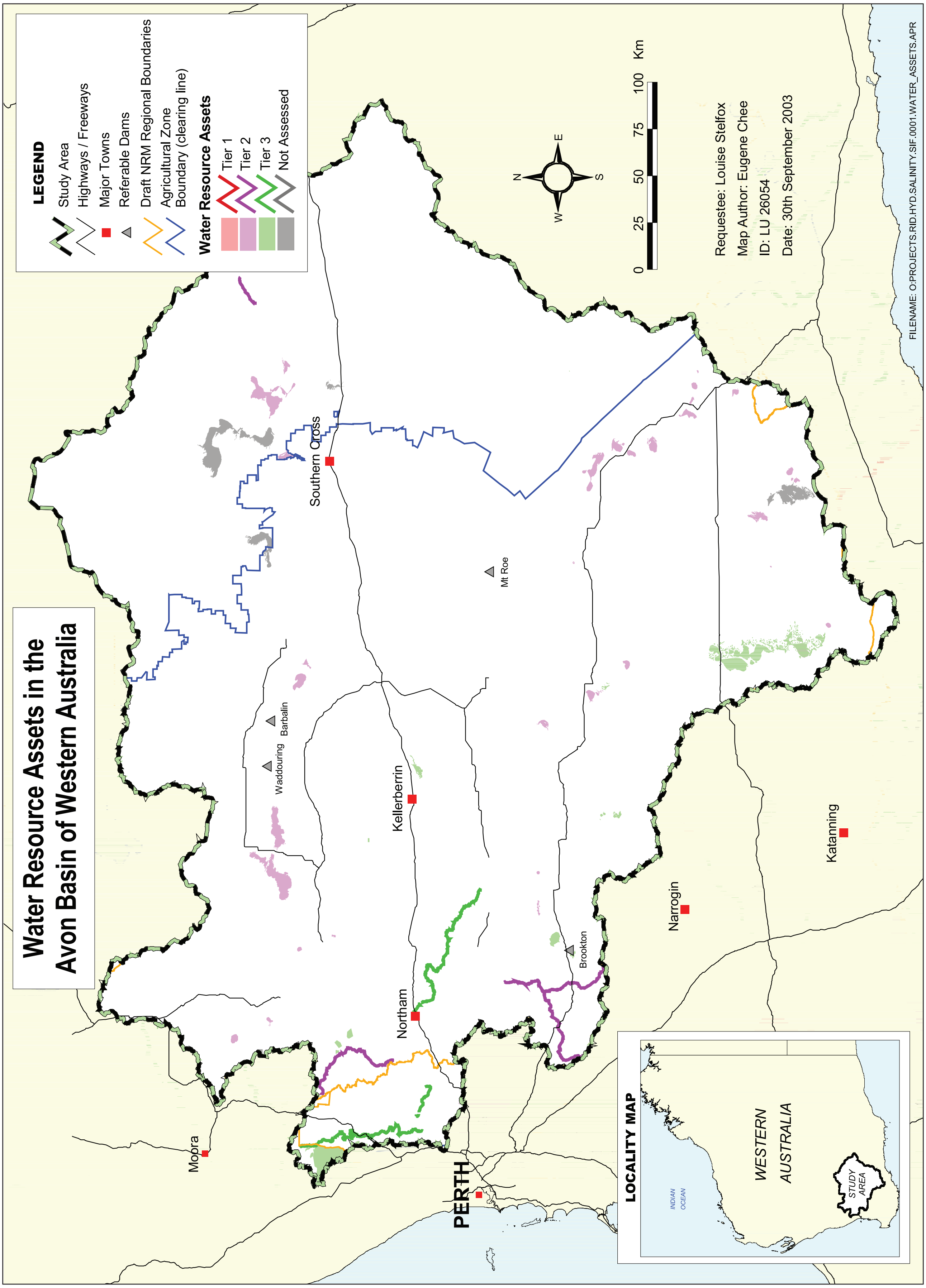

Figure 3.2 Water resource assets for the Avon Basin

This assessment was based on the knowledge of the expert panels and the published reports and spatial information available at the time. New information will always be generated, this process should consider any new information as it becomes available. Work will continue to improve this process and the products of its analysis as new information and knowledge becomes available.

The tier ranking of assets identified in this report does not by any means represent a final priority ranking for investment. Further information on tractability is required before this important step can be finalised. Information on threats other than salinity, goals for assets, management options, costs of management, technical and social feasibility collected through the expert panel will provide a good starting point for further investigations into tractability.

Recommendations

- This process and its results should undergo review by the community or representatives from the community.
- As new information on asset value and salinity threat becomes available it should be incorporated into this process and the results modified accordingly.
- The results of this report do not represent a final priority ranking for investment. Further investigations on feasibility should be completed.
- The assets identified by this report represent a state perspective. Assets not identified by this report are also important; however, a different process should be developed to rank them.

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Addendum 1 — State water resource assets

Notes:

GWA = groundwater area
GW = groundwater
WR= water reserve
TWS = town water supply
PHS or PH = pipehead supply
DS = potential dam site
CA = catchment area

Waterscape assets

Tier 1 — High value/High threat
Lake Warden Wetland System
Fitzgerald River
Lake Toolibin
Avon/Swan River

Tier 2 — High value/Medium threat
Wellstead Estuary
Denmark River
Vasse-Wonnerup Estuary
Hill River

Tier 2 — Medium value/Medium threat
Mortijinup Lake System
Yellilup Yate Swamp System
Balicup Lake System
Pallinup River
Owingup Swamp System
Muir–Unicup Wetland System
Lake Bryde Catchment
Chapman River
Lake Barlee
Lake Dowerin
Lake King
Lake Mears
Lake Walymorouring
Lake Koobekine
Lake Wallambin
Lake Brown
Eva Lake
Lake Ninan
Lake Kondinin
Jilakin Lake
Lake Gounter
Lake O'Connor
Lake Liddelow
Lake Carmody
Lake Hurlstone
Lake Gurlson
Lake Camm
Lake Ace
Lake Newton
Lake Cobham
Lake Royston
Lake Morris
Lake Lockhart
Lake Hinds
Lake Kathleen
Lake Pallerup
Lake Pingarup
Lake Chinocup
Lake Dorothy
Lake Campion
Baladjie Lake
Lake Julia
Lake Seabrook
Jilakin Lake
Lake Hurlstone
Lake Carmody
Lake Varley
Lake Kurrenkutten
Dale River
Dale River South

Tier 2 — Medium value/High threat
Lake Gore System
Kent River
Coyrecup Lake
Blackwood Catch/River
Murray River and Tribs
Yenyening Lakes System
Hutt River
Lake Lechenaultia
Cowcowing lakes
Lake Milarup
Easdalie Creek
Toodyay Brook

Tier 3 — High value/Low threat
Thomas River
Alexander River
Stokes Inlet
Oldfield Estuary
Hammersley Inlet
Fitzgerald Inlet
Beaufort Inlet
Kalgan River
Frankland River
Gingilup–Jasper Wetland System
Scott Lower
Lower Blackwood Estuary
Broadwater
Preston River
Leschenault Estuary
Lower Moore/Gingin Brook

Tier 3 — Medium value/Low threat
Blackboy Creek
Mungliginup Creek
Duke Creek
Daily River
Lort River
Young River
Oldfield River
Munglinup River
Jerdacuttup River
West River
Phillips River
Culham Inlet
Hammersley River
Marbellup Brook
Byenup Lagoon System
Lake Muir
Dumbleyung Lake
Towerinning Lake
Cape Leeuwin System
Toby Inlet
Vasse Catch/River
Benger Swamp (Wellesley)
Murray Catch/River
Brockman River
Lower Avon River
Moore Upper River
Lake Logue/Indoon System
Greenough Catch/River

Tier 3 — Low value/Low threat
Hay River
Bandy Creek
Coramup Creek
Kateup Creek
Coobidge Creek
Coomalbidgeup Creek
Moolyall Creek
Woodenup Creek
Steere River
Sussetta River
Needilup River
Gairdner River
Devil Creek
Jackitup Creek
Six Mile Creek
Warperup Creek
Martaquin Creek
Wadjekanup River
Jam Creek
Pinjalup Creek
Slab Hut Gully
Uannup Brook
Cowenup Brook
Gordon River
Towerlup River
McCarleys Swamp (Ludlow)
Thompsons Lake
Lockhart River
Yilgarn Catch/River
Yorkrakine Rock Pools
Middle Avon River
Chandala Swamp
Mongers Lakes
YarraMonger Trib
Yarra Yarra Lakes
Lake Moore
Irwin Catch/River
Bowes River
Arthur River
Beaufort River
Lake Polaris
Mortlock River
Moore Middle River

Tier 3 — Low value/Medium threat
Coomalbidgup Swamp
Jerdacuttup Lakes
Bremer River
Peenebup Creek
Peniup Creek
Corackerup Creek
Wagin Lakes
Lake Cronin
Wannamal Lake System
Lake Pinjarrega

Tier 3 — Low value/High threat
Mills Lake Wetland system
Lake Grace System
Yealering Lakes System
Upper Avon River
Chittering Lakes
Neridup Creek

Water supply assets

Tier 1 — High value/High threat
Denmark River WR
Wellington Dam CA

Tier 2 — High value/Medium threat
Angove River
Mundaring Weir CA

Tier 2 — Medium value/High threat
Kent River WR
Warren River WR
Dumbleyung TWS
Collie Irrigation District

Tier 2 – Medium value/Medium threat

- Waychinicup River
- Hay River Tributary PHS
- Wilgarup River DS
- Warren River DS55
- Dombakup Brook DS
- Harvey Irrigation District
- Waroona Irrigation District
- Jane Brook CA
- Arrowsmith WR

Tier 2 — High value/Low threat

- Deep River WR
- Lefroy Brook CA
- Margaret River CA
- Busselton WR
- Harris River CA
- Stirling Dam
- Harvey Dam
- South Dandalup Dam CA
- South Dandalup PH CA
- Conjurunup Creek PH CA
- Nth Dandalup Dam CA
- Serpentine Dam CA
- Serpentine PH CA
- Gooralong Brook WR
- Lower Helena River
- Canning Dam CA
- Churchmans Brook CA
- Wungong Brook CA
- Victoria Dam CA
- Bickley Brook CA
- Lower Bickley Brook

Tier 3 – Low value/High threat

- Esperance WR
- Quickup Dam
- Perup River PHS
- Padbury Dam (Balingup TWS)
- Wooroloo Brook

Tier 3 – Low value/Low threat

- Condingup WR
- Salmon Gums TWS
- Gibson WR
- Bremer Bay WR
- Bolganup Dam
- Quickup River
- Boorara Creek DS2
- Tinkers Brook PHS
- Quinninup Brook
- Manjimup Brook DS
- Record Brook DS
- Big Easter Brook
- Donnelly River WR
- Boyinup Brook Dam (TWS)
- Hester Dam (Bridgtn TWS)
- Dalgarup Brook DS1.5
- Norilup Brook DS1.5
- Tanjannerup Dam (Nannup TWS)
- Nannup Brook DS6
- Long Gully DS2
- McAtee Brook DS
- Red Gully
- Milyeannup Brook DS
- Rosa Brook DS
- Adelaide Brook
- Abba River DS
- Marinup Brook
- Dandalup River System
- Jandakot Mound
- Karnup-Dandalup GWA
- Bolgart WR
- Red Swamp Brook
- Bindoon-Chittering WR
- Calingiri-Yenart WR
- New Norcia WR
- Mt Magnet CA
- Allanooka WR

Tier 3 – Low value/Medium threat

- Cordingup Dam (Ravensthorpe)
- Hopetoun WR
- Gnowangerup TWS
- Brookton CA

Tier 3 – Medium value/Low threat

- Marbellup WR
- Mitchell River
- Weld River
- Big Hill Brook DS
- Phillips Dam CA
- Scabby Gully Dam (Manjimup TWS)
- Big Brook Weir
- Pemberton Weir
- Donnelly River DS40
- Barlee Brook DS
- Carey Brook DS4
- Millstream Dam (Bridgetown TWS)
- St John Brook
- Chapman Brook
- Capel River
- Capel River DS
- Preston Valley Irrigation
- Bunbury WR
- Brunswick Creek CA
- Bancell Brook CA
- Samson Brook CA
- Boddington CA
- Davis Brook DS
- Dirk Brook WR
- Brookton WR
- Gingin GW Area
- Gingin Brook

Addendum 2 — Avon water resource assets

Avon waterscape assets

Tier 1 – High value/High threat
Swan River

Tier 2 – Medium value/Medium threat
Lake Bryde Catchment
Lake Barlee
Lake Dowerin
Lake King
Lake Mears
Lake Walymorouring
Lake Koobekine
Lake Wallambin
Lake Brown
Eva Lake
Lake Ninan
Lake Kondinin
Jilakin Lake
Lake Gounter
Lake O'Connor
Lake Liddelow
Lake Carmody
Lake Hurlstone
Lake Gurlson
Lake Camm
Lake Ace
Lake Newton
Lake Cobham
Lake Royston
Lake Morris
Lake Lockhart
Lake Hinds
Lakke Kathleen
Lake Pallerup
Lake Pingarup
Lake Chinocup
Lake Dorothy
Lake Campion
Baladjie Lake
Lake Julia
Lake Seabrook
Jilakin Lake
Lake Varley
Lake Kurrenkutten
Dale River
Dale River South

Tier 2 – Medium value/High threat
Yenyening Lakes System
Lake Lechenaultia
Cowcowing lakes
Lake Milarup
Easdalie Creek
Toodyay Brook

Tier 3 – Medium value/Low threat
Brockman River
Lower Avon River

Tier 3 – Low value/Low threat
Lockhart River
Yilgarn Catch/River
Yorkrakine Rock Pools
Middle Avon River
Chandala Swamp
Lake Polaris
Mortlock River

Tier 3 – Low value/Medium threat
Lake Cronin
Wannamal Lake System

Tier 3 – Low value/High threat
Lake Grace System
Yealering Lakes System
Upper Avon River
Chittering Lakes

Avon water supply assets

Tier 2 – High value/Medium threat
Mundaring Weir CA

Tier 2 – Medium value/Medium threat
Jane Brook CA

Tier 3 – High value/Low threat
Lower Helena
Canning Dam CA
Churchmans Brook CA
Wungong Brook CA
Victoria Dam CA
Bickley Brook CA
Lower Bickley

Tier 3 – Medium value/Low threat
Brookton WR

Tier 3 – Low value/Low threat
Bolgart WR
Red Swamp Brook
Bindoon-Chittering WR
Calingiri-Yenart WR
New Norcia WR

Tier 3 – Low value/Medium threat
Brookton CA

Tier 3 – Low value/High threat
Wooroloo Brook

Notes:
GWA = groundwater area
GW = groundwater
WR= water reserve
TWS = town water supply
PHS or PH = pipehead supply
DS = potential dam site
CA = catchment area

Appendix 4 — Agricultural land and rural infrastructure assets at state scale

Introduction

The outputs from this assessment of salinity impacts on agricultural land and rural infrastructure are:

- a spatial representation of areas of land and infrastructure currently affected (AOCLP) and at risk (AHAVF)
- value at risk (where possible)
- technically feasible treatments
- probability of adoption of those options
- economic analysis.

The process

Assessment of the extent and trends in salinity of agricultural land

Land Monitor (a satellite based assessment and mapping program of salinity, topography and vegetation extent and change; <www.landmonitor.wa.gov.au>) and National Land and Water Resources Audit (NLWRA, <www.nlwra.gov.au>) datasets were compiled and an assessment made of the impact of salinity on agriculture and infrastructure related assets.

Townsite infrastructure

Rural Towns Program salinity data were assessed to determine the urgency and degree of risk in towns according to population and time to impact of salinity on infrastructure. This was based on data gathered in the Community Bores Project (a series of comprehensive groundwater studies covering 38 towns), short and longer-term groundwater trends, salinity prediction modelling and economic analysis tools as required. Priorities for investment were based on the town's population (as a guide to infrastructure value and risk) and time to risk (as a guide to urgency).

An Economic Impacts of Salinity on Townsite Infrastructure study (URS 2001), was undertaken by the DoA in 2001. The assessment, which included a cost-benefit analysis, was conducted on six representative towns to quantify the economic impacts of salinity on townsite infrastructure with a great deal more precision than a simple index. The intention is to complete the economic assessment for the remaining 32 towns in the Rural Towns Program to enable a more accurate ranking of townsite salinity risk.

Road and rail

The lengths of road assets at risk were classified according to classes used in the NLWRA and as provided by Main Roads WA. Four classes of road were assessed: highways, main, local and unclassified roads. Of these classes, all but unclassified roads have a clear definition and could be easily mapped. Unclassified roads include some unsealed shire roads, but also include roads within public land, and so-called unmade roads on private land. Differing classes of railway assets were not provided nor assessed. Lengths of assets were calculated that pass through areas classified as currently affected (AOCLP) or at risk (AHAVF).

Treatments options

An assessment of the range of options for salinity management was undertaken for each of the soil–landscape zones. The options assessed include engineering and plant based practices, or systems of practices that already exist, that will deliver the maximum impact on the extent and severity of saline land. The matrix of generic options nominated for each of the soil–landscape zones is provided in Addendum 1 of this Appendix.

To assess the area of land currently affected by salinity and at risk in each zone, three datasets were collected and collated in terms of the three goal-based criteria defined in the State Salinity Action Plan (2000): Recovery, Containment and Adaptation.

1. Timing of salinity impacts

The average time required for a zone to reach hydraulic equilibrium (when groundwater levels in areas of risk cease to rise) was assessed on the basis of available raw data. This was based on analysis prepared for the National Land and Water Resources Audit (Short & McConnell 2000), and includes average depth to groundwater and rate of rise. The assessment also considered available numeric modelling to determine when the systems would come to effective equilibrium[19] in terms of the area at risk of salinity.

Rating Scale — Urgency

0 No significant problems from salinity
1 Most potential salinity after 2075
2 Most potential salinity after 2030 and before 2075
3 Most potential salinity after 2020 and before 2030
4 Most potential salinity after 2010 and before 2020
5 Most potential salinity at or before 2010

2. Technical Feasibility

Technical feasibility (TF) is a measure of the availability and capacity of salinity management options to recover, contain or allow adaptation of salt-affected land or soils at risk. The factors are largely qualitative, but were based on available published data and supported by assessments of each of the regional hydrologists. In particular, the technical factors are based on the average response of the entire zone, not a specific part.

It must therefore be noted that while it was considered that, with unlimited money and time, it is technically possible to reclaim nearly all areas of dryland salinity, in practice, the technical feasibility is constrained by an array of factors. The principal factors taken into consideration are represented below as key questions:

- Is the practice or series of practices possible according to the physical conditions of the soil–landscape zone?
- Is the practice appropriate across the majority of the zone?
- Will implementation of the practice lead to impact within a reasonable time frame?
- Has the practice been modelled or demonstrated to be effective in that zone?
- Are there major offsite issues or downstream impacts that would prevent development?

[19] Effective equilibrium means that although groundwater levels may continue to rise in elevated areas, the area of discharge has come to equilibrium. This implies the rate of discharge per unit area may continue to increase after this point. It may take from as little as a few years to millennia for salt to come to equilibrium.

Rating Scale — Technical Feasibility

0 Not applicable
1 Very Low (0.1)
2 Low (0.175)
3 Moderate (0.375)
4 Good (0.625)
5 Excellent (> 0.75)

Technical factors are thus a spatially averaged indication of effectiveness and exist within the context of our current scientific knowledge of the impact of salinity management options. They can be assessed under current technical criteria (e.g. TF1a) or using factors expected to be developed over time (e.g. TF1b). The factors used in this analysis are generic and must be reviewed when applied to specific cases (local scale), and reviewed over time (as knowledge builds).

3. Probability of Adoption

The probability of adoption was also based on soil–landscape zones, results of the '…effectiveness and adoptability…' surveys undertaken as part of the National Land and Water Resources Audit (McConnell, 2001) and the hydrologists' current assessment of the likelihood/probability of an option or suite of options being adopted.

As with technical feasibility, the adoption of practices or systems is dependent on a wide array of issues. The principal issues are represented below as key questions;

- Is the practice viable and affordable (cost effective)?
- Can the practice be easily adopted (advice, support, regulations etc)?
- Does the practice fit within the context of the current farming systems?
- Does the practice or system fit with the skills and aspirations of the farm owner?
- Are there major offsite issues or downstream impacts that would prevent adoption?

Rating Scale — Probability of Adoption (AF: Adoption Factor 1-3)

0 No adoption
1 <10% adoption (x0.1)
2 10-25% (x0.175)
3 50-75% (x0.625)
4 > 75% (0.75)

Equations 1-3 were used to calculate the Area of Impact

R = AF1 ((TF1a * AOCLP) + TF1b (AHAVF-AOCLP)) Equation 1
C = AF2 * TF2b (AHAVF-AOCLP) Equation 2
A = AF3 ((TF1a * AOCLP + TF2b (AHAVF-AOCLP)) Equation 3

In the cases assessed (where TF1 = TF2), these reduce to Equations 3-6.

R = AF1 * TF1 * AHAVF Equation 4
C = AF2 * TF2 (AHAVF-AOCLP) Equation 5
A = AF3 * TF3 * AHAVF Equation 6

Infrastructure

Rural Towns

The 38 rural towns in the Rural Towns Program were analysed. Rates of groundwater rise were calculated from existing datasets or from bores nearby, and a time to impact, established. The extent of current salinity and town areas at risk was derived from the Land Monitor datasets. However, the datasets provided to be inaccurate at the scale required. The actual area of townsite salinity was small when compared to broadacre farming areas, water catchment areas and regions of high biodiversity value. Until all townsites at risk from salinity have been analysed in terms of the economic impact, a surrogate relationship has been defined to enable an estimate of the risk of towns and priority for investment.

Roads

Department of Main Roads estimates of repair and maintenance costs (Jerome Goh, *pers. comm.* 2002) and road classification system, was used to assess the costs of salinity on roads. Roads were classified into four groups: highways, main roads, local and unclassified roads. The length of roads in each class was assessed with the areas of AOCLP and AHAVF. Only the raw[20] Land Monitor data was used to estimate lengths affected or at risk.

Railways

The length of railways assessed to be in areas classified as currently affected (AOCLP) or at risk (AHAVF) were calculated. Raw Land Monitor data were used. The costs of management were determined by methods documented in RTP studies (URS 2001) which defined the two critical depth indicators (watertable as < 1.5 m and < 0.5 m). The costs in each class were assessed.

Economic Analyses

The estimation of the benefits to agricultural land of the salinity investments utilised the estimated impact of the adoption of technically feasible practices provided by regional hydrologists. The benefits are the present value of a forecast stream of additional profits (and losses avoided) of farm businesses on each of the three land classes (R, C, A) in each zone.

The net profits from management of the land classes (e.g. recovery area) in the soil–landscape zones depend on the rate of change in the areas of these land classes prior to equilibrium and the profit difference between land practices on these areas made possible by salinity investment compared to land practices when no salinity investment occurs. For example, on lands affected by salinity, now and in the future, farmers could generate additional profit due to the current findings for improved management of saline land. Much greater profits would be possible on lands that would otherwise become saline were it not for public investment in salinity management. Also on lands that are salt-affected, yet which are recovered due to public investment, larger gains in profitability will also be experienced.

The estimation of these benefits from salinity management depends on describing a flow of farm profits through time then expressing this flow in present value terms. The formula for deriving those benefits is not simple as it must allow for discounting, different profit flows depending on land class types, areas and rates of change in areas, zonal location, intervals to hydrological equilibrium or steady state conditions, and in perpetuity benefits.

[20] Land Monitor data used in this analysis was that provided to the DoA in late 2002, and did not include the final analysis for the Dumbleyung and Jackson scenes. It was considered that this would not significantly influence the results of this analysis.

Results

Biophysical

The area of salinity and length of the major road and rail assets affected (AOCLP) or at risk (AHAVF, 2.0 m class), as defined using the Land Monitor methodologies and datasets is presented in Table 4.1. Just over 1 000 000 ha of land is currently affected. Of this 783 800 ha is agricultural land. A further 4 360 000 ha of agricultural land is at risk of shallow watertables.

Table 4.1 A statewide summary of the agriculture based SIF analyses.

Asset class

SW total area	26 511 000 ha
Agricultural land	18 790 000 ha

		Low productivity (AOCLP)	Potentially at risk (AHAVF 2.0 m class)
Shires	(ha)	1 046 800 (5.5%)	5 428 000 (28.9%)
Agricultural land (private)	(ha)	783 800 (4.1%)	4 316 500 (23.9%)
Public land (including saline lands)	(ha)	267 000	932 000*
Towns	(ha)	4 000	20 800
Roads	Highway (km)	1100	520
	Local (km)	2400	14 900
	Main (km)	140	670
	Unclassified (km)	1450	810
Railways	Total (km)	210	1050
Soil zones	(ha)	992 000	5 139 000
Soil systems	(ha)	992 000	4 794 000
Hydro zones	(ha)	992 000	5 139 000
Vegetation	DCLM (ha)	196 500	764 000
	Plantations (ha)	0	40
	Private (ha)	390	8900

* Defined by subtraction of total shire area and area of AHAVF.

A revision of the estimates in Table 4.1 was required when hydrologists reconsidered the raw Land Monitor estimates (see Table 4.2). Revised areas of agricultural land (private) classified by the Land Monitor method and ascribed as affected by dryland salinity (AOCLP) and as area of valleys floors (where the watertables may be close to the surface and represent a future risk; AHAVF < 2.0 m), are estimated to be 783 800 and 4 300 000 hectares respectively.

Estimated areas at risk ranged from 2 798 000 (less than 0.5 m class) to 4 316 000 (less than 2.0 m class). This range reflects the likely extent of salinity and related area of waterlogged land if currently observed long-term (1975–2000) trends in groundwater levels continue. These estimates need regular re-evaluation on the basis of revised climate forecasts and continued groundwater-level monitoring.

Results of analysis of the area of impact by designated treatments on the areas of 'current salinity' (AOCLP) and 'valley areas' (AHAVF) considered to be at risk (Urgency Factor) are presented in Table 4.2.

Table 4.2 Analysis of biophysical factors impacting on the area of salinity on agricultural land

Agricultural - private land only - affected and at risk of salinity

Region	Zone	Urgency	Technical feasibility			Probability of adoption			Area of impact			Revised		Land Monitor	
			R	C	A	R	C	A	R	C	A	AHAVF	AOCLP	AHAVF	AOCLP
SWAN	211 Coastal Dune Zone	5.00	0.375	0.625	0.100	0.100	0.175	0.100	1425	0	380	38000	38000		
	212 Bassendean	5.00	0.625	0.625	0.625	0.175	0.375	0.375	1006	1078	2156	9200	4600		
	213 Pinjarra - Dryland	5.00	0.625	0.625	0.625	0.175	0.625	0.625	4375	2344	15625	40000	34000	2.00	1.06
	(Pinjarra - Irrigated)	5.00	0.625	0.625	0.625	0.375	0.750	0.175	2344	1172	1094	10000	7500		
	214 Donnybrook Sunkland	0.00												21.88	
	215 Scott River	0.00													
	216 Leeuwin	0.00													
GREENOUGH	221 Coastal	2.00	0.375	0.375	0.625	0.175	0.175	0.100	656	525	625	10000	2000	258.81	7.25
	222 Dandaragan Plateau	4.00	0.375	0.625	0.750	0.175	0.375	0.750	8203	25314	70313	125000	16993	85.56	16992.56
	223 Victoria Plateau	3.00	0.100	0.175	0.625	0.100	0.100	0.375	800	1372	18750	80000	1628	166553.31	1628.44
	224 Arrowsmith	2.00	0.625	0.625	0.750	0.375	0.375	0.625	18750	18281	37500	80000	2000	71.44	
	225 Chapman	5.00	0.625	0.625	0.625	0.175	0.175	0.175	4519	4458	4519	41314	557	41314.00	557.25
	226 Lockier	3.00	0.375	0.375	0.375	0.100	0.100	0.175	1750	1662	3063	46676	2354	46676.31	2354.00
CARNARVON	231 Geraldton Coastal	0.00										296	107	295.75	107.31
	232 Kalbarri Coastal	3.00	0.625	0.625	0.750	0.175	0.175	0.375	1669	1655	4290	15255	121	15254.94	121.31
STIRLING	241 Pallinup	3.00	0.625	0.750	0.375	0.375	0.375	0.375	19522	20659	11713	83295	9842	83294.50	9841.94
	243 Jerramungup Plain	4.00	0.625	0.750	0.375	0.375	0.375	0.375	14063	9563	8438	60000	26000	151108.38	4380.31
	245 Esperance Sandplain	2.00	0.375	0.625	0.750	0.375	0.625	0.375	38961	105188	77923	277058	15525	53961.75	15525.13
	242 Albany Sandplain	2.00	0.175	0.625	0.375	0.375	0.625	0.175	788	2344	788	12000	6000	12248.94	589.31
	244 Ravensthorpe	2.00	0.375	0.375	0.375	0.375	0.175	0.375	1723	294	1723	12249	7777	277057.94	7776.50
	246 Salmon Gums	1.00	0.175	0.375	0.375	0.100	0.175	0.175	1925	6575	7219	110000	9803	357828.94	9802.63
	248 Stirling Range	5.00	0.375	0.375	0.625	0.375	0.175	0.375	3797	1403	6328	27000	5618	40099.56	5617.56
AVON	250 SE Ancient Drainage	2.00	0.175	0.375	0.375	0.375	0.175	0.375	27396	21330	58705	417459	92436	417458.94	92435.69
	253 Eastern Darling Range	3.00	0.625	0.625	0.750	0.375	0.375	0.375	35204	31647	42245	150204	15177	150203.81	15176.50
	254 Warren-Denmark	5.00	0.625	0.750	0.750	0.375	0.625	0.625	19463	29550	38925	83040	20000	83040.06	5238.94
	255 Western Darling Range	4.00	0.625	0.750	0.750	0.375	0.375	0.625	4050	4187	8100	17281	2395	17281.06	2395.06
	256 North Rejuvenated Drainage	3.00	0.375	0.375	0.625	0.375	0.375	0.375	37500	26743	62500	266666	76495	266666.00	76494.75
	257 South Rejuvenated Drainage	3.00	0.375	0.625	0.625	0.375	0.375	0.375	43506	62529	72511	309378	42587	309378.31	42587.38
	258 North Ancient drainage	2.00	0.175	0.375	0.375	0.375	0.100	0.175	95595	45258	95595	1456679	249796	1456679.38	249796.19
	259 SW Ancient Drainage	2.00	0.175	0.375	0.625	0.375	0.375	0.375	15985	25741	57091	243587	60537	243587.25	60536.69
KALGOORLIE	261 Southern Cross	1.00	0.100	0.375	0.375	0.100	0.100	0.100	574	2117	2154	57450	1006	57449.63	1006.38
MURCHISON	271 Irwin River	3.00	0.175	0.175	0.375	0.175	0.175	0.375	7577	6567	34794	247426	32988	247426.31	32987.50
									413126	**459555**	**745065**	**4326514**	**783841**	**4495305.00**	**653958.00**

The analysis shows that, with current assumptions of technical feasibility and adoption rates, the total area of recoverable land in all zones is 413 000 ha. Areas that could be contained were estimated to be 457 000 ha, and land for which systems of adaptation could be established was estimated to be 745 000 ha. The impact of treatments is highly variable between zones.

Economic

The present value of the benefits of investment in salinity management in each zone is shown in Table 4.3. The total benefit across all zones is $716 million. This figure represents the present value of additional profits (and losses avoided) by farm businesses that arise from alteration in land class areas and improved management on saline lands. In other words, the investment in salinity management is estimated to eventually generate a stream of additional profits (and losses avoided) for farmers that, in present value terms, equates to $716 million.

As shown in Table 4.3 most of the benefits (and losses avoided) for farmers stem from the containment of salinity and the recovery of salt-affected areas. This is intuitively correct, as the profit differential between land use on salt-affected land versus land either protected from salinisation or recovered from being salt-affected is likely to be large. By contrast, the profit improvements on saline land that remains saline are likely to be much less, even with emerging technologies. There is likely to be a many-fold difference in losses avoided by maintaining agricultural land unaffected by salt compared with profit improvement on land that remains saline. In effect, the profits derived from use of several hectares of saline land will equate to profits derived from a single hectare of land unaffected by salinity.

The relative benefits of recovery, containment and adaptation need to informed by knowledge of the true costs of set-up required to actually recover saline land. In some circumstances, the differences will be markedly reduced and containment and adaptation may offer a higher return on investment (if recovery costs are high).

Table 4.3 also shows the gross benefit per hectare of investment in salinity management across the zones. For example, recovery benefits on the high-value soils of the coastal areas (e.g. Bassendean Zone 212) are far greater than those in the wheatbelt (e.g. SW Ancient Drainage Zone 259). The area impacted is also relevant with large area zones giving high levels of benefit which is low on a per hectare basis.

The results indicate that priority areas for the investment of public funds are in soil–landscape zones where salinity can be most effectively managed. These exist in areas where salinity management options are available (feasible and adoptable) and where commodity values are high. Although annual rainfall is a surrogate for successful management in most cases, the extent of impact is also important.

The analysis also can be used to speculate that the annual cost to farmers of forgone profit is around $300 million and the present value of those annual impacts (losses) is around $4 billion.

Towns

The potential risk of salinity on rural towns shows that towns with a higher population and relatively short time to realisation of the risk have the highest ranked index. The analysis supports the results and general priorities for investment of previous studies by the Rural Town Program (URS 2001).

Roads

The length of highways and main roads currently affected by salinity is about 252 km. The length of local and unclassified roads affected is about 3850 km. The annual cost of repairs and maintenance due to salinity (based on data provided by Main Roads WA) is assessed to be $19 840 per kilometre for highways and main roads and $6614 per kilometre for local and unclassified roads. The total combined current annual cost is around $21m. However, the length of highways and main roads at risk (AHAVF) is estimated

Table 4.3 Present value of gross benefits to agriculture of forecast salinity management outcomes

Soil–landscape zone	Zone no.	Present value of gross benefit in recovery area (R) ($'000)	Present value of gross benefit in containment area (C) ($'000)	Present value of gross benefit in adaptation area (A) ($'000)	Present value of gross benefit ($'000)	Present value of gross benefit per hectare of agricultural land ($/ha)
		R	C	A	(R+C+A)	
Coastal dune zone	211	12225	0	652	12877	110
Bassendean	212	8633	9249	3700	21582	145
Coastal	221	392	314	75	780	7
Dandaragan Plateau	222	6084	18775	10430	35289	71
Arrowsmith	224	7679	7487	3072	18237	42
Victoria Plateau	223	489	838	2291	3618	6
Chapman	225	3489	3442	698	7629	28
Lockier	226	847	804	296	1947	13
Kalbarri Coastal	232	1019	1011	524	2555	28
Pallinup	241	9940	10519	1193	21652	58
Jerramungup Plain	343	6953	4728	843	12516	36
Esperance Sandplain	245	21608	58336	8643	88587	108
Albany Sandplain	242	490	245	98	834	2
Ravensthorpe	244	882	150	176	1208	16
Salmon Gums	246	534	1825	401	2761	3
Stirling Range	248	2932	1083	977	4992	53
SE Ancient Drainage	250	8181	6370	3506	18057	10
Eastern Darling Range	253	26887	24170	6453	57511	68
Warren-Denmark	254	28385	43097	11354	82835	176
Western Darling Range	255	10952	11321	4381	26654	120
North Rejuvenated Drainage	256	25777	18382	8592	52751	47
South Rejuvenated Drainage	257	31567	45369	10522	87458	67
North Ancient Drainage	258	28547	13515	5709	47772	10
South Ancient Drainage	259	7092	11421	5066	23579	20
Southern Cross	261	52	192	39	284	2
Irwin River	271	3665	3177	3366	10208	13
Total		**280609**	**315928**	**119206**	**715743**	**Average 39**

to be 1194 km and the length of local and unclassified roads affected is assessed to be 22 960 km. Assuming no change in the cost per kilometre repaired, and assuming all roads in need of repair are fixed, then the annual cost of repairs and maintenance due to salinity will increase to $23.7m for highways and main roads and $151.9m for local and unclassified roads. The combined annual cost will be $175.5m.

Table 4.4 Ratings used to establish priority towns for evaluation in the Salinity Investment Framework

Town	Population	Years to impact (watertable < 1.5 m)	Index (pop./ years impact)	Ranking
Katanning	4160	1	4160	1
Wagin	1450	1	1450	2
Narrogin	4700	4	1175	3
Darkan	500	1	500	4
Bakers Hill	455	1	455	5
Merredin	3630	9	403	6
Pingelly	800	2	400	7
Wongan Hills	800	3	267	8
Lake Grace	1035	4	259	9
Narembeen	950	5	190	10
Mullewa	700	5	140	11
Moora	1800	14	129	12
Morawa	600	5	120	13
Brookton	700	6	117	14
Boddington	1420	17	84	15
Tambellup	300	4	75	16
Dowerin	400	6	67	17
York	2000	31	65	18
Woodanilling	130	2	65	19
Kellerberrin	855	15	57	20
Cranbrook	320	6	53	21
Perenjori	250	6	42	22
Nyabing	120	4	30	23
Quairading	680	24	28	24
Corrigin	750	27	28	25
Bruce Rock	700	31	23	26
Goomalling	600	31	19	27
Dumbleyung	230	12	19	28
Mukinbudin	400	26	15	29
Koorda	315	22	14	30
Bencubbin	170	15	11	31
Piawaning	10	1	10	32
Wandering	80	10	8	33
Beacon	120	16	8	34
Bullaring	10	2	5	35
Trayning	120	30	4	36
Pingrup	80	24	3	37
Carnamah	410	217	2	38

Allowing for the gradual increase in repair and maintenance of roads as salinity spreads, and assuming all affected roads are repaired, then the present value of forecast road repair costs is $1938 million, of which $271 million is needed for highway and main road repairs. If only highways, main roads and local roads are repaired (i.e. unclassified roads are not repaired) then the present value of future repair and maintenance costs is forecast to be $1355 million.

Around 80% of this cost is attributed to local roads rather than highways and main roads. Hence, an issue for many rural shire councils will be whether it is financially wise to maintain the current network of local and/or unclassified roads. Even halving repairs and maintenance expenditure will still mean that the impact cost of salinity on these roads will be higher than the farm-level benefits generated by the adoption of the intervention strategies forecast in Table 4.2.

Railways

The length of railways currently affected (AOCLP) and at risk (AVAHF) is estimated to be 210 and 1050 km respectively. The costs associated with this risk are defined by the depth to watertable (URS 2001). The likely cost range for currently affected area rail is $458 800 to $1 427 000, and for potentially affected rail $2 242 000 and $6 977 000. The present value of 'in-perpetuity annual costs' of rail repair and maintenance is $176 million.

Discussion

Risk and threat matrices

To assess relative benefit (present value of gross benefit) of investment (land) and value of roads at risk of salinity, a risk versus threat matrix was constructed (Addendum 2) which identifies in which zone the benefits of investment, or values, are greatest. A matrix could not be developed for towns as values were only available for six towns (URS 2001). The ranking column in Table 4.4 is presented as a surrogate, until further data are collected as part of the Rural Towns Program.

For land, the benefits are greatest where the land values and probability of salinity management are highest. This area includes many of the higher rainfall zones where the effectiveness of salinity management options is greater and probability of adoption is higher. However, this result also depends on the timing of salinity. Lower returns in eastern zones may be due to the long lead times for salinity development and management, reducing returns on money invested today. Conversely, if reported as the product of the area and benefit, then those areas that are larger become those where the total value is highest. In terms of investing public funds the value per hectare is an important factor in assessing areas of priority for investment of public funds.

The highest value of roads occurs in the areas where the threat is imminent (< 20 years, 20–75 years) and the length of roads affected is greatest. In this analysis, the Warren Zone is the only zone with a high–high rating. This is because the analysis indicates that the zone has the greatest length of local roads affected, or is at risk from a shallow watertable (as defined by AHAVF). This is in part due to the effectiveness of treatments and in part due to the methods used in the analysis. The areas at greatest risk are those of medium threat and highest value.

Sensitivity analysis of investment in management of agricultural land

Table 4.5 shows the variability or sensitivity of investment returns to an increase in the level of technical feasibility or adoption by a one-unit change for each zone. Some zones benefit more from an increase in adoption and others suggest a focus on improving the technical feasibility of the practices.

Table 4.5 Impacts on investment returns of changes in technical feasibility and adoption likelihood of salinity management options[1]

Soil–landscape zone	Zone no.	Percentage change in the benefit due to a one unit change in technical feasibility (%)	Percentage change in the benefit due to a one unit change in adoption likelihood (%)
Bassendean	212	26	56
Warren-Denmark	254	68	55
Esperance Sandplain	245	39	53
Dandaragan Plateau	222	28	49
Pallinup	241	65	62
South Rejuvenated Drainage	257	21	63
Chapman	225	22	63
Stirling Range	248	30	53
Jerramungup Plain	243	86	70
Western Darling Range	255	65	64
North Rejuvenated Drainage	256	78	59
Eastern Darling Range	253	57	64
Irwin River	271	81	69
North Ancient Drainage	258	22	61
SE Ancient Drainage	250	16	69
SW Ancient Drainage	259	17	53
Salmon Gums	246	55	67
Lockier	226	37	63
Ravensthorpe	244	83	66
Coastal	221	63	70
Southern Cross	261	65	64
Albany Sandplain	242	95	66

[1] *The benefit cost ratio used in these calculations is a partial measure of investment return as it only includes farmers' returns. Excluded are on-site and off-site public benefits and off-site private benefits.*

Scale of analysis

Our analysis was applied at a regional scale (soil–landscape zones) and hence is not explicit or immediately useable at a local scale. It is likely that the assessment of a smaller area of land within a zone may differ from that for the zone as a whole.

For example, in Zone 257 (Southern Zone of Rejuvenated Drainage) the technical factor for recovery was moderate (0.375). In this zone, pumping and drainage were seen as a means to achieve recovery. However, in terms of pumping, optimal sites (e.g. those that contain palaeochannels) are confined to specific areas within the catchment (maybe only 5%). While it may be possible to lower watertables in a specific area in this zone, for example, Toolibin Lake, and attain recovery (i.e. Technical Factor = 1), hydrologists considered that such conditions are not attainable across the entire zone.

Conversely, when managing a specific asset at a local scale (e.g. Toolibin Lake), more favourable conditions may exist than expressed by our generic factors. Technical factors are thus a spatially averaged indication of effectiveness and exist within the context of our current scientific knowledge of the impact of salinity management options. They are also more appropriate when considering the impact of extensive treatments (recharge-based options) than they are for more targeted treatments. The later require site specific information.

The Technical Factors need to be reviewed at a local scale when assessing specific assets, and need to be updated as knowledge increases with time.

Certainty in underpinning science

These forecasts are based on our knowledge of the ability of treatments to influence trends in soil salinity. Assessments of the impact of biological systems have been undertaken for two decades or more on many of the soil–landscape zones. There is therefore a relatively high confidence on these results, relative to those where treatment systems have been less rigorously assessed (e.g. Perth Basin).

The impacts attributed to engineering are based on recent analysis of the impact of drains, the development of raised-bed systems and the opportunity for the productive management of saline land. The relative effectiveness of practices (e.g. deep drains) and farming systems needs to be continually assessed. In particular, the role of engineering systems requires the highest level of input and is the least well represented category of practices represented in this analysis.

Groundwater trends over the period 1975–2000 have been used in this analysis. This period has been dry by comparison with the rest of the century, but is consistent with forecasts of drier climates. Implicit in our estimates of risk is that groundwater trends in the next 25 years will reflect those in the last 25 years. Continued monitoring and modelling are essential to ensure forecasts are regularly updated.

Adoption of treatments

The adoption patterns used in this report were based in part on an earlier assessment by McConnell (2000) and in part on the knowledge of regional hydrologists. McConnell's review of available salinity management options and workshops with senior extension staff revealed the limited capacity of the current systems to reduce recharge.

In this analysis we used questions (see methodology) and a review of the level of adoption over the past decade to define adoption factors for each zone. We concluded that the factors that lead to the adoption of salinity management practices or systems are extremely variable. They not only depend on the technical feasibility of the option, but also on the knowledge, skills, attitudes and aspirations of the property owner. As has been shown in Table 4.5, altering the degree of adoption has a significant effect on the effectiveness of the options.

In addition, the effectiveness of the technical options varies according to the scale on which they are adopted. For example, the adoption of tree-based systems needs to be undertaken on very large areas in broadacre catchments to have a measurable impact on salinity, or contain it (George et al. 2001). Similarly in eastern zones with low topographic and groundwater gradients, the effectiveness of valley floor based engineering systems may be compromised unless there is full participation by landholders in the catchment.

Conclusions

The following main conclusions can be drawn from this analysis:

1 Salinity either currently affects or threatens large areas of agricultural land and many sites containing high-value infrastructure.

2 Most of the benefits (and losses avoided) for farmers from the adoption of factors assessed in this review stem from the containment of salinity. Benefits from recovery of salt-affected areas are imputed to be higher than those for the improved management of saline areas, although this is dependent on actual costs of recovery.

3 There is a high degree of variability between the zones where benefits were incurred (or losses avoided), with many eastern zones having a lower return on investment than those to the west. Net return per hectare needs to be considered along with return per zone.

4 Improving either the technical feasibility or adoption greatly boosts the potential returns on investment in many zones.

5 Further analysis of the economics is warranted as this analysis was undertaken only at regional scale and was related to agriculture and infrastructure alone. A transparent analytical tool is required that allows further sensitivity analysis to be undertaken, and regional variations better accounted for.

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Addendum 1 — Management options for agricultural Land

Management practices (generic descriptions only) used for zone-scaled definition and assessment of the Technical Feasibility and Probability of Adoption of salinity management options.

Zone	Objective	Management options
211 Coastal (mainly north of Perth)	**Recovery** **Containment** **Adaptation**	Drainage Tillage and changed irrigation practice Changed crop to increase salt tolerance
212 Basendean	**Recovery** **Containment** **Adaptation**	Drainage (north and south) Deep ripping (south of Perth), pines and other commercial trees (north of Perth) Saltland grazing systems based on legumes/grasses, and saltbush (north of Perth)
213 Pinjarra (irrigated)	**Recovery** **Containment** **Adaptation**	Drainage (related to ~ 30 000 ha commandable area) e.g. Norton and Clarkes Not usually appropriate in high value areas, but may include surface water management, deep ripping Selection and tolerance of pastures/crops
213 Pinjarra (dryland)	**Recovery** **Containment** **Adaptation**	Drainage (25% readily drainable (as above), remainder requires improved drainage/ tillage/soil management systems Surface water mgt, Deep ripping (e.g. Edwards system) Saltland grazing systems based on grasses/legumes
214 to 215		no significant area of salinity
221 Coastal zone	**Recovery** **Containment** **Adaptation**	Drainage from sediments Perennials (where not at equilibrium) Salt Bush system (e.g. Lakelands)
222 Dandaragan Plateau	**Recovery** **Containment** **Adaptation**	Drainage from sediments, commercial trees and tagasaste if in large areas Lucerne, tagasaste, pines and surface water management Saltland perennials (based on Wiley system)
223 Victoria plateau	**Recovery** **Containment** **Adaptation**	Internal swales — no drainage possible without management of enhanced internal drainage and gradient Oil mallee alleys and high water use farming system and surface water management Perennial pasture and saltbush system (alleys)
224 Arrowsmith	**Recovery** **Containment** **Adaptation**	Drainage for water supplies, northern areas less suitable for waters supplies Lucerne plus fodder shrubs and surface water management a) Saltland perennials, b) Saltbush in the south
225 Chapman	**Recovery** **Containment** **Adaptation**	Drainage for water supplies (siphons, pumps) Perennials where appropriate, saline land at equilibrium Saltland perennials and surface water management
226 Lockier	**Recovery** **Containment** **Adaptation**	Possibility of tube or open drains? Oil mallee alleys and surface water management Saltbush and related perennial systems
231		No significant area of salinity
232 Kalbarri Sandplain	**Recovery** **Containment** **Adaptation**	Drainage and perennials Perennials where appropriate, saline land at equilibrium Adapt and benefit from excess water (aquaculture)
241 Pallinup	**Recovery** **Containment** **Adaptation**	Phase farming (5/10), drainage Drains and perennials (lucerne phase) and surface water management. Saltbush, Tall wheat grass
242 Albany Sandplain	**Recovery** **Containment** **Adaptation**	Commercial trees, phase farming, some pumping and drainage Phase farming and surface water management Saltbush, Tall wheat grass and related PURSL

243 Jerramungup Plain	**Recovery** **Containment** **Adaptation**	Phase farming (5/10) Drains and perennials (lucerne phase) and surface water management Saltbush, Tall wheat grass and surface water management
245 Esperance Sandplain	**Recovery** **Containment** **Adaptation**	Commercial trees, some perennials, drainage and surface water management Perennials, drainage and surface water management Surface water management and PURSL
244 Ravensthorpe	**Recovery** **Containment** **Adaptation**	Perennials, drainage (open, siphon) and surface water management (including raised beds) Perennials (lucerne) and drains Surface water management and PURSL
246 Salmon Gums	**Recovery** **Containment** **Adaptation**	Drainage where permeability and soils allow, and surface water management Oil mallees, lucerne where practical, surface water management Surface water management and PURSL
248 Stirling Range	**Recovery** **Containment** **Adaptation**	Phase farming (5/10) and drainage (e.g. deep open drains, siphons) where gradient is adequate, (including raised beds) Phase farming (3/3) Saltbush, tall wheat grass, alleys with annuals
250 SE Ancient Drainage	**Recovery** **Containment** **Adaptation**	Drainage systems (except where limited by sodicity), limited siphons and pumping Some lucerne, oil mallee, surface water management (including raised beds in SW areas) Salt bush systems (PURSL)
253 Eastern Darling Range	**Recovery** **Containment** **Adaptation**	Drainage (siphons, deep drains), commercial trees Block planting commercial trees, alleys, lucerne (including raised beds) PURSL, salt tolerant grasses and shrubs
254 Warren Denmark	**Recovery** **Containment** **Adaptation**	Commercial trees, drainage (siphons, deep drains), large engineering systems in recovery catchments Alleys including perennials, and surface water management (including raised beds) Salt-tolerant pastures, surface water management
255 Western Darling Range	**Recovery** **Containment** **Adaptation**	Commercial trees, deep drainage (siphons) and some pumping, large engineering systems in recovery catchments (e.g. pipelines, void disposal, desalinisation) Commercial trees (wood lots, bluegums etc), lucerne on selected soils and surface water management (including raised beds) Alleys including perennials, and surface water management
256 N. Rejuv. Drainage	**Recovery** **Containment** **Adaptation**	Salt-tolerant pastures, surface water management Oil mallee alleys, lucerne (e.g. Wrights) and long season annuals, surface water management (including raised beds) PURSL, surface water management
257 S. Rejuv Drainage	**Recovery** **Containment** **Adaptation**	Drainage and pumping (siphons in dissected area) Oil mallee alleys, lucerne and long season annuals, surface water management (including raised beds) PURSL, surface water management
258 North Ancient Drainage	**Recovery** **Containment** **Adaptation**	Drainage systems, (deep open drains most effective in permeable sediments) Oil mallee alleys, targeted perennials, surface water management (including raised beds in western areas) Saltbush, bluebush, samphire (PURSL) systems, surface water management.
259 SW Ancient Drainage	**Recovery** **Containment** **Adaptation**	Drainage systems (limited by sodic soils), targeted perennials Oil mallee, lucerne (including raised beds) Saltbush systems (PURSL)
261 Southern Cross	**Recovery** **Containment** **Adaptation**	Drainage systems (limited by sodic and low permeability soils) Oil mallee alleys, where rainfall is sufficient Saltbush, bluebush, samphire system
271 Irwin River	**Recovery** **Containment** **Adaptation**	Engineering options limited by permeability and gradient Oil mallee options limited by soils and growth rates Saltbush only

Addendum 2 — Value–threat matrices for roads and land

Value of land (PV gross benefit)

Value Vs. Threat		Value of Land (PV Gross Benefit)		
		High (> $20m)	**Medium ($10–20m)**	**Low (< $10m)**
Threat to Land (Years)	Imminent < 20 years **(high threat)**	Warren-Denmark Dandaragan Western Darling Range Bassendean	Jerramungup Plain	Chapman Stirling Range Coastal Dune Pinjarra Plain
	20–75 years **(medium threat)**	Esperance Sandplain S. Rejuvenated Drainage Eastern Darling Range North Rejuvenated Drainage North Ancient Drainage SW Ancient Drainage	Pallinup Plain SE Ancient Drainage	Irwin River Albany Sandplain Lockier Ravensthorpe Pt Gregory Coastal Arrowsmith Kalbarri Victoria Plateau
	> 75 years or asset significantly affected **(low threat)**	Nil	Nil	Salmon Gums Southern Cross

Value of land ($/ha)

Value Vs. Threat		Value of Land (PV Gross Benefit)		
		High (> $100/ha)	**Medium ($50–100/ha)**	**Low (< $50/ha)**
Threat to Land (Years)	Imminent < 20 years **(high threat)**	Warren-Denmark (195) Bassendean (161) Western Darling Range (119)	Dandaragan (71) Stirling Range (58)	Chapman (31) Jerramungup Plain (36) Coastal Dune (0) Pinjarra Plain (0)
	20–75 years **(medium threat)**	Nil	Esperance Sandplain (92) Eastern Darling Range (58) S. Rejuvenated Drainage (57)	Pallinup Plain (49) North Rejuvenated Drainage (40) SW Ancient Drainage (17) Ravensthorpe (14) Lockier (11) Irwin River (11) North Ancient Drainage (8) SE Ancient Drainage (8) Pt Gregory Coastal (6) Albany Sandplain (3) Arrowsmith (0) Victoria Plateau (0) Kalbarri (0)
	> 75 years or asset significantly affected **(low threat)**	Nil	Nil	Salmon Gums (4) Southern Cross (2)

Value of roads

Value Vs. Threat		Value of Land (PV Gross Benefit)		
		High (> $10m)	**Medium ($5–10m)**	**Low (< $5m)**
Threat to Land (Years)	Imminent < 20 years **(high threat)**	Warren-Denmark	Western Darling Range	Chapman Stirling Range Jerramungup Plain Dandaragan Pinjarra Plain Coastal Dune
	20–75 years **(medium threat)**	Nil	Albany Sandplain Esperance Sandplain Victoria Plateau	Pallinup Lockier Ravensthorpe Kalbarri Pt Gregory Coastal Arrowsmith
	> 75 years or asset significantly affected **(low threat)**	Nil	Salmon Gums	Southern Cross

Appendix 5
Social assets at state scale

Introduction

This brief report defines and describes social assets that form part of the rural environment being affected by salinity in WA. The report was prepared for the Salinity Investment Framework (SIF) Steering Committee, which is guiding the development of the SIF processes across the state. The implementation of the SIF for determining investment priorities is being managed through Water and Rivers Commission (now part of the Department of Environment, Water and Catchment Protection).

Background

Asset classes in the State Salinity Investment Framework

The State Salinity Investment Framework Steering Committee has developed the asset classes and responsibilities for developing rules for allocating priorities for investment as shown in Table 5.1. The process is developing asset value/threat matrices for separate asset classes to determine priorities for public investment.

At the state scale, the Steering Committee decided that social assets needed to be considered alongside the biophysical assets, but was keen to get direct input from the regional communities before determining state-level categories.

Table 5.1: State asset classes

Asset classes	Main state types	Responsible agency
Land	Land values and productivity at soil–landscape zone scale used to determine best land use/ management strategy. Agricultural land assessed for market value in four classes • Not impacted by salinity • Salt spotted • Poorer saline grazing land • Bare salt lands	DoA
Biodiversity	• Rare plants and animals • Rare ecological communities • ‘Target landscapes’ that include best representations of biodiversity assets	DCLM
Water	• Commercial water supplies • Significant wetlands • Major waterways in good condition • Minor waterways in good condition	DoE
Infrastructure	• Roads and rail • Towns	 DoA

Input from the regional workshops

The SIF process was applied in the Avon Region with four Regional Workshops held through October and November 2002. The project brief for the regional process developed by the Steering Committee required specific attention to the social assets, and participants were asked directly to identify the components of these assets. All four workshops were able to define social assets and, in three of the four workshops, these assets were seen as being of highest priority as targets for investment in salinity management.

The regional communities' definitions of social assets revolved around the critical mass in rural communities, the quality of communications, internal and external networks, levels of service provision for farm businesses, knowledge and skills in agricultural management, health and education services and the pivotal role of recreational pursuits in maintaining a sense of community. Cultural and spiritual assets received attention — both those based on natural features of the landscape and those derived from built infrastructure. In particular, Aboriginal heritage is receiving attention and is being recognised for its importance.

Overall, the view was that the impact of salinity as an additional force on trends affecting social and socio-economic assets was seen as marginal. Other forces such as declining terms of trade, improved communications and the replacement of labour by technology are far larger influences, for better and for worse, on how the region functions. However, maintaining and strengthening the ability of the social and socio-economic assets — the community's capacity to manage salinity impacts — were seen as being of very high priority for salinity investment.

The case for including socio-economic assets

The conclusion from the Regional Workshops was that social assets needed to be included as a distinctive asset class — broadly defined as the 'social wealth' or 'social capital' available at state, regional and local scales. Enhancement of the social assets is seen as being critical in delivering capacity to address the threat posed by salinity to all asset types, such as biodiversity and land. The state SIF Steering Committee decided to develop a series of social asset categories for inclusion in the state framework.

Methodology

The Salinity Investment Framework Steering Committee established a subcommittee to use the outcomes from the Regional Workshops and define social assets for consideration in the state and regional priority setting processes. Members were:

Damien McAlinden, Executive Officer, Salinity Investment Framework Committee,
Water and Rivers Commission (DoE)
Charlie Nicholson, DCLM
John Ruprecht, Water and Rivers Commission (DoE)
Janette Hill-Tonkin, DoA
Ted Rowley, Amron Pty Ltd
Don Burnside, URS Australia Pty Ltd

The subcommittee addressed the following points.

- What are the social and socio-economic assets?
- What is the condition of these social and socio-economic assets — how well are they able to deal with salinity issues?
- How can the state SIF process deal with social and socio-economic assets?

Defining social and socio-economic assets

The following sections present types and items for the social and socio-economic assets, together with aspirational goals, rules for allocating priorities and data sources. The subcommittee resolved that at a later stage social assets need to be presented in a fashion similar to biophysical assets, with use, if possible, of a value–threat matrix.

Although considered originally in the context of salinity threats and management, the assets are presented within the wider context of NRM. The social assets are summarised in Table 5.2. Detailed descriptions are provided in the following subsections.

Table 5.2 Social asset types and items

Asset type	Asset items
Knowledge and skills	Knowledge and skills available Ability to grow knowledge and skills Robustness and availability
Values/culture	NRM values Sense of place, cultural heritage appreciation Robustness, persistence, resilience and availability
Community well-being	Community health Cohesiveness
Networks/organisations	NRM values Quality of social interaction Information flow Learning capacity
Economic resources	Investment available from sources within the area Investment available from sources outside the area
Governance capacity	Institutional arrangements for NRM

An underlying assumption in the definitions and descriptions is that the social assets will have value proportional to their alignment with underlying NRM values that are reflected in goals and strategies operating at a range of scales. As such, the social assets are not absolute assets, nor are they ‘value-free’. They need to be considered in the context of their NRM relevance. For example, ‘cultural values’ as a social asset can have more or less desirable characteristics in respect of NRM goals. Examples of less desirable underlying cultural values may be strongly held prejudices against participative and inclusive processes for establishing community goals and objectives. Conversely, cultural values that include an encouragement of new ideas, or a willingness to embrace change are more desirable characteristics in relation to NRM goals. Another, simpler example will be where one view held is that saline land is useless and ruined, whereas another view will be that saline land has potential for saltland grazing, or desalination of available water.

It is worth noting that the *Focus on the Future — the WA State Sustainability Strategy*, Draft Consultation Paper has as its goal for ‘Sustainability and community’ — ‘Support communities to fully participate in achieving a sustainable future’ (Government of WA, 2002, p164). The Draft *Regional Policy Statement* includes strategies aimed at supporting communities involved in natural resource management (Department of Local Government and Regional Development, 2003).

Many recent so-called ‘triple-bottom line’ reports have attempted to define, describe and measure social assets. The Australia Institute <www.tai.org.au> defines categories of ‘human capital’ and ‘social capital’ that deal in part with how a community behaves and performs. *Minnesota Milestones* <www.mnplan.state.mn.us> and *Tasmania Together* are examples of the many state/local reports that value social capital through goals and indicators for categories such as sense of community, volunteerism, and support for each other.

Knowledge and skills

Knowledge and skills are important instrumental assets for a community, or a social grouping. The National Collaborative Project on Indicators for Sustainable Agriculture (SCARM Technical Report 70) lists 'Managerial skill' as one of five peak indicators for sustainable agriculture. Included in this peak indicator are (i) education levels of farmers, (ii) extent of participation in landcare-related activities, and (iii) implementation of sustainable practices. Information on managerial skills has been presented, albeit at coarse scale in the National Land and Water Resources Audit 2001, and in the SCARM document.

The stock of knowledge and skills

Description: Knowledge and skills are located within people's heads, and operate at several levels. It includes the conceptual skills to ask the right questions, and to search for the right answers; and the applied knowledge and skills that can be directed towards solving problems. Conceptual skills include a capacity to ask 'second-level questions'. A first-level question may be 'How do I get better wheat crops from this land?'. A second-level question is 'Should I be farming this land?'.

Goal: Appropriate and sufficient knowledge and skills are held by decision-makers responsible for managing natural resources to ensure progress towards preferred short-term and long-term outcomes.

Rule for determining asset value: In a SIF context, the simplest measures of knowledge and skills are (i) the education level of decision-makers having an influence on the use of natural resources; (ii) the level of adoption of sustainable management practices; and (iii) knowledge and skills in processes for setting goals/targets and developing local/region level plans.

Data sources: NLWRA data. ABS/ABARE survey data. The DoA captures information on the percentage of farmers implementing sustainable practices (see Annual Report 2001). These data may be available at spatial scale. More specific data on knowledge, skills and behaviour exist for some agricultural regions in the findings in local surveys (e.g. Fionnuala Frost's PhD studies, Living Landscapes, Alcoa Landcare Reviews). Development Commissions also collect demographic and knowledge/skills information at regional scale.

Ability to grow knowledge and skills

Description: Knowledge and skills need to be accumulated at a rate sufficient to address emerging problems and challenges. A range of means exists — reflective self-learning at individual or group levels, informal learning activities, formal training, and engagement of external professional advice. Activities such as TopCrop, Woolpro, Living Landscapes, catchment planning, and river management courses provide learning opportunities.

Goal: Abundant opportunities, accessible by individuals and groups exist at single- and multi-disciplinary levels for the accumulation of knowledge and skills by those responsible for the management of natural resources.

Rule for determining asset value: Opportunities for, and level of involvement in, community-supported learning activities that enhance capacity for natural resource management.

Data sources: NLWRA data. ABS/ABARE survey data. AAAC data. The DoA captures information on the percentage of farmers involved in learning groups, those undertaking personal development activities, those working with sources of professional advice and those involved in their own action learning.

Robustness and availability

Description: The depth and spread of knowledge and skills available to a local community. For example, are there important sources of knowledge held by a few key community members, or is it widely held and shared readily within a community? In terms of content, are the knowledge and skills held about single issues or multi-issues and/or integrated or segmented domains? Are these assets demonstrated at farm or landscape scale, and/or within industry or community environments? Further, is there is a willingness for inter-generational transfer of these assets? Finally, is there diversity in the knowledge and skills or is there a tendency to excessively 'unified thinking'?

Goal: Knowledge and skills within a community are widely shared across community members and valued for their diversity.

Rule for determining asset value: Number of recognised 'knowledge leaders' and 'knowledge brokers' at local community scale. These can be groups and/or individuals who give the community capacity to access knowledge and skills from within the community.

Data sources: May be captured through surveys undertaken by Development Commissions, Departments of Community Development, Health, Education and Agriculture, or through existing expert knowledge about which communities are richer in their depth, spread and sharing of knowledge and skills.

Values and Culture

All societies, communities and organisations have distinctive values and cultures. For the Salinity Investment Framework, the importance of 'Values and Culture' as an asset will depend on their compatibility with national and state goals for NRM. The people who directly manage land, water and biodiversity and the people who impact directly and indirectly natural resources are the relevant communities of interest. Values about natural resources as a farmer, family member, community official, industry group member may vary according to the context — whether the values are being established as an individual level or as a member of society. Thus the context for the values and culture is very important in considering goals and the 'condition' of these assets.

NRM values

Description: Values that are grounded in an appreciation of the worth of the natural resources will be an asset when employed in managing these resources. The National Land and Water Resources Authority notes that 'Australian farmers generally have a positive and pragmatic attitude towards environmental issues'. These attitudes will be based on a set of personal values which include an appreciation of the natural resources. These values can be instrumental ('What the resources can do for me'), or intrinsic ('I value the resources for what they are'). Another important component of a person's value set will be their appreciation of timescale — for example the relative importance of short-term and long-term returns from their decisions. For example, a sense of legacy describes a value set that has a long-term time dimension.

Goal: Values held by industry, family, community about natural resources encourage wise long-term use.

Rule for determining asset value: Variation in values about natural resources may have some spatial, cultural and experiential variability, dependent on the level of planned activity in natural resource management (e.g. the Alcoa catchments).

Data sources: Gasson (1973) developed a means of measuring values which was used by Fionnuala Frost in the 1990s in determining values amongst farmers in a number of catchment groups. There has been little other specific work done at community scale. The Social Capital index is a measure of community health which in part reflects underlying values. These data are being captured by the Department of Health at shire scale.

Sense of place, cultural heritage appreciation

Description: Sense of place is defined by the affective feelings a person has for the physical environment, a landscape or location, or a community that are independent of material goods and gain. For example, many regional workshop participants highlighted special places in the landscape that gave meaning and value to their lives, such as granite rocks, historic homesteads and certain vistas.

Appreciation of cultural heritage includes the built heritage and the area's stories, both indigenous and European in origin. The recognition of the value of Aboriginal dreaming trails and European heritage trails is evidence of appreciated heritage values.

Goal: Appreciation of sense of place and cultural heritage enhances personal and community commitment to the region's natural resource assets.

Rule for determining asset value: Difficult to determine rule. Some cultural heritage sites are clearly identified by location (dreaming trails, historic wells and buildings etc.), but strength of appreciation of this heritage is not. The Social Capital index is a measure of community health, which in part captures sense of place and an appreciation of what the community offers. The level of cross-boundary landscape planning and appreciation, collective involvement in setting goals and targets for local and regional environments is evidence of appreciation of the landscape.

Data sources: Little available beyond general surveys of what people like about their region (see Living in the Regions 1999). Social Capital index presented at shire scale (as captured by the Health Department) may be useful. There are relevant data available for confined areas of the wheatbelt from the Living Landscapes project and the Alcoa Landcare surveys.

Robustness, persistence, resilience and availability

Description: A appreciation of the natural resources that is reflected in the NRM values can change over time, with shifts in community demographics and external cultural influences. The resilience of the community's appreciation of what is has in the way of natural resources and their importance will be an asset that increases the stake that people will have in the area. It provides a 'grounding' for short- and long-term behaviour.

Goal: NRM values are appreciated and shared widely across all sectors of the community and across generations.

Rule for determining asset value: Difficult to determine rule. The level of multi-generational/multi-sectoral involvement in, and care given to, looking after significant landscapes, sites and histories at local community scale provides some indication of the depth and strength of the natural resource values held by individuals and communities.

Data sources: Amount of, or existence of, collective planning and action in natural resource management. Level of investment by local communities into landscape management, and maintenance of special places, and documentation of myths and dreamings. Number of histories, nature of sites and specific areas of local importance.

Community well-being

A high level of community well-being is an essential requirement in achieving a sustainable future. The Draft State Sustainability Strategy (p. 165) emphasises the integration of social development into the achievement of sustainability. Healthy communities are able to develop long-term visions and values, knowledge and skills, and can generate resources to implement effective natural resource management. Traditional reporting in this area has focused on social measures such as educational attainment, physical and mental health status, and crime levels. Many of these measures will be adequate for defining the condition of community well-being, with the addition of new measures such as the Social Capital index (as measured by the Health Department).

Community health

Description: Physical and mental health have been recognised as being linked to the state of the environment. Good health is an important asset of any community. Without robust physical and mental health, community productivity is lower, the diversion of resources into healthcare needs to be higher and the ability to grow community knowledge, skills and economic resources is reduced (see Draft Sustainability Strategy, p. 175). Health issues are significant and urgent in some regions, amongst rural youth and in the indigenous population.

Goal: Healthy communities able to devote resources to natural resource management.

Rule: Health standards at regional and local scales, with special attention to youth and indigenous health.

Data sources: The Department of Health collects data on a very wide range of health issues down to shire scale.

Cohesiveness

Description: 'Community cohesion is essential for the accomplishment of community goals' (Draft Regional Policy Statement, p. 44). It includes the willingness to contribute to the community good through participation in voluntary activities and service provision. It also includes the trust that exists between sectors in a community and the acceptance of the value of diversity.

Goal: Regional and local communities committed to looking after their affairs in an integrated and inclusive way.

Rule: The level of volunteerism that occurs at local scale. Evidence of support for diversity in the community. The number and vigour of community service organisations. The quality of community decision-making processes. The quality of community visions and goals.

Data sources: May be captured through surveys undertaken by Development Commissions, Departments of Community Development, Health, Education and Agriculture, or through existing expert knowledge about which communities are richer in their cohesiveness. The measure of Social Capital being used by the Department of Health also considers trust and cooperation.

Networks and organisations

An increasing complexity of formal and informal networks, organisations and groups are influencing social and socio-economic thinking and behaviour in managing natural resources. These entities can be single or multi-interest in nature, broad or narrow in their demographic make-up, with widely varying spheres of influence. Examples include:

- large well-resourced community-led research and development (R&D) groups such as Western Australian No-Till Farmers Association, Lucerne Growers Association, and the Kondinin Group
- regionally significant groups formed to improve productivity such as the Liebe Group, the Facey Group and the South East Premium Wheatgrowers Association
- agricultural knowledge brokers such professional consultants, marketing groups and service organisations
- landcare networks, community networks and associations of networks (e.g. NEWROC)
- heritage groups (e.g. historical societies, National Trust, local museum groups)
- landcare and catchment groups

- conservation networks such as Greening Australia (WA), Wildflower Society and the World Wide Fund for Nature.

These and other networks are increasing their involvement for R, D & Extension in rural industry development, sustainable regional development, natural resource management, heritage knowledge and protection and economic diversification, and their capacity represents an important asset in NRM.

NRM values

Description: Networks and organisations will vary in their NRM values, with some focusing on maximising short- to medium-term productivity growth, some on triple-bottom line outcomes, while others have clear landscape and off-site conservation objectives. There is value in all types, but an important asset of the networks and organisations in the context of NRM will be the natural resource values that they bring to their normal collective thinking and actions taken in their own domains.

Goal: All relevant networks have NRM values reflected in their core business.

Rule for determining asset value: NRM values will be revealed in the policies, strategies, and activities of individual networks and organisations.

Data sources: Networks and organisations could be ranked for the 'NRM relevance' of their policies, strategies, and activities. For example, QA activities on farm led by a local marketing network will have some NRM relevance, but may be of more importance in the context of enhancing food safety.

Quality of social interaction

Description: 'Strong communities are more sustainable in themselves and are more able to contribute to sustainability in general' (Draft State Sustainability Strategy, p. 167). In an NRM sense, quality of social interaction will be an asset if the relationships within a community and between communities are open, enquiring, constructive, and build NRM capacity.

Goal: The quality of interaction and participation in NRM dialogue builds informed, empowered and committed communities.

Rule for determining asset value: The revealed level of trust and community cohesion at spatial scale, with the preference being landscape or natural region scale.

Data sources: Social Capital index presented at shire scale (as captured by the Health Department) will be useful. It will be helpful if this information could also be presented at a landscape or natural region scale.

Information flow

Description: The asset is the ability for networks and organisations (and their component individuals) to operate as information brokers and managers to ensure that those that need information can readily access what they need. This does not imply a capacity to just 'shift' bulk, unsorted information, but assumes a capacity to value-add information as well as assisting its movement through the NRM environment. Issues of scale are important so that information available at one scale can be re-interpreted to support learning at another scale.

Goal: Best practice systems are available for collecting, sharing, storing, managing and re-interpreting information to ensure sound information support for NRM decisions at all scales (adapted from the Draft Regional Policy Statement, p. 13).

Rule for determining asset value: The capacity of individual networks and organisations to handle information flows to and from, and within and between, their own operating environments.

Data sources: Networks and organisations could be ranked for the quality of their information management and their 'reach' to (and influence with) those with responsibility for decision-making. Those networks with potential could be supported to increase their capacity in this area.

Learning capacity

Description: Networks and organisations need to be able to grow their capacity if they are to continue to be relevant. This means incorporating new information and thinking, re-setting goals and targets, extending their area of interest, incorporating new people and values, and reviewing performance. An ability to build capacity in process and content areas is an important asset for these groups and one that is worth fostering. In the NRM context, networks and organisations will be an asset if they are able to keep pushing the boundaries of what can be achieved in sustainable development.

Goal: Local and regional networks are at the 'cutting edge' in NRM thinking and action.

Rule for determining asset value: The revealed dynamism and vigour of individual networks and organisations in their thinking and actions in NRM.

Data sources: Networks and organisations could be ranked for their dynamism and vigour in considering NRM. Those networks with potential could be supported to increase their capacity in this area.

Economic resources

The social and socio-economic assets of an area, or community or a region include the available investment capital that can be directed into addressing NRM requirements. These assets include the capital generated from economic activities within the region or area, including those based on the use of natural resources. It also comprises economic resources that can be attracted into the region as normal investment capital, or as part of philanthropic investment. This latter asset item is significant, with corporate and community philanthropic investments now totalling many millions of dollars annually.

Investment available from sources within the area

Description: Addressing NRM obligations or aspirations often requires short-term investment for long-term gain. Assuming the investment is viewed as rewarding, it requires businesses and regions to have the capacity to either generate the capital, or to be able to service borrowed capital. In both situations, this requires the economic activities in a region to generate a sufficient surplus to meet those obligations or desired outcomes.

Goal: Regional economies are able to benefit from and contribute to sustainability (adapted from goal for business in the Draft State Sustainability Strategy, p. 194). Regional businesses generate their own sources of investment from profitable economic activities sufficient to address NRM obligations and aspirations.

Rule for determining asset value: The aggregate business profit per hectare or per industry unit that is available for re-investment into sustaining of the natural resources.

Data sources: Data are available at coarse scales in the National Land and Water Resources Audit (2001), and in various ABARE and ABS datasets. The DoA and some finance houses also have relevant data.

Investment from sources outside the area

Description: Significant funds are invested by a range of organisations into environmental projects. Organisations can include major corporations (e.g. Alcoa, Western Power), specialist bodies like the Australian Wildlife Nature Conservancy, part-publicly funded organisations like Greening Australia, Research and Development Corporations (RDCs) (e.g. Grains RDC), Landcare Australia Limited, and Government (e.g. the NHT). The capacity to attract appropriate levels of these discretionary funds to a locality, region, or issue is an asset.

Goal: Regional communities are able to attract significant external commercial or philanthropic investment to address shared NRM aspirations.

Rule for determining asset value: Current finding allocations provide one measure of the capacity to attract investment. However, this may just be a measure of 'grantsmanship'. A better rule may be the existence of long-term partnerships between communities and external providers of investment.

Data sources: Nature and operating domain of long-term partnerships that direct investment into improved management of natural resources.

Governance capacity

This asset class is the commitment and support that can be provided by Government at all levels and across all domains in providing an 'enabling environment' for sound NRM. Commitment and support will include formalised partnerships for NRM across levels of Government and community and an equitable allocation of roles, responsibilities and resources.

Institutional arrangements for natural resource management

Description: The asset is the legislative, policy, and institutional support for NRM that operates at Commonwealth, State and Local Government levels. The WA Draft Sustainability Strategy highlights the role that Government at all levels must play in progressing sustainable development. The Draft Regional Development Policy also includes a range of strategies for sustainable development in the regions. Sound arrangements for NRM governance will ensure that communities and government at all levels are able to work well in partnership, with mutual recognition of each other's roles and support for them.

Goal: 'Ensure that the way we govern is driving the transition to a sustainable future' (Goal taken from the Draft Sustainability Strategy 2002, p. 34)

Rule for determining asset value: Extent to which sustainability is embedded in state, regional and local governance. Partnerships between State and Local Governments and community in implementing NRM plans and programs.

Data sources: Government reporting against indicators in the Draft Sustainability Strategy.

Glossary and acronyms

Adaptation

Adaptation implies a preparedness to live with salinity impacts now and into the future, by coping with the consequences of salinity and minimising the losses (Government of Western Australia 1996). Deciding to continue with a long-term program of road repair and maintenance in the face of salinity threats is an example of adaptation. Establishing salt tolerant pastures (shrubs and grasses) on salt-affected land is another example.

Agricultural land

For the purposes of the SIF, agricultural land is defined as that land held as freehold that is used for food and fibre production. In the context of a farm, 'agricultural land' refers to the cleared proportion only. Natural habitats (i.e. uncleared or regrowth land) occurring on freehold land are considered in the SIF process as potential biodiversity habitats.

Asset hierarchies

The table below presents terms used within this report to distinguish between different levels of asset description. These have been applied in the state level of assessment. The presentation shows all categories, classes and types, with examples given for specific items.

Asset category	**Biophysical**		**Economic**			**Social**
Asset class	**Biodiversity**	**Water**	**Agricultural land**	**Rural infrastructure**	**Technologies**	**Social**
Asset type	1. Rare species 2. Rare communities 3. Representative landscapes	1. Water supplies 2. Waterscapes	31 soil–landscape zones. Agricultural land assessed for its market value in four classes: • Not impacted by salinity • Salt spotted • Poorer saline grazing land • Bare salt lands	1. Towns 2. Roads 3. Rail	1. Agronomic technologies 2. Engineering technologies	1. Knowledge and skills 2. Values/culture 3. Community well-being 4. Networks/ organisations 5. Economic resources 6. Governance capacity
Asset items (examples)	• Lake Toolibin • Lake Campion • Mortlock River system	• Fresh ground-water supplies • River pools	• Valley floors • Slopes	• Main roads • Local roads • Individual towns (e.g. Merredin, York)	• Saltland pasture systems • Perennial pastures systems • Drainage	• Social capital (e.g. trust) • Community cohesion • NRM values

Assets of public value

Assets that have values that cannot be realised by individuals, but instead generate benefits that will be shared amongst a community or communities, are termed 'assets of public values'. The clearest examples are clean air, and water catchment areas that yield fresh run-off into publicly owned reservoirs. In the SIF context, rare species and communities are assets of public value, in that the current or potential benefits they provide cannot be 'captured' by individuals.

Assets of private value

Assets with values mainly realised by individuals are termed ‘assets of private value’. Thus, freehold agricultural land that can support crops and pastures provides rewards mainly for the holder of the freehold title. Similarly, a house in a town threatened by rising groundwater has private values which are realised by the owner of the house.

In reality, many of the assets considered in this report provide a mixture of private and public benefits. For example, a fenced piece of remnant bushland on freehold land will be providing private benefits in terms of shelter for sheep, and high water use; and public benefits as a habitat for birds and small mammals.

Containment

Contain or control — bring the process of managing salinisation to the point where further damage is contained (Government of Western Australia 1996). In Katanning, groundwater pumping is being implemented to ensure that saline groundwater within the town is kept below the level at which it would affect the town’s infrastructure. On farms, strategic tree planting and water management is being used to prevent further localised rise of groundwater levels.

Feasibility

This term means the ability to do something for an asset which requires consideration of goals, management options, costs, other threats, and social and technical capacity. Determining the feasibility of a salinity management option for an asset item requires a number of important aspects to be considered:

- How much will the management option cost?
- Is it technically feasible?
- Will the option achieve the goal?
- How long will it take for the goal to be achieved?
- Will the option be implemented or be supported by surrounding land managers?
- What are the other threats to the asset (weed invasion, eutrophication, erosion etc)?

Land Monitor

Land Monitor is a program of salinity-risk prediction at broad spatial scales. It uses landsat imagery and digital elevation models (similar to contour maps) of the varying terrain to predict areas that will be affected by shallow groundwater levels in the future.

Acronyms

ACC	Avon Catchment Council
AHAVF	Average height above valley floor
AOCLP	Area of consistently low productivity
DCLM/CALM	Department of Conservation and Land Management
DoA	Department of Agriculture
DoE	Department of Environment
MCA	Multiple-criteria analysis
NRM	Natural Resource Management
SIF	Salinity Investment Framework

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