REGIONAL
NATURAL RESOURCE
MANAGEMENT STRATEGY

Northern Agricultural Region
of Western Australia

Prepared by the Northern Agricultural Catchments Council (NACC) 2005 www.nacc.com.au
NORTHERN AGRICULTURAL REGION

Figure 1. NAR showing shires, sub-regions and extent of coastal waters.
PREFACE

It is with great pleasure that I present this natural resource management strategy to the community. Our strategy is the culmination of the efforts of many people. We have asked for a huge effort and commitment from the NACC team. This has been forthcoming throughout the preparation of the strategy. We commend them for their professionalism and their willingness to assist the management team along the way.

We are fortunate that the Northern Agricultural Region has not only economic strength, but also many beautiful and valuable environmental assets. In the past, natural resource management in the region has tended to focus on broadacre farming and salinity control. While these are still paramount, this strategy demonstrates that there are many other issues we now recognise as important.

I am delighted that a wide cross section of the community has contributed to this document and that issues such as water quality, river, coastal and marine management, farm forestry and Indigenous values are now also gaining prominence.

My own definition of natural resource management covers three broad components:

- a ‘green’ component about protection of our natural assets of water quality and biodiversity on land and sea;
- a ‘brown’ component about sustainable production and encouraging changed management practices in response to changing circumstances; and
- a ‘business’ component about encouraging investment by the region in order to attract investment in the region from the State and the Australian Governments.

To convince our investors of the benefits of their continued involvement we need to demonstrate our capacity for on-ground delivery and support. Such demonstration will include monitoring and evaluation of projects in substantial ways, as well as promoting our successes to the public.

We all have ideas of what we want for our future. Throughout our strategy development we have heard the many people who attended our workshops voice their desire for more investment in the region. People want more social capital, the best available advice, improved management of water, biodiversity, and other natural resources, good science and many other management actions, as this document demonstrates. Your input through the workshops provided the actions and targets presented here. We are indebted to you and look forward to your continued involvement.

Many more of you will become involved with NACC through development and implementation of subsequent on-ground activities in a variety of ways. We look forward to you joining with us to achieve real improvements to natural resource management.

Elizabeth Eaton
Chair
Northern Agricultural Catchments Council

“We look forward to you joining with us to achieve real improvements to natural resource management”
THE NACC TEAM

This publication has been prepared by the Northern Agricultural Catchments Council (NACC) on behalf of the community of the Northern Agricultural Region of Western Australia. We acknowledge the assistance of the Commonwealth Government and the Government of Western Australia for funding this strategy process, and their agencies and staff for supporting us in conducting it.


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Disclaimer
This publication is intended to provide the State and Commonwealth Governments with a clear indication of our community's thinking on natural resource management. All information is provided to the best of our ability and within the limits of our knowledge. Any proposals for NACC-supported actions that result from this document will need to be further detailed and agreed to by all parties. The document may also be of assistance to you for other reasons, but we do not guarantee that this publication is appropriate for your particular purpose.
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EXECUTIVE SUMMARY

LIVING WITH OUR LAND AND SEAS - NATURALLY

The Northern Agricultural Catchments Council, (NACC) with the assistance of a vibrant regional team, has developed this regional NRM strategy to help conserve and enhance our natural resources. We aim to provide scientifically sound but practical on-ground actions to enhance our resource condition. Our vision is a balance between environmental, economic, and social outcomes.

We have followed an asset-based methodology identifying key assets, analysing threats, and developing actions and targets to achieve improvements. Issues addressed include salinity, the integrity of marine, terrestrial and aquatic communities, water land and marine scapes, groundwater, farming systems and biosecurity. In addition we have explored some community and infrastructure assets in particular in relation to community capacity.

We have consciously adopted a “bottom-up” approach with the community actually writing the actions and targets. We believe this will lead to a higher degree of community ownership than other methods. We have identified the current state of natural resources in the region, linked this with the community’s aspirational targets, then tested the final framework to check that the primary issues are dealt with.

Development of this strategy has included a wide range of innovative and vibrant activities throughout the region to develop aspirations, actions and targets focussed on future NRM scenarios. Many different community interest groups and special interest groups were involved in activities and there was also a wide geographical spread of events. In the process we have also developed the capacity of the NACC team. It has been an exciting exercise and one which is already bearing fruit in the form of increased community awareness of, and commitment to, NRM.

The Northern Agricultural Region is the traditional land of two Aboriginal groups. Yamaji (also spelled Yamaṯi) people are the traditional owners of land and coastal waters to the north and Noongar people are the traditional owners of all land south of Coorow and Lake Moore. There are at least six distinct Yamaji language groups and at least two Noongar language groups. Aboriginal people have an historical and spiritual attachment to natural resources and they were an integral part of the strategy engagement process. Their input into the strategy is valued.

In using an “asset/threat” paradigm for the development of this strategy we have been conscious of the risk of developing a “problem-centred” focus. However, we are blessed with the fact that the NAR has a beautiful environment that will respond to improvement, a stable and prosperous economy based on a range of different industries, and a vibrant, committed and independent community. In addition there are many new economic opportunities opening up which we are keen to take advantage of. One of the strengths of this strategy will be if we can link the resource and management targets we have set for natural resources to the development of these opportunities.

Some of the reasons that opportunities exist in the region are: cheap land, good quality groundwater, high value conservation assets, mineral, oil and gas deposits, pristine oceans with abundant fish, and a long coastline with unoccupied beaches. We have outlined some of the opportunities that these present, in particular intensive production and innovative developments in agriculture, forestry, tourism, mining, fishing, aquaculture and lifestyle and urban expansion.

The following goals, information, actions and targets were analysed, formulated and tabulated:

- Aspirational Targets
- Current Resource Conditions
- Resource Condition Targets
- Management Actions
- Management Action Targets

Actions were formulated of the following types:

- Resource Assessment
- Planning
- Institutional Change
- Community Capacity
- On-ground works

Synergies were developed with government and non-government strategies and actions, cross-region and cross-theme, and actions were cross-checked with the “Matters for Target” prescribed by the government in the “National Framework for Natural Resource Management Standards and Targets”.

A range of existing legislation, policy and plans at the Commonwealth, State, local government, regional, sub-regional and local levels interact with NRM. We are very conscious of the need to link all levels and to develop a coordinated approach. We have provided an overview of these issues and attempted to link
our actions to existing policies and actions to avoid duplication. In addition, we have identified “institutional change” as an activity in our actions and targets.

Monitoring, evaluation and reporting (MER) is a key platform of our approach. In the NAR we see MER as an opportunity to assist us in identifying change and we are keen to use MER to provide feedback to assist with adaptive management. Monitoring evaluation and reporting of all projects and investments will be undertaken and will be incorporated into each project budget. In addition we will have a specific regional level project to conduct a monitoring needs analysis, prioritise investigations, work on synergies with current agency monitoring programs, and develop community capacity in MER across the region. We believe that integrated NRM program logic, NHT objectives and program activities can be linked through MER.

We developed a very large number of Resource Condition Targets, Management Action Targets and Management Actions. Overall there were more than 1000 actions identified. Using the criteria below, actions were selected that:

- target the significant opportunities and threats;
- protect high value assets;
- deliver improvement in a wide area; and
- build up capacity long-term.

Linked with the targets is a framework for investment based on assessment of values and trade-offs. Following on from this strategy, we will be developing an investment plan based on the priorities developed in this process. The investment plan will be prepared in parallel with the community consultation phase of this strategy development, and it is anticipated that it will be complete in early 2005.

Good governance by NACC is assured, but we are also conscious that partnerships with other organisations are essential to successfully integrate NRM into all facets of the region. Several of the issues raised by the community, and translated into actions and targets during the course of this strategy development, were to do with the need to better coordinate all our efforts.

We have identified on-ground works as a key priority. However, we also recognise that capacity building is necessary to enable on-ground activities to be fully developed. As individuals we all require the skills, knowledge (and the commitment) to respond effectively to new NRM challenges, and adopt an integrated approach in a search for long-term solutions. This will promote local ownership and increase the uptake of existing and newly developed sustainable NRM practices and processes.

Moreover, we need to strengthen strategic leadership skills within the community so that we can efficiently integrate the complex set of actions needed for effective Natural Resource Management in the region, and assist in directing and implementing change.

“We aim to provide scientifically sound but practical on-ground actions to enhance our resource condition”
1. INTRODUCTION

1.1 VISION AND OBJECTIVES

1.1.1 OUR VISION

We aspire to be part of a vibrant community in a diversified economy with a healthy environment

The Northern Agricultural Region of Western Australia is a productive farming and fishing area with abundant natural features, many of significant international environmental importance. Within the region we are committed to working together to enhance our natural resources and interlink the integrity of the environment, economy and social fabric. With this focus we have embarked on the development of this regional Natural Resource Management (NRM) Strategy. We are grateful to the Commonwealth and State Governments for resourcing this process which we see as an opportunity to put in place a firm framework to integrate government and community priorities in NRM.

1.1.2 THE CONTEXT

In December 2002 and September 2003 important bilateral agreements were signed by the Commonwealth of Australia (the “Commonwealth”) and the state of Western Australia (the “State”). The first was with respect to the extension of the Natural Heritage Trust and the second dealt with the implementation of the National Action Plan for Salinity and Water Quality. While we have developed various strategies and processes in the past in relation to the development NRM in the region, these “NRM bilaterals” have been the impetus for this current process and have guided us in its development. We believe the resulting strategy is an excellent blueprint for the focus of future NRM actions and good on-ground outcomes that will attract investment from both the State and the Commonwealth.

1.1.3 OBJECTIVES

In line with Commonwealth, State and regional priorities, our aim is to achieve the following objectives:

- to develop sound, logical and practical management actions that will improve the condition of key resources and will lead to enhanced on-ground outcomes;
- to link community aspirations, opinions and values to Commonwealth and State legislative imperatives and priorities and to develop meaningful trade-off preferences;
- to promote a broader understanding of the importance of investing in NRM in this region and to develop a framework for such investment; and
- to integrate and coordinate activity both across the region and with State and Commonwealth partners.

1.1.4 COMMUNITY ENGAGEMENT

A key element of this strategy is the involvement of the community in developing the directions. While we have drawn on much expert advice, the community has been at the centre of the process (see p 10) and we recognise the importance of engaging the energies, knowledge and commitment of local people.

1.1.5 THE NORTHERN AGRICULTURAL CATCHMENT COUNCIL (NACC)

This strategy has been coordinated by the Northern Agricultural Catchments Council (NACC) with the direct financial assistance of the Commonwealth and in-kind and technical assistance from the State. The Northern Agriculture Integrated Management Strategy group (NAIMS), a precursor to NACC, was formed in 1995 and was responsible for developing a draft strategy with the cooperation of the State and considerable volunteer community input. While the original strategy was of limited scope, it laid the groundwork for the current directions.

NACC is a group consisting of 11 community representatives (three “special interest” and two representing each of the four sub-regions), together with five state agency representatives and an independent chair. The five agencies currently represented are the Department of Agriculture, the Department of Conservation and Land Management, the Department of the Environment, the Forest Products Commission...
and the Mid West Development Commission.

Through the help of the Commonwealth and State, NACC has employed a team of people across the region to help develop the strategy. This has included “Local NRM Officers” (local NRMOs) working at the grass roots and “Regional NRMOs” with cross-regional, technical and specialist responsibilities.

We have also been supported by a Commonwealth-appointed Regional NRM Facilitator and various state level facilitators.

Our regional team is a vibrant and committed group, and together, considerable capacity has been developed across the region, both in technical aspects of NRM and in facilitation and community engagement techniques. One of the strengths of our process has been the cooperative team approach and the development of local and regional capacity. We must retain this capacity. One of our key priorities is to develop and increase the ability of the community to engage in the process of protecting our natural resources, and to do this we need to maintain the momentum of the current team.

1.1.6 OUR GOALS

As described later in this document, we have identified six key assets to be protected. We have developed aspirations for each of these as follows:

**Land**

Sustainable land-use systems implemented to ensure our agricultural soils are improved and managed in a healthy, productive and sustainable way.

**Biodiversity**

Species and ecological community diversity, and ecological processes, maintained, protected and enhanced for all terrestrial, aquatic and marine habitats.

**Water**

1. To conserve, maintain and enhance the ecological processes and species richness of waterscapes, and minimise the impacts to water quality.

2. Water resources managed to facilitate regional development, enable sustainable allocation and maintain environmental values.

**Coastal and Marine**

Sustainable fishing and recreational protocols implemented to maintain the integrity of fish resources, and coastal, marine and island habitats.

**Atmosphere**

1. Air quality maintained by limiting threatening developments.

2. Risk management implemented to predict and account for climate change.

**Community Assets**

1. Opportunities developed that balance economic, social and environmental outcomes.

2. Built environment to enhance environmental values and to be protected from environmental threats.

3. Self-reliant, informed and active communities able to identify, direct and implement change to protect and improve our natural resources.

4. Cultural aspects of natural heritage to be respected and enhanced.
1.2 METHODOLOGY

1.2.1 DEFINITION OF A REGIONAL STRATEGY

In developing our regional strategy we have used the following Commonwealth guidelines:

“A regional strategy provides a strategic framework through which regional communities can identify natural resource management issues, assess the social, economic and biophysical drivers, develop regional targets, identify actions to achieve these targets and evaluate the strategy’s success…. For these purposes, NRM is “concerned with the sustainable use and management of the living components of the environment along with associated physical parts of the environment that support those living things”. The natural resource components such as water, land, vegetation, marine, coastal and biodiversity are interconnected …. so it is necessary to integrate across the issues and to work across boundaries.”

Thus we have used an asset-based approach; identification of key natural assets, describing their condition, status and values, then analysing the main threats (whether biophysical, social, institutional or economic). Where possible existing scientific information was used in describing the existing condition of assets and the threats faced by them. Unfortunately the level of objective base knowledge for a number of assets is restricted.

We have examined a range of actions with the potential to achieve targeted improvements, and we have ranked these against criteria including level of public benefit, technical feasibility, probability of success, and risk. Risk assessment was based on existing scientific knowledge and principles.

The following diagram (Figure 1) demonstrates the integrated NRM logic that we have used in developing our actions and targets.

1.2.2 TARGETS ACTIONS & PREFERENCES

We recognise the Commonwealth and State’s requirement for the development of targets in a number of key areas. Using an extensive, innovative, varied and energetic community engagement process we have identified:

• Aspirational Targets (vision and goals)
• Resource Condition Targets (RCTs)
• Management Options
• Management Action Targets (MATs)
• Trade-off criteria and preferences for priority actions

Targets have been developed in a range of key areas, including salinity, the integrity of marine, terrestrial and aquatic species and communities, water quality, farming systems and biosecurity. Later in this document there is a detailed tabulation of assets, actions and targets. Once again existing scientific knowledge has been used as a guide in setting resource condition targets and the management actions to achieve same. Improving knowledge about the resource base was identified as a matter of high priority in future activities for a number of assets. As noted in later sections, policies and legislation have provided a further guide in the setting of targets and actions.

“The community have been extensively involved in developing Management Action Targets.”
Figure 2. Diagram of Integrated Program Logic used in the development of our strategy.

Questions to guide development of Program Logic

1. Where do we want to be in 50 years time?
2. What is the current condition of our biophysical assets and what are the threats to these assets?
3. What should the condition of our natural resources be in 10-20 years time?
4. What are the capabilities of our community, and the human and social capital of our region? (social context)
5. What do we need to achieve in the next 1-5 years to move towards our resource condition targets (including specific areas of practice change we need to undertake in the way we manage and use our natural resources, where this change needs to take place and who should participate in this change)?
6. What kind of activities will we do to make this happen?
7. What activities must we do to get the kind of changes we need to achieve our targets?
8. How much will it cost?
2. OVERVIEW OF THE REGION

2.1 ECONOMIC

The Northern Agricultural Region (NAR) of Western Australia is a rich farming and fishing area to the north and north east of Perth, covering 7.5 million hectares. It is characterised by near pristine beaches and offshore islands, coastal sandplain with considerable areas of retained natural vegetation, and a fertile low-rainfall hinterland. Broad acre agriculture is the predominant industry, but fishing, mining, and tourism also contribute very significantly to the economy. There is a growing diversity of agriculture where groundwater is available.

2.1.1 THE ECONOMIC BASE

The predominant industry is agriculture, which accounts for 35% of the regional economy and is worth $1000m annually. Other significant industries with links to NRM are mining ($400m), and fishing ($200m). Tourism is expanding rapidly, and with its focus on our pristine environmental values, is an important opportunity in relation to our natural assets. The relative contribution of various industries to the regional economy is shown in Figure 3.

Figure 3. Industry Share of the Regional Economy

<table>
<thead>
<tr>
<th>Industry</th>
<th>Share of Regional Economy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>35%</td>
</tr>
<tr>
<td>Fishing</td>
<td>10%</td>
</tr>
<tr>
<td>Mining</td>
<td>11%</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>11%</td>
</tr>
<tr>
<td>Building</td>
<td>3%</td>
</tr>
<tr>
<td>Retail</td>
<td>19%</td>
</tr>
<tr>
<td>Tourism</td>
<td>7%</td>
</tr>
</tbody>
</table>

Agriculture

Approximately half the region is cleared and cropped or pastured, supporting over 2000 agricultural enterprises. Broadacre farming predominates, and uses a wide range of soils and rainfall zones, including loam, clay loam and sandplain in the low (<350 mm) rainfall zone, loams and sandplain in the medium rainfall zone and duplex soils and deep infertile sands in the high (>450 mm) rainfall zone.

The dominant agricultural industries are wheat, lupins, wool, meat and other cereal and pulse grain crops. The region produces 35% of the State’s wheat production, 50% of the State’s lupin production and 10-15% of the production of oats and barley. There are a number of specialised horticultural industries, including citrus and stone fruit, mangoes, broadleaved and root vegetables, and floriculture. Many of these are expanding. There are also emerging aquaculture and farm forestry (based on Pinus pinaster) industries. Sheep and wool production in the region is significant and accounts for up to 20% of the state’s production. Cattle numbers are low, but are increasing on areas of perennial pasture.

Diversification of broadacre farms

There is increasing interest in the region in diversifying traditional broadacre holdings to include intensive and/or value-added enterprises. Examples are table grapes in Northampton, aquaculture in Morawa, wine and olives in Gingin and Nabawa, eucalyptus oil in Dalwallinu and soft flour in Calingiri. While few of these enterprises are yet significant enough to register on the regional economy, they are an expanding and potentially important element.

Mining

This occurs throughout the region, with the main product being mineral sands which was valued at $353.2m in 1997/98. Current mineral sands mines are located at Eneabba and Cataby, with another being developed near Gingin, but a large proportion of the coastal plain is currently subject to mineral exploration licenses. Also of note is the increasing demand for lime sand by the agricultural sector. This will continue to be mined and transported from the coast inland to the broadacre agricultural sector. Natural gas is also produced in the region at sites around Dongara with production valued at $40.3m in 1997/98. The petroleum industry, particularly offshore from Dongara is also developing rapidly.

Fishing

The coastline of the region supports the major part of the West Coast Rock Lobster Fishery. The region’s total live weight catch of all species in 2001/02 was valued at over $200m, with the rock lobster catch representing 95% of the total value.

Silviculture

Farm forestry is gaining in popularity, with both the Forest Products Commission and the Department of Conservation and Land Management actively promoting the benefits of share farming to local farmers. The region provides excellent conditions for the production of pines and can increase productivity of other crops and stock by providing shade and
Tourism

This is a major economic sector and is expanding rapidly. The region boasts some of the State’s major tourism attractions including the Pinnacles, New Norcia, Kalbarri, Murchison River gorges, wildflower country, the Abrolhos Islands and the Batavia Coast. In addition the coast is very popular for leisure pursuits including windsurfing, fishing, surfing and beach recreation. Lancelin and Geraldton are internationally renowned as windsurfing locations.

Current annual tourist numbers are estimated at 600,000 (worth $200m). With the construction of the coast road linking Lancelin with Jurien, it is envisaged that larger numbers of tourists will transverse the region, with visitor numbers to the Pinnacles alone being estimated at 400,000.

2.1.2 REGIONAL DIFFERENCES: COASTAL AND INLAND ENTERPRISES

Apart from the clear distinction between coastal and inland towns in relation to fishing income, there are interesting and significant differences in the types of enterprises contributing to the local economy across the region. For example a snapshot comparison of agricultural production in the shires of Mullewa (100km inland and 500km from Perth) and Gingin (on the coast and 100km from Perth) shows startling differences: 51% of Mullewa’s agricultural income is derived from wheat, 15% from wool, 9% from lupins and 6% from beef; in contrast 43% of Gingin’s agricultural income is from vegetables, 19% from other horticultural products such as nurseries, fruit and vines, 14% from pig meat, 12% from beef and only 4% from wool. Gingin also has a small but significant poultry industry. Mullewa is dependent on a broadacre system whereas Gingin, though originally settled for sheep grazing, is becoming increasingly a focus of irrigated enterprises.

High quality underground water throughout the coastal plain, coupled with demographic changes linked with migration to the coast, are likely to widen the differences between enterprise profiles across the region. These trends provide both opportunities and risks in relation to the management of our natural resources.

2.2 COMMUNITY AND INFRASTRUCTURE

2.2.1 DEMOGRAPHICS

The NAR is an area of approximately 7 million hectares under the administration of 17 local government authorities: Victoria Plains, Gingin, Moora, Dandaragan, Coorow, Carnamah, Three Springs, Dalwallinu, Perenjori, Mingenew, Irwin, Greenough, Morawa, Mullewa, Chapman Valley, Northampton and Geraldton. The shires are outlined on the map of the region on the inside cover (Figure 1). The population of the region is about 60,000, which is 13% of the total regional population of Western Australia. There are many small towns, but only one city. The Geraldton/Greenough urban area has a population of 25-30,000, and the population is heavily weighted towards this centre with over half the population living in the City of Geraldton and the surrounding Shire of Greenough (Figure 4). The coastal towns of Kalbarri, Dongara and Jurien, and the rural centre of Moora all have populations between 1-2000; there are also about 15 centres with 200-1000 people.

Population decline is a feature of most of the inland centres while coastal towns and settlements are experiencing rapid growth. For example, the town of Jurien on the Central Midlands coast (Dandaragan shire), which is predicted to be a major centre once a planned coastal road is completed, has experienced a doubling of population in the last 5 years (from 600 in 1999 to 1200 in 2004). The coastal shires of Gingin, Irwin and Northampton are also experiencing rapid growth (see further data on page 31).
Changes in demographics have the potential to significantly alter community values in relation to NRM issues. There is a trend towards intensive landuse with irrigated enterprises developing rapidly on the coastal plain combined with increasing urban migration to coastal towns for lifestyle reasons. In addition, in the western higher rainfall sectors of the region, former agricultural holdings are increasingly being subdivided into small holdings (<40ha) and used for hobby farms, small horticultural pursuits or special rural residential purposes. This is creating an increasing demand for some resources (for example roads, powerlines and fresh water from aquifers) and new management problems such as fire, weeds and intensive grazing. While the region is still dominated by rural and broadacre farming issues, these trends are very significant.

The region has well developed core infrastructure including transport facilities, industrial land, communications, water and energy supplies, education and vocational training facilities and health services. Such infrastructure may need to be extended in the future to keep pace with new developments and to fully service inland areas.

2.2.2 TRANSPORT

There is a well developed road system which networks towns and rural areas within the NAR and provides links to the Perth metropolitan area. There are several major road arteries through the region providing separate links between Perth and major rural centres (for example the Brand Highway, the Midlands Road and the Great Northern Highway). Roads are a key investment for both the state Department of Main Roads and local government authorities. While the transport issue is of paramount importance for economic reasons, road verges are frequently wide with high biodiversity values, such that the management of roads is becoming a key NRM issue.

Bulk haulage of grain, fertiliser, mineral sands, talc, iron ore and industrial chemicals are handled by rail in many parts of the region, but there are no passenger services. There are two main railway lines running north/south through the region, both linking with Narngulu near Geraldton, then on to the Geraldton Port. The only port in the region is at Geraldton. This handles imports of mainly phosphorous, urea and petroleum products and exports include grains, lupins, mineral sands, talc, livestock, copper and zinc. Approximately 3 million tonnes of cargo are moved through the Geraldton port annually. A recent expansion and deepening of the port will allow larger vessels to berth and will improve transport elements, but has also resulted in community concern over environmental management of the expansion. Additional port facilities have been considered at Oakajee north of Geraldton and at Breton Bay north of Perth, to service potential heavy industry sites, but both projects have been dropped, partly because of community resistance to the developments.

The region’s principal airport is located near Geraldton where the Shire of Greenough has recently completed the construction of a general aviation terminal and intends to upgrade the runway to accommodate international freight flights. There are also plans to upgrade the existing airport at Kalbarri. Most towns in the region have airport facilities for small craft, but none of economic significance.

2.2.3 POWER AND WATER

Power is generated external to the region and delivered via an interconnected grid from the Bunbury, Muja and Kwinana coal fired power stations. Isolated towns also use alternative power sources, such as diesel generators, and at Kalbarri, solar power is used. There is increasing interest in wind turbines for electricity generation with projects being developed by both government and private investment near Geraldton and Cervantes, and with another proposed development near Oakajee north of Geraldton. The coastal parts of the region are exposed to the trade winds, offering significant opportunities for alternative power generation.

The Water Corporation operates water supply schemes at major centres but water continues to be a contentious issue as supply to rural areas is limited. Many farms must provide their own water supplies which are mainly drawn from groundwater resources. Urban expansion and the need to protect supplies from contamination is raising awareness about the water quality. Some small settlements (eg Woodridge and Redfield Park in the Gingin shire) have recently experienced elevated nitrate levels in groundwater which have been linked with nearby intensive land uses, so there is a need for vigilance.
2.3 NATURAL RESOURCES

2.3.1 NATURAL DIVERSITY & ITS MANAGEMENT

The NAR is divided into four (4) sub-regions, based loosely on natural catchment boundaries. Note that areas east of the clearing line are classified as pastoral and are not included in this strategy. They are covered by a previous Gascoyne Murchison strategy and the current rangelands strategy.

Yarra Yarra

This is the internally drained area between Kalannie in the south, Yarra Yarra lakes near Three Springs and extending north into the Morawa shire. The Yarra Yarra Catchment Group is an active community group in this sub-region.

Moore River

The Moore River catchment lies between the river mouth at Guilderton inland to the Yarra Yarra lakes in the North East. The Moore Catchment Group is very active. This area is primarily productive broadacre farming land. Land use pressures are being experienced due to production diversification to horticulture and silviculture and population pressures in the coastal towns of Guilderton and Lancelin.

West Midlands

This is the coastal area between Lancelin in the south and the Arrowsmith catchment in the north, extending east over the Brand Highway to include the Dandaragan township. The Hill and Arrowsmith Rivers are the prominent watercourses and there are several nearshore islands. The area has very high biodiversity values, an excellent and relatively undeveloped groundwater supply, a rapidly developing coastal population, and an expanding nature-based tourism industry. The West Midlands Natural Resource Management group helps manage local NRM issues.

Greenough

This is the northern part of the region and includes catchments of the Irwin, Greenough, Chapman, Bowes and Hutt Rivers. It contains highly productive agricultural land and also encompasses the city of Geraldton. There is no overall NRM group, but the Mingenew Irwin Group and Active Community Environmentalists are both involved.

2.3.2 GEOLOGY AND SOILS

Within the NAR there are four distinct geological provinces:

The Yilgarn Craton lies to the east of the Darling Fault and encompasses areas of the Yarra Yarra, Moore River and Greenough sub-regions. It covers 2.5 million hectares and has salinity as an increasingly significant problem.

The Perth Basin underlies about 2.5 million hectares, mostly in the West Midlands sub-region. It is a deep trough (possibly to 15,000m) of sedimentary layers and contains substantial groundwater reserves.

The Irwin Sub-Basin is an area of 0.6 million hectares - a narrow trough of sediments more than 5000m thick. The sedimentary sequences are dominantly fine grained resulting in poorly drained soils and saline groundwater.

The Northampton Block underlies 0.3 million hectares entirely in the Greenough sub-region. It is essentially a large outcrop of crystalline granitic basement partially capped in the southern and western areas by thin sequences of Mesozoic sediments. The soils are of high agricultural value.

The soils of the NAR are derived mainly from ancient sedimentary rocks which have been subjected to dramatic climate changes resulting in soils with deeply weathered profiles that are inherently low in nutrients. The physical fertility of such soils, however, is usually good. NAR soils are predominantly acid to very acid, with limited alkaline soils to the east of the Darling Fault. The soil resource has been substantially altered since European settlement and farming practices have resulted in higher levels of organic carbon and nutrients than are found in the natural soils. However, higher nitrogen and nutrient levels may be causing eutrophication of water bodies. Agricultural development has exacerbated soil hazards such as wind erosion, water erosion, hard setting, nutrient leaching, acidification, compaction, water repellence, water logging and salinisation. Large areas are beginning to be affected by secondary salinisation and water logging.
2.3.3 TERRESTRIAL NATURE CONSERVATION AND RECREATION

Although the bulk of the region is cleared and used for farming, there are extensive areas of natural bushland remaining on pastoral land to the east, and within nature reserves and national parks nearer the coast. The latter represent some of the richest botanical areas in the world, with nodes of extreme floral diversity, especially around Mt Lesueur.

Major national parks include Nambung, Watheroo, Kalbarri and Moore River National Parks. These areas are important tourist destinations and recreational areas as well as being of high nature conservation value.

Bushland on pastoral leases has been disturbed by grazing, fencing and installation of water points, but continues to provide a major resource of native eucalypt woodland and sandplain heath. Very large numbers of endangered or threatened plant species have been identified. Native fauna in the area is in decline as a result of loss of habitat or predation by introduced animals.

2.3.4 WATERSCAPES AND GROUNDWATER

The surface water resources of the NAR are divided into four drainage basins: the Murchison, Greenough, Moore – Hill and Yarra Yarra. The region is characterised by a diverse system of waterscapes. Saline lakes occur in the eastern reaches of the region where drainage lines consist of broad palaeochannels with mosaics of flat channels and small episodically filled playa lakes. To the west are a variety of groundwater fed wetlands, coastal dune wetlands, swamps, springs, karst limestone cave pools, meandering coastal plain river systems and associated pools and estuaries.

Waterways that are protected for their significant ecological values include Greenough, Chapman, Hill and Moore river estuaries, which are significant migratory bird feeding areas. Directory of National Significance wetlands include Hutt Lagoon System, Murchison River (lower reaches), Lake Logue/Indoor System, Lake Thetis, Guraga Lake, Karakin Lakes, Wannamal Lake System, Chandelier Swamp and the Lancelin Defence Training Area.

Waterscapes across the NAR are impacted by urban and rural landuse resulting in high levels of erosion, sedimentation and nutrients. The Moore River estuary is subject to algal blooms during summer, particularly when the sand bar remains closed. Few fresh streams remain in the Greenough and Murchison basins and many are increasing in salinity as a result of catchment clearing. The condition of fringing vegetation is generally moderate to poor and continues to deteriorate from land uses such as grazing.

The groundwater resources of the NAR are contained in two different types of aquifers: unconfined aquifers (superficial and surficial) and semi confined to confined aquifers. The superficial aquifer forms an extensive shallow system containing large groundwater resources held in sand, gravel and limestone. The groundwater is generally fresh with a salinity of less than 1000 mg/L TDS. Groundwater in the surficial aquifer system occurs only locally and is sometimes found in alluvial and colluvial deposits, sand associated with laterite, and palaeochannel sediments. Groundwater in this aquifer is generally fresh.

The semi confined to confined aquifers form extensive deep aquifers and groundwater is generally fresh except in eastern and coastal areas – these areas typically contain brackish to saline groundwater. The semi confined and unconfined aquifers are hydraulically linked with the overlying superficial or surficial aquifers and are recharged from groundwater that infiltrates vertically from the overlying sediments. Recharge is generally high where the aquifers are semi confined, yet limited where they are confined.

Groundwater management in the NAR is based on a partnership arrangement between the community and the Department of Environment. For the purpose of management, groundwater resources are divided into 4 areas: the Arrowsmith Groundwater Area, which spans 10 300 km2 and has a total groundwater availability of 188 million m3; the Jurien Groundwater Area, which spans 5 027 km2 and has a total groundwater availability of 98 million m3; the Gingin Groundwater Area, which spans 6 445 km2 and has a total groundwater availability of 222 million m3; and the Gascoyne Groundwater Area, which extends north to Kalbarri and bounds the Arrowsmith Groundwater.
Area east to pastoral country. The total groundwater availability is currently unknown.

2.3.5 COASTAL AND MARINE RESOURCES

The NAR has a coastline of about 400km, and includes the “Central Coast” from Guilderton to Dongara and the “Batavia Coast” from Dongara north to Kalbarri. There are many relatively pristine beaches and dune systems, with the northern portion also including impressive coastal cliffs.

This coast includes significant marine assets such as the globally significant terrestrial and marine systems of the Houtman Abrolhos Islands; one of the largest temperate limestone reef systems in Australia; and thirty eight offshore island nature reserves between Dongara and Lancelin. These features provide habitat for a mix of temperate, tropical and endemic marine fauna and flora, and diversity of terrestrial ecological communities. Human pressures on coastal and marine assets are increasing with more people having easier access, and increasing development activities.

2.3.6 INDIGENOUS INVOLVEMENT IN NRM

As members of the broader community, Indigenous people continue to be involved in generic community volunteer initiatives, such as tree planting and ‘clean-up’ days.

Specific Indigenous involvement in NRM activities is inclusive of, but not restricted to:

- The work of the Billinu Aboriginal Corporation in the sale of native seeds for rehabilitation of mining areas in the West Midlands.
- Native plant propagation and sale of plants by Geraldton Streetwork Aboriginal Corporation.
- Assisting NRM proponents to address Aboriginal Heritage sites issues impacting on on-ground projects.

2.3.7 COMMUNITY LEADERSHIP IN NRM

Traditionally the 30 regional Land Conservation District Committees (LCDCs) have played an important role in overseeing local NRM. However, while some of these groups are still very active, many have become moribund. Some have metamorphosed, or been superseded by vibrant integrated groups with greater scope of purpose (eg the Mingenew Irwin and Liebe groups). Recently strong sub-regional groups have emerged in three of the four sub-regions (Yarra Yarra, Moore and West Midlands). In addition, the role of the Northern Agricultural Catchments Council (NACC) is becoming increasingly important in identifying priority directions for NRM across the whole region. NACC is taking a lead role in promoting improved NRM in the NAR. The evolution of regional groups will present many challenges. The recent inclusion of coastal and marine issues also provides for some exciting opportunities.

There are substantial natural resources including pristine bushland, waterways, groundwater, coastal & marine reserves, and productive soils.
3. COMMUNITY ENGAGEMENT PLAN

3.1 PRINCIPLES & COMMUNITIES OF INTEREST

This section summarises the planned approach NACC has used in engaging the communities (geographic and communities of interest) within the region in the development of the regional NRM strategy.

3.1.1 NATIONAL CONTEXT – COMMUNITY CAPACITY

In line with the principles of the Commonwealth’s Community Engagement and Capacity Building Working group, we have been mindful of the following outcomes:

- Ensuring that community engagement is explicitly linked with NRM outcomes;
- Engaging the community in identifying and articulating specific changes in the way we do business and expressing them as Management Action Targets (MAT); and
- Including consideration of economic and social trends in relation to NRM management;

We are very conscious of the fact that the process of developing this strategy, and the community engagement process itself, have provided important capacity building opportunities, both within the NACC strategy team, and in the wider community. It is important to capitalise on this and maintain the momentum into the implementation phase.

3.1.2 REGIONAL CONTEXT

NACC has established a network of NRMO’s (Natural Resource Management Officers) to support the strategy development process. There are local officers in each of the four sub-regions at the grass-roots level and, in addition, a group of “Regional NRMOs” have responsibility for technical issues such as biodiversity, water, land, coastal and marine, sustainable agriculture, agroforestry, and Indigenous engagement. NACC has also employed a Strategy Coordinator (responsible for coordinating technical input and writing the strategy), and a Strategy Facilitator (responsible for community engagement and communication about the strategy). This team of people, coupled with the NACC Executive, forms the NACC Strategy Team.

The strategy process is the “foundation” for the relationship that NACC has with the region, and in particular with the community. Thus we have put considerable emphasis on engaging all of the region in a conversation about what they want their region to be like in 20-50 years, and within that context, what condition they wish their natural resources to be in. This is a conversation that moves beyond, “what projects do you wish to undertake in your local area?”. It is a conversation about imagining a future, creating an aspirational target “sustainable prosperity”, and then working that level of concept to the stage where NACC can identify the condition that each of the natural resources in the region needs to be in 20-50 years to deliver on the vision.

The key principles we have used to underpin the engagement process are:

1. Equality of opportunity in processes.
2. Grassroots participation and use of personal invitations where feasible.
3. Deliver value to participants, and make strategy process the first step in a long-term relationship with regional and local players.
4. Make participation exciting and an opportunity to learn something new.
5. Trust intuitive knowledge, and give it equal value and weighting to scientific knowledge (particularly when developing MAT’s = targets or change).
6. Strong respect for others, and recognition that we are more similar than we are different.
7. Cultural sensitivity.
8. Positive communication that is succinct, in layman’s terms, and which results in action.
9. Something for everyone in the process i.e. make processes diverse and accessible.

3.1.3 COMMUNITIES OF INTEREST

In the context of this strategy, NRM applies across all tenure and land uses, including State marine waters. It requires an integrated and interdisciplinary approach between all parts of the community, including government agencies, conservation interests, industry, and private and public land managers.

We have endeavoured to engage as many different interest groups as possible. In the past, one of the weaknesses of the regional process was that our consultation processes, whilst having considerable depth and geographic spread, were conducted mainly with farmers. In this strategy, mindful of the important contribution that agriculture plays in our economy, we have still involved people with farming interests. However, we have endeavoured to involve people with a varied spread of interests.
Regional NRM Strategy - Northern Agricultural Region of WA

One of the complexities of developing a strategy on NRM is that the value systems of different components of the community can vary widely. We believe it important to hear as many opinions as possible, and are mindful that true community ownership cannot occur unless all interest groups are effectively engaged. The region has a broad range of people with an interest in NRM at either a personal, recreational, management, business or scientific level. Some of the type of people we have engaged have included:

- Town and city dwellers;
- Professional and recreational fishermen and women;
- Broadacre farmers;
- Horticulturalists, and landowners with an interest in diversification and value-adding;
- Mining interests;
- Tourism operators;
- Representatives of local government – both employed and elected;
- Local government authorities as entities;
- Indigenous representational bodies;
- Environmental groups, Land Conservation District Committees, and sustainable agriculture groups;
- Representatives of government departments and statutory authorities;
- Scientists, including those with expertise in botany, agriculture, marine and coastal processes, groundwater allocation, waterways, environmental pollution, etc;
- Planning and urban development professionals.

3.1.4 GEOGRAPHIC SPREAD

We have also been mindful of the importance of allowing people the opportunity to participate locally, without having to visit a major centre or travel long distances. Thus activities have been available across the whole region, in small and large communities and in both coastal and inland locations. Locations are included in Appendix 11.

3.2 PROCESS

Our full process is articulated in our Community Engagement Plan which was endorsed by the “Joint Steering Committee” of the Commonwealth and the State in February 2004, and which is included in the reference material accompanying this strategy. Below is a brief summary of the activities, which can be broadly grouped into 3 interlinked and concurrent actions. Also see Appendices II and III.

- We developed a clear picture of the regional interest groups and, using an interview process, we identified NRM drivers, blockers and aspirations. This involved identifying NRM leaders and emerging influencers or builders in each community of interest and geographical community; mapping government, local government, the scientific community and the Indigenous community. The latter included four sub-groups: cultural custodians, traditional owners, historical owners and contemporary communities. This group of people were interviewed in one-on-one interviews to gather information on what they see as values, needs, barriers to participation and aspirational targets for NRM in the region.

- We carried out a series of meetings, workshops, and other “happenings” to identify a range of strategy elements. This included the following:
  - Photolanguage project: community members were given cameras to take photos of natural resources that they valued, or that they thought were under risk, and these images were discussed in group sessions to arrive at a range of key issues and to form targets;
  - Technical support documents and maps were produced and distributed to assist local NRMOs and the community with background natural resource information and for use in MAT workshops;
  - Regional workshops, including both technical experts and community representatives, were held to determine key asset classes, current
resource condition and resource condition targets;
- Bus-trips were held to move people out of their environment and assist them to develop shared perspectives on “whole of region” issues and opportunities;
- One local group conducted a “vermin hunt” to highlight the importance of invasive pests to NRM;
- A survey of Indigenous contacts was conducted, and two Indigenous Reference Groups were formed and consulted, and an Indigenous survey was conducted to identify areas of NRM opportunity they wished to collaborate on. We were fortunate to have the services of a dedicated Indigenous Support Officer which gave significant impetus and credibility to this process.
- Various meetings were held with groups of local government senior staff, as well as individual representation at council meetings. The NRM representatives of the West Australian Local Government Association were particularly helpful with these processes;
- MAT workshops: The goal of this extensive series of local workshops was to establish Management Action Targets (MATs). Threat risk maps were used in the workshops.
- Regional workshops pulled together the results of other activities to ensure consistency with our targets and to identify linkages, gaps and issues with legislative implications. These workshops also included the “Compass concept” which canvassed topics with broad implications that help to inform us about the future scenarios.
- You Decide Workshops: These discussed value principles and trade-off criteria to arrive at preferences to be implemented via the investment framework.

We developed clear, easily understood, consistent communication with communities and participants.
- Clear messages about the plan and the process were articulated in laymans terms and distributed widely throughout the region with the assistance of a data manager and a communications officer appointed by NACC. Communication took several forms and included letters and brochures mailed to the community, special interest groups (including Indigenous, industry, business and local government stakeholders) via an extensive data base developed for the purpose. Phone calls were also used extensively.
- Print and radio media were used regularly throughout the process to highlight issues, discuss ideas and to publicise events and meetings.
- A broad range of team members (in particular local NRMOS) were used in media interviews to personalise and localise the stories.
- Local government authorities, Indigenous Reference Groups, key potential investors, and all strategy team members, were invited during the development phases to comment on conceptual ideas, and drafts of the strategy as it was being developed, to create an ongoing feedback loop for continual improvement, and to identify gaps and omissions.

3.2.1 INDIGENOUS CONSULTATION

While Indigenous people participated in the mainstream consultation process, additional ongoing effort is being given to ensure Indigenous engagement. It has been determined that the timeframe for the development of this document did not allow for true and comprehensive consultation with Indigenous stakeholders.

The establishment of two Indigenous Reference Groups made up of service providers to Indigenous people has enabled identification and initial consultation with Indigenous NRM stakeholders in the NAR.

The expectation is that the Indigenous Reference Groups (IRG’s) will be expanded to include identified key stakeholders from the Indigenous community. In recognising the diversity within the Aboriginal Communities of the NAR, individual and localised approaches to engaging Indigenous people will be developed with the advice and assistance of the IRG’s. Once relationships have been established at a local (sub-region) level, Indigenous involvement will be encouraged and developed.

As well as encouraging and supporting the participation of Indigenous people in on-ground works projects, a key component of the Indigenous engagement process will be the identification of individuals who can represent Indigenous views in the decision making process. Where required, support will be offered to assist individuals and groups to be effective in their role.
4. ASSETS VALUES AND THREATS

Asset: Anything we value that is based on our local natural resources or which is impacted on by management, or neglect, of these resources

4.1 ASSETS

4.1.1 CONCEPT AND IDENTIFICATION OF ASSETS

An important formative decision in the development of this strategy was choosing the assets we would focus on, and the way in which we would assess problems and opportunities associated with those assets. At a meeting involving the NRM team, NACC council members, community members and other stakeholders, we formulated our approach. We decided on the above definition of an NRM asset.

To a certain extent the choice of assets is constrained by the strategy framework provided by the state and Commonwealth. Thus the inclusion of biodiversity, water, land, and marine resources was a requirement. However, in line with our community-based approach, we were open to other ideas and inclusions. Following facilitation, an additional biophysical asset identified for consideration was the atmosphere. The group also felt strongly that regional infrastructure, a stable regional economy, and cultural and natural heritage were important. Most significantly, people were seen as central to our future, and social and human capacity was highly valued.

Our chosen assets are depicted graphically on page 18 in what we refer to as our “asset wheel” consisting of a range of assets and their “sub-assets” arranged in concentric inter-locked circles to depict their inter-dependency. Note that the position of asset circles does not indicate any hierarchical importance. This wheel has been used as a reference point for development of all aspects of the strategy. In tabular form it can be depicted as in the table below.

4.1.2 ANALYSING OUR ASSETS

Our regional NRM Officers, with assistance from State Government department officers, conducted detailed research into each of the assets, compiled background information, and developed digital presentations, charts and maps to use in informing the community of local issues. A summary of this information is given in the following section (commencing on page 21).

Particular attention has been given to the current condition of the resource, threats to that condition, and actions that can be taken to alleviate the threat. More detailed technical and scientific information will be available on the NACC website (www.nacc.com.au) and will be made available as a CD to support this strategy.

We have also been conscious that in many cases opportunities for the future use of an asset can balance some of the problems. The section commencing on p 98 addresses opportunities for the use of our assets.

<table>
<thead>
<tr>
<th>ASSET</th>
<th>Sub-Assets</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAND</td>
<td>Agricultural Urban and Crown Aboriginal Coastal</td>
</tr>
<tr>
<td>BIODIVERSITY</td>
<td>Terrestrial Aquatic Marine</td>
</tr>
<tr>
<td>WATER</td>
<td>Waterscapes Groundwater</td>
</tr>
<tr>
<td>COASTAL &amp; MARINE</td>
<td>Coastal systems Fish Resources</td>
</tr>
<tr>
<td>ATMOSPHERE</td>
<td>Air Quality Climate Change and Seasonal Variability</td>
</tr>
<tr>
<td>COMMUNITY ASSETS</td>
<td>Human Capacity Governance Culture and Heritage Built Environment Regional Economy</td>
</tr>
</tbody>
</table>

Coastal Land is dealt under Coastal and Marine - Coastal Systems. Also referred to elsewhere as Infrastructure.
4.2 VALUES & THREATS

There is a wealth of scientific research and conflicting methodologies focussed on valuation and it is impossible, and probably impractical, to attempt a thorough analysis in the course of this strategy. We recognise the complexity of the concept of valuation, the inter-connectedness of economic and social values, and the difficulties in assessing the “worth” of any asset. There are direct and indirect economic values, social values and environmental values. In a broad sense, we have used the concepts embedded in the State’s “Salinity Investment Framework” as our model for identifying values, and have used a non-empirical value versus threat approach to help identify our NRM priorities.

Initially we kept the analysis broad. It is more relevant to work at the generic level when attempting such an analysis as, at the local level, emotional and non-objective issues intrude. In the following section, accompanying the overview of each of the assets, is a discussion highlighting the values of each of them to the region. We recognise the importance attributed to various assets by the State and Commonwealth, and we have identified regional values by first exploring local values then balancing these with State and national priorities.
4.2.1 THREATS

A threat is defined as anything that diminishes the value of the asset. There is a wide range of threats in our region, and they are associated with many different processes and activities, some natural and some of our own making. In many cases there is an interaction between the way in which we manage the asset and the underlying biophysical process, so it is difficult to differentiate or compartmentalise threats into simple categories. Some of the main threats are listed below. In the following section there is more discussion of such threats including their specific links with each of the assets.

**Threatening Biophysical processes**

- Altered hydrology
- Loss of ecological processes
- Ecosystem fragmentation, habitat loss
- Erosion – wind, water
- Sedimentation
- Salinisation of land and waterways
- Rising water tables and waterlogging
- Acidification
- Soil structural changes: compaction, hardsetting, water-repellance
- Declining water quality
- Enhanced greenhouse effect, Eutrophication, reduction in populations of species

**Human interference or activity**

- Active and passive clearing
- Exotic pests and diseases, biosecurity
- Altered fire regimes
- Land development and urbanisation
- Expansion or intensification of activity
- Industrial development & infrastructure
- Point source pollution
- Drainage modification
- Habitation and associated waste
- Inappropriate recreational use of resources
- Nutrient export and deposition
- Economic exploitation
- Unsustainable levels of exploitation

4.2.2 MEASURING THREAT

Each threat has a number of different parameters: spatial, temporal and intensity, and different threats have different impact characteristics. For example, landscape salinisation may be initially of low intensity, but serious and extensive in the long-term, whereas point-source pollution of a river may be intensive, short-term, localised and transitory. Comparing threats thus poses an additional strategic dilemma. Human nature is such that we tend to respond only to threats with immediate severe impact. We have been conscious of this in our deliberations and have attempted to remain objective in assessing the way in which the assets will be impacted by the threat. We have also tried to assess the probability of any potential management actions making a real difference.

4.2.3 RANKING THREATS

In order to accurately set priorities it is necessary to identify the most important assets and threats. There is discussion of asset prioritisation on page 147-148. With regard to threats, we devised a ranking tool, which is described in Appendix IV.

Using the asset ranker, the major threats to the main assets are as follows:

**Agricultural Land & Farming Systems**

- Dryland salinity
- Biosecurity
- Herbicide resistance

**Terrestrial Biodiversity**

- Historic clearing of native vegetation / fragmentation
- Current clearing (or grazing) of native vegetation
- Altered hydrology
Waterscapes
- Increased surface water runoff
- Salinity
- Loss of riparian vegetation

Groundwater
- Increased demand from population and industry growth
- Over allocation
- Reduced groundwater availability for waterscapes

Coastal and Marine
- Degradation and pollution affecting estuarine habitat
- Fragmentation and degradation of coastal vegetation
- Resource sharing issues affecting sustainable use of fish resources

4.2.4 CROSS-BOUNDARY ISSUES
An analysis of values and threats is not possible in isolation as many issues cross sub-regional, regional or even state boundaries. A threat may be able to spread (e.g., air or water pollution, diseases, and pests), it may cause off-site or downstream effects (e.g., stream salinisation caused by upper catchment clearing), or the asset itself may cross boundaries (rivers and oceans). In addition, many issues are generic and there is benefit in tackling them as part of a cooperative program at the state or multi-region level. We have attempted to identify any key issues that could benefit from a cooperative approach.

4.2.5 ISSUES OF SCALE
In analysing the relationship between assets, values and threats, a critical issue is the scale at which the assessment is made; whether local, regional, state or national. Government entities usually set priorities at a state or national level. However, most community members think at the local level, and in the same location, even sub-catchment, local government and community group opinion will differ. Our compromise with this strategy is to integrate across scale and focus our assessments of significance at the regional level. While this will result in a coarser resolution than that sought by some of the community, it provides a compromise that will produce achievable outcomes. This does not mean that there will not be local level actions, rather that there will need to be trade-offs between different sectors for the future benefit of the region as a whole.

One of the complications of different value-systems at different levels of scale, is that the local community can feel powerless and frustrated by an inability to have their needs addressed. An example of this is where there is legislation in place that is at odds with the needs identified by the community. While we recognise that it is not possible for this strategy to solve such issues, we have had an attitude that “all bets are on” and have encouraged the community to articulate all issues concerning them.

4.2.6 TRADE-OFFS AND PREFERENCES
In a later section (p148) the issue of setting trade-offs and arriving at regional “preferences” is addressed.

4.2.7 LINKING OPPORTUNITIES AND THREATS
We have tried to focus on the positive in this strategy, and thus have a substantial section on “Opportunities”. Most of these are economic opportunities that have links with NRM in that they assist in achieving one or more of our targets by helping to reduce a threat. In some cases the “opportunities” themselves pose a threat to natural resources, particularly where there is an intense or uncontrolled use of the resource.
5. **ASSETS**

### 5.1 LAND - AGRICULTURAL

**Goal:** Sustainable land-use systems implemented to ensure our agricultural soils are improved and managed in a healthy, productive and sustainable way.

#### 5.1.1 AGRICULTURAL LAND: A DEFINITION

The asset agricultural land has two major components; the soil resource and the farming system associated with it. The soil resource is a large complex structure of unspecified dimensions consisting of mineral and organic particles in which plants can grow. The farming system is one that is profitable and maintains the production capacity of the land while minimising energy and resource use and optimising recycling of matter and nutrients (Campbell 1991). Whilst, this is theoretically an economic asset, it is of such overwhelming significance to the region, and so closely aligned with the natural resources, that we have included it in this strategy.

#### 5.1.2 RESOURCE DESCRIPTION AND CONDITION

The soil landscapes of the region are derived from mostly sedimentary rocks of the Perth Basin to the west and igneous and metamorphic rocks of the Yilgarn Block to the east that are amongst the oldest in the world. Large proportions of these landscapes have remained above sea level since the separation of Australia from Gondwana Land thirty million years ago and have been subject to dramatic climate changes including several ice ages. This has resulted in aggressive weathering over a long period of time, producing soils with deeply weathered profiles that are inherently low in nutrients and have an accumulation of salts deep in the profile. The soils thus contrast markedly with those of Eastern Australia and the Pacific region, that formed from volcanic rocks only a few million years ago, and those of other continents that are derived from recent sediments.

Such geological forces have also resulted in an extensive range of landscapes and soil types, with the soils in the region ranging from loose pale sands, to loams and heavy clays. Sandplain soils occur on the sediments west of the Darling Fault whilst hard setting loams dominate in the incised valleys to the west of the Fault and on the lower and upper slopes of the broad valleys east of the Fault. Alkaline soils also occur in areas to the east that have experienced arid climates and on the coastal dunes where soils were formed from calcareous marine sediments. In the eastern part of the region, salt lakes have formed in the internally draining Yarra Yarra catchment and upper catchment of the Irwin River. (See Figure 6)

The NAR covers approximately 4.7 million hectares of mixed farmland, including some very valuable soil and water resources. However, due to alterations in the soil profile, the quality of the soil is decreasing. These changes are mainly a consequence of European clearing and associated farming practices, which in turn has resulted in increased levels of organic carbon and chemical nutrients in the soil. Nutrients such as trace elements, nitrogen and phosphate have enabled crops and pastures to be grown where it would have otherwise been difficult.

There have also been significant changes to hydrological and biological systems brought about by land clearing and agricultural practices which have promoted soil hazards such as wind erosion, water erosion, water logging, groundwater rise and salinity, hard setting, nutrient leaching, acidification, compaction and water repellence. There is an urgent need to manage agricultural land in a sustainable manner in order to alleviate the problems facing these systems.

#### 5.1.3 THREATENING PROCESSES AND MANAGEMENT RESPONSES

There are a number of processes threatening the

<table>
<thead>
<tr>
<th>NACC Sub-region</th>
<th>Total sub-region area</th>
<th>AOCLP (excluding remnant vegetation)</th>
<th>AHAVF (at risk)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Midlands</td>
<td>1,143,173 ha</td>
<td>10,471 ha (1%)</td>
<td>255,283 ha (22%)</td>
</tr>
<tr>
<td>Yarra Yarra</td>
<td>1,791,584 ha</td>
<td>73,583 ha (4%)</td>
<td>332,785 ha (19%)</td>
</tr>
<tr>
<td>Greenough</td>
<td>3,415,820 ha</td>
<td>36,557 ha (1%)</td>
<td>309,571 ha (9%)</td>
</tr>
<tr>
<td>Moore River</td>
<td>1,598,948 ha</td>
<td>175,632 ha (11%)</td>
<td>482,662 ha (30%)</td>
</tr>
<tr>
<td>Totals</td>
<td>7,949,525 ha</td>
<td>296,223 ha (4%)</td>
<td>1,379,301 ha (17%)</td>
</tr>
</tbody>
</table>
ecological integrity of agricultural land. Programs and projects designed to address these are at a local, regional and State and National scale. The following section provides an overview of the major threatening processes and some local and regional scale management responses. Table 3 outlines the State and National management responses. It is important to note that limited data exists for the resource condition of agricultural land and this gap in knowledge needs to be addressed before the impact and management processes can be monitored and evaluated. In addition, on the basis of a value versus threat matrix, the threats related to agricultural land have been prioritised, refer to in Appendix X. Further information on threats and priorities can also be obtained from the Preliminary Agency Statement of Natural Resource Management Priorities in Western Australia (Government of Western Australia, 2003).

**Groundwater rise and dryland salinity**

The fundamental cause of dryland salinity is the replacement of deep-rooted perennial native vegetation with shallow rooted annual plants. Agricultural crops and pastures use less of the available rainfall than the vegetation they replaced, resulting in increased runoff and recharge, causing groundwater levels to rise. Dryland salinity occurs when the watertable rises close to the land surface.

The Department of Agriculture’s Land Monitor Project described the current area of salinity and the area considered to be at risk of salinity in the future. The current area of salinity was mapped as areas of consistently low production (AOCLP). The areas considered to be at risk of salinity in the future were constrained to the lowest areas in the landscape and were derived by determining for a particular point its ‘average height above valley floor’ (AHAVF).

Table 2 presents Land Monitor Project data for each of the NACC sub-regions. Note that the project was confined to cleared agricultural area although two sub-regions extend into the pastoral area.

In the Northern Agricultural Region, most of the current extent of dryland salinity occurs on the Yilgarn Craton. The Yilgarn Craton underlies most of the Yarra Yarra sub-region and parts of the Moore River and Greenough sub-regions. The amount of land currently affected by salinity is about 10% but it is predicted this could expand to about 25% of the area. While significant this only represents a doubling of the area affected by salinity compared to a potential twenty-fold increase predicted for the Perth Basin (Refer to Table 2).

The entire West Midlands sub-region and parts of the Moore and Greenough sub-regions overlie the Perth Basin. Groundwater levels are observed to be rising at higher rates and more consistently in the Perth Basin compared with any other geological area in the NAR. It is within the parts of the area overlying the Perth Basin that there is likely to be the greatest increases in dryland salinity. Presently the area of salinity is relatively small (~ 1%) but potentially could expand to affect about 20% of the area. Parts of the Yarra Yarra, Greenough and West Midlands sub-regions overlie the Irwin Sub-Basin. Groundwater in this Sub-Basin is typically saline and little utilised. Consequently, knowledge of groundwater processes and trends is poor. Much of this area is characterised by flat to gently rolling plains cut by deeply incised drainage lines. It is likely that these drainage lines play a crucial role in draining saline groundwater, possibly limiting watertable rise and development of salinity. If this is so, then maintaining the health and integrity of these drainage lines is imperative. (Speed 1991).

The Northampton Block, which is situated entirely in the Greenough sub-region is considered to have a moderate salinity risk with medium salt storage. Large parts of this area appear to be approaching or may have already attained hydrological equilibrium. That is, groundwater levels rise and fall in response to seasonal conditions, but the longer term trend is stable, particularly in the southern portion around the Chapman Valley. However, the severity of salinity can continue to develop in wet areas and seeps by evaporative concentration (Speed 2002).

**Current management response**

Many landholders have been managing salinity on an ad hoc basis with little integration with neighbouring landholders. While individual Property Management Planning projects were developed on a catchment basis and run in the early 90’s, a change in government policy has seen support to landholders reduced to a broader sub-regional level through the ‘Rapid Catchment Appraisal’ process.

However, the site specific nature of salinity means that advice at a paddock scale is essential for landholders to make informed management decisions. Determining the groundwater flow system causing the salinity, the role of surface water control and the broad range of agronomic options available need to be discussed. At this point in time there is clear market failure in providing this “on farm”...
Past and current efforts by natural resource management officers, agency staff and other landcare professionals have focused on developing high water using farming initiatives. As a result, farmers have been engaged and encouraged to integrate the establishment of native vegetation, perennial pastures and a variety of tree crops into their farming systems. These high water use farming systems assist in combating issues such as salinity, waterlogging, soil erosion, and the degradation of biodiversity on farms and across catchments.

There have been thousands of hectares of tree crops established that assist in combating the rising groundwater and salinity with *Pinus pinaster* (Maritime Pine), Oil Mallees, and Sandalwood the most notable.

In response to rising groundwater tables, numerous kilometers of drainage have also been constructed in various areas of the NAR. It has been observed that drains having the greatest impact were those installed at the break of slope. This was because either their location was at a point of stronger upward flow, the discharge areas were small and or as a result of interaction with dykes (or other geological formations). Drains installed in low, flat valley floors appeared to be less successful. It is important to note that if drainage construction were to proceed, flood risk and impact assessments should be conducted. These assessments would ensure that the contribution to peak flow discharge downstream is not detrimental to the capacity of the system to accept the flow and that consultation with downstream neighbours and wider community consultation has occurred.

Salinity is a threat that affects not only agricultural land but also other assets such as biodiversity, waterways and regional infrastructure. Rising ground water and dryland salinity continues to be a major challenge for this region therefore, there are many Management Action Targets included in the targets tables section of the strategy.

### Biosecurity

Plant and animal pests and diseases that are the result of deliberate or accidental introductions pose a serious problem and all sub-regions in the NAR are affected. Introduced plant pests compete with native species and/or agricultural crops and pastures, with the cost to agricultural industries being estimated at approximately $3.3 billion per annum nationwide. In Western Australia’s agricultural systems, weed control costs have been estimated at 20% of production costs, sometimes significantly higher. Weed invasion is also a severe threat to natural ecosystems, but the cost is difficult to measure in monetary terms. Rabbits, foxes and feral pigs are the most common vertebrate pests in the NAR; others include rodents, deer, and goats. Native animals, whilst not a biosecurity issue, can also have a negative effect on agriculture, and present a complex control problem, with kangaroos, emus, dingoes, native parrots and cockatoos all implicated. Issues such as increasing incursions of new wheat rust strains require production research and management, but do not generally have broader environmental impacts. Significant animal diseases in the region include Footrot with increasing reports of Johne’s disease. These risks may present systems issues and changes in management practices that may in turn impact on other agricultural management techniques.

### Current management response

Various biosecurity control legislation, practices and programs are in place to manage biosecurity risk including the Agriculture and Related Resources Protection Act 1976 which provides wide powers for the detection and eradication of pests. Landholders are required by legislation to manage ‘declared’ plants and animals on their individual properties and have a range of chemical, physical and biological options available. The extent and effectiveness of landholders control of declared and non-declared pest and diseases on their properties is dependant on the resources they have available and how seriously they regard the threat to be towards their productivity and natural resources. Community groups also have a range of options available to manage pant and animal pests; however they often lack the resources available for effective management.

### 5.1.4 Farming Systems and Soil Condition

#### Herbicide resistance

Increasing cropping percentages and reliance on chemical weed control instead of cultivation and grazing has resulted in high selection pressure from repeated use of chemicals. It is becoming a problem with many weed/herbicide combinations, with annual ryegrass the most prone to developing resistance and wild radish an emerging problem. The NAR is regarded as having the worst herbicide resistant ryegrass problem in the world.
Herbicide resistance is worst on sandplain soils where there has been a strong reliance on the lupin: wheat rotation for many years. Growers are now faced with the dilemma of re-introducing pasture and changing to a less profitable system. As well as significant economic costs, herbicide resistance may result in environmental impacts caused by a return to conventional weed control methods such as full cultivation, stubble burning or increased grazing which could increase the incidence and extent of soil erosion, compaction and structure decline.

Current management response
Phase farming and the use of a mixture of herbicide and non-herbicide weed control or an Integrated Weed Management approach are useful management options in limiting herbicide resistance. However, due to herbicide resistance being site-specific these approaches do not always work. It is necessary to work closely with growers to develop a systems approach that is specific to each farm. This “systems approach” has been adopted by staff at the Department of Agriculture to address the problem of herbicide resistance.

Wind erosion
With frequent high winds, wind erosion threatens most land in the NAR. About 47% of soils have a high to extreme risk of being affected by wind erosion, with 10% of these soils classified as having a very high to extreme risk. Wind erosion occurs on all soils, but the potential is highest in the Greenough and West Midlands sub-regions where extensive sandy soils occur and crop stubbles are often light. Over-grazing of such soils will lead to erosion and there will be further aggravation if these areas are cultivated for cropping or if stubbles are burned or over-grazed. However the severity of wind erosion will depend on the soil type. Even heavier-textured hard-setting soils to the east and south of the region will blow if they are over-cultivated and left exposed for long periods, although significant erosion will not occur if surfaces remain cloddy.

Current management response
It is well known that reduced tillage, good stubble or pasture cover and animal management practices prevent wind erosion. In addition, the development of pastures such as perennial grasses, lucerne and deep-rooted serradellas have also been important developments. Farmers who fail to protect their soils can be issued a Soil Conservation Notice possibly followed by prosecution.

In response to the continual loss of scarce and highly valued top-soils through wind erosion many farmers throughout the region have also been strategically establishing tree crops and native vegetation across their farms to protect their soils. As general guide there is a 1:10 ratio of height to horizontal area of protection of those areas established. Pinus pinaster (Maritime Pine) and Oil Mallees are the most frequently established.

Water erosion
Water erosion is caused by heavy rainfall (such as summer thunderstorms in this region) impacting on unprotected land where there is insufficient drainage or cover to absorb or channel the water appropriately. Salinity and waterlogging exacerbate the problem. Gullies, sedimentation of waterways, flooding and increased salinity, are all consequences of water erosion. Since erosion is often associated with natural drainage systems, the many tons of soil that are detached and transported into the waterways goes largely unnoticed. In the NAR, water erosion is not a widespread problem, but in some areas, such as the Nangetty area near Mingenew, in the Irwin River Catchment, it is very significant. Localised erosion also occurs throughout the region, particularly in conventionally-cultivated hilly areas, or on land where heavy summer grazing or animal tracks concentrate water.

Current management response
Good management of grazing, working on the contour, and maintenance of stubble or pasture cover are sufficient in most areas of the NAR to control erosion. New pasture species have helped in some instances in retaining cover. However, areas like Nangetty continue to be a major problem. In general there is market failure in the provision of on-farm surface water control advice and services.

Soil acidity
Soil acidity is a widespread problem in the NAR, particularly on the sandy soils. It is a natural process that occurs during weathering, but it can be accelerated by some farming practices, including the addition of acidic fertilisers, alkali product removal and the leaching of nitrate. Soil acidity is most prevalent in sandy soils with a low capacity to buffer pH change.

Current management response
The recognition and treatment of surface acidity is
Figure 6. Map of soils of the region.
increasing, and a ‘lime sand industry’ is developing rapidly in coastal locations such as Lancelin and Dongara to supply lime to farmers. A “Time To Lime” campaign has successfully increased application rates, but much more needs to be done. Identification and remediation of sub-soil acidity (10-30 cm) is proving more difficult. Cost effective techniques for remediation of sub-soil acidity are still being developed (Department of Agriculture, 2004).

**Fertility decline**

Most soils of Western Australia have low fertility as they are ancient and highly weathered. They have low organic matter (frequently less than 1%) and are inherently low in all nutrients, with phosphorus, nitrogen and trace elements such as copper and zinc being historically of most significance. However, continual removal of potassium and sulphur in agricultural produce, and the use of fertilisers low in these nutrients, has resulted in wider problems. Losses from leaching or surface water run-off and soils that have a low capacity to retain anions can cause substantial losses of nutrients, especially nitrate. Loss of nutrient availability can also occur for some nutrients by fixation into organic matter and reactions with soil minerals.

**Current management response**

Soil fertility varies with the type and intensity of land use, but there is no comprehensive data on the extent of soil fertility decline available for the NAR and urgent investigation is needed. While the use of fertilisers and the growing of pasture and crop legumes have greatly increased the levels of soil nutrients, there is a real risk of excessive or poorly applied fertiliser leading to eutrophication of surface water and contamination of fresh groundwater.

**Non wetting soils**

Hydrophobic materials including fungal hyphae, waxes and other organic matter, consist of long hydrocarbon chains which are chemically water-repellent. In sandy soils these hydrophobic materials coat soil particles and soil aggregates making the soil water-repellent, reducing infiltration, (especially early in the growing season) and increasing runoff. Over 40% of soils susceptible to non-wetting in the NAR are found in the West Midlands sub-region, because of the predominance of sandy duplex and deep sand profiles.

Current management response

Machinery design has played a major role in alleviating water repellency. Furrow sowing techniques have resulted in using the water repellent soil to harvest water in furrows where the seed and fertiliser are placed. Claying has also proved useful.

Areas that have deep sands and are water repellent often have maritime pine or tagasaste (a fodder tree) established on them. Hence a vast majority of the pines found in the NAR are in the Midwest and Moore subregions where deep sandy soil profiles occur. The Pines also reduce the runoff from such areas and minimise other negative impacts such as erosion.

**Nutrient loss and eutrophication**

Eutrophication is the nutrient enrichment of waterways leading to the deterioration of water quality (see also the water section on p 58). A related problem is the loss of nutrients from agricultural systems. Nutrient export is difficult to measure, but it is estimated that in the NAR 12% of all soils have a high to extreme phosphorus export hazard risk. Nutrient export is largely by non-point source discharges from broad scale agriculture or urban developments, but point sources such as septic tank effluent, piggeries, stock yards and feedlots may be locally significant.

**Current management response**

The management of nutrient loss and eutrophication can often be implemented as part of an integrated package to combat salinity, flooding, water erosion and/or waterlogging.

**Structure decline**

A decline in soil structure occurs when the relationships between soil particles, organic matter and soil pores change, pores decrease in size and the movement of air, water and nutrients is limited. The main causes are excessive cultivation, large raindrops, the loss of organic matter and burning to reduce stubble. In addition, in medium and fine textured surface soils (clay 10-35%), the wetting and drying of clay may cause soil structure decline in the formation of hard crusts. In the NAR, 32% of all soils are susceptible to developing soil structure decline. The most extensive areas of susceptible soils are in the Yarra Yarra sub-region due to the high clay and sodium content, but in the Greenough sub-region there are also soils with naturally poor soil structure that are exacerbated by cultivation practices or stock movement.
Current management response

Extensive research in the region has shown that reduced cultivation is the most effective method of reducing structural problems. In other regions, gypsum application is used, but in the NAR, the structural problems are rarely assisted by such applications.

The establishment of deep rooted woody perennial vegetation can also assist in improving soil structure. They can add organic matter to the soil and have root systems that can provide habitat to microorganisms that have a positive affect on the soils structure and productive capabilities.

**Soil compaction**

Soil compaction is due to compression from a vertical force such as cultivating machinery or livestock and by shearing and smearing from horizontal forces such as spinning and slipping of machinery wheels. This causes soil aggregates to break and smaller silt and clay particles to be carried through the profile until they are trapped creating an impermeable hard pan (DAWA, 2004).

The typical ‘traffic hard-pan’ caused by heavy machinery is more common on sandy soils and usually 10-40 cm below the soil surface. It has been estimated that 36% of soils in the region are susceptible to soil compaction, particularly in the Greenough and Yarra Yarra sub-regions where sandy soils and uniform coarse textured soils dominate.

Cost-effective remediation methods for soil compaction are known and have been adopted across the NAR in the last 10 years. Deep ripping which has been extensively researched and adopted in the region can usually alleviate soil compaction. Recent work on reduced traffic and tramline farming is also proving very effective.

**5.1.5 OTHER IMPORTANT ISSUES**

**Soil biological activity**

Soil flora and fauna play critical roles in decomposition of organic matter, mineralisation and fixation of nutrients, assisting plant uptake of nutrients and degrading toxic substances. Beneficial organisms also reduce the incidences of soil-borne plant diseases. The importance of agricultural practices in maintaining soil health is gaining international attention, but as yet it is not well known how farming practices affect soil biological activity in the NAR. It is speculated that the use of pesticides, herbicides, burning and tillage practices have a significant impact on soil biological activity.

Current management response

There is limited information on the impacts of farming practices on soil flora and fauna. Soil biological activity occurs at healthy levels when conditions such as nutrient ratios, organic matter, oxygen availability and temperature are optimal. The interaction of biological components of soil is very complex. Further research is needed to develop a better understanding of these components to be able to manage the effects of agricultural practices.

**Waterlogging**

Waterlogging is most significant in areas of low relief that receive more than 400 mm of annual rainfall and in areas with soil profiles that have a permeable A horizon, that overlie an impermeable or slowly permeable B horizon. Conditions are accelerated by having the clay subsoil closer to the surface, having little infiltration pathways such as tree roots, and by having low hydraulic conductivity of sandy top soils. Land with a high to very high waterlogging risk is minimal in the NAR. Land with a moderate or high risk of waterlogging is more pronounced in the Moore and Yarra Yarra sub-regions due to broad valley floors and susceptible soils in these areas. However, many soils are affected by subsoil waterlogging which is not readily visible and so the true extent of waterlogging is often underestimated. Although satellite imagery can be used to assess the extent of waterlogging, no comprehensive mapping throughout the agricultural area has been undertaken.

Current management response

The management of waterlogging can often be implemented as part of an integrated package to combat salinity, flooding, water erosion and/or nutrient loss. Such management options include establishing high water use pasture, crops and trees upslope to reduce recharge and waterlogging, minimising tillage and applying gypsum to improve water percolation through the soil profile, installing shallow surface drains, interceptor drains and banks, deep open drains and subsoil drainage. In addition, raised beds to lift plant roots above saturated soil may also be an option.
### Table 3. State and National responses to threatening processes affecting agricultural land.

Note the State Act which covers all threats to soil is the Soil and Land Conservation Act 1945.

<table>
<thead>
<tr>
<th>THREAT</th>
<th>RESPONSE</th>
</tr>
</thead>
</table>
| **Rising groundwater and salinity** | • Sustainable Rural Development Program, Salinity Sub Program  
  - Spatial Data and Information  
  - Farming Systems Development  
  - Farm Forestry and Revegetation  
  - Engineering Water Management  
  - Rapid Catchment Appraisal  
  - Social Impact of Salinity  
  - Rural Towns Project  
  - Training and Development  
  - Information and Communication Management  
  • National Dryland Salinity Program  
  • Joint Venture Agroforestry Program  
  • CRC for Plant Based Management of Dryland Salinity  
  • CRC for Landscape Environments and Mineral Exploration  
  • National Heritage Trust  
  • National Action Plan for Salinity and Water Quality  
  • Australian Government Envirofund Projects  
  • State Salinity Action Plan (1996)  
  • Draft Salinity Investment Framework 2003 |
| **Biosecurity**                     | • Industry Initiatives  
  - GrainGuard  
  - HortGuard  
  - BeeGuard  
  - StockGuard  
  • Evaluation of the Effectiveness and Efficiency of the Wild Dog Control Program in WA  
  • National Feral Animal Control Program (established under the Australian Governments Natural Heritage Trust)  
  • Agriculture and Related Resources Protection Act 1976 |
| **Soil Acidity**                    | • A “Time To Lime” campaign has successfully increased application rates, but much more needs to be done. |
| **Nutrient loss and eutrophication** | • National Water Quality Management Strategy 1992  
  • State Water Quality Management Strategy 2000 |
| **Soil Contamination**              | • The Australian National Residue Survey (NRS) program is the Primary Monitoring Program responsible for safeguarding the health of consumers from agricultural products |
Flooding

Flooding is stormwater flowing outside its usual channel and usually occurs along drainage lines, in low-lying valleys and on land with poorly defined drainage networks. Flooding frequency is generally highest in high rainfall zones, but it also occurs in duplex soils where internal drainage reaches the clay subsoil causing the water table to temporarily perch (Department of Agriculture, 2004). In the NAR, the land in the Moore River sub-region and to a lesser extent the Yarra Yarra sub-region have the highest risk of flood hazard.

Current management response

The agricultural areas of the Northern Agricultural Region are still undergoing immense hydrological change in response to clearing and development. The ability to determine the potential impacts of this, as well as the ability to develop remedial measures, is greatly hindered by a lack of suitable climatic and landscape runoff information. To date, management is based on common sense, supported by observation.

Soil contamination

Soil Contamination results from spilling, burying or migration of deposited hazardous substances from smokestacks or contaminated water, or from previous use of certain pesticides (e.g., DDT, organochlorines) which are now banned. Contaminants can affect the health of plants when they are taken up by the roots, and of animals and humans if the soil is ingested or inhaled. Contaminated soil can be treated in various ways to ameliorate the problem. There is little information on soil contamination in the NAR but it is a potential problem.

Current management response

The Australian National Residue Survey (NRS) program is the Primary Monitoring Program carried out for both the Commonwealth and State governments, responsible for safeguarding the health of consumers from agricultural products. Producers are responsible for the quality assurance of their products and are recommended to identify and contain potential contamination sources to prevent exposure to livestock.

Acid groundwater

Acid groundwater usually occurs in areas of good rainfall and/or waterlogging soil profiles developed from granite, where the groundwater system is near weathering bedrock. Limited data suggests that the production of acid groundwater has occurred in various areas of the Yarra Yarra sub-region, and the upper catchments of the Moore, Chapman and Greenough Rivers. However, further investigations concerning the extent of acid groundwater in the NAR is currently underway and until all bores have been measured for pH, it is not possible to quantify the extent or severity of acid groundwater in the region.

Current management response

There is very limited information for the treatment of natural acidic groundwater in the quantities present in the Northern Agricultural Region. Combinations of management options are common in the treatment of highly acidic effluents. The limitations of effectiveness in acid mine drainage treatment are also likely to apply to acidic groundwater.

Acid Sulphate Soils

Acid sulphate soils have generally been formed from the inundation of sediments by seawater containing sulphate. The extent of existing and potential acid sulphate soils in the NAR is currently poorly understood and urgently requires investigation. Potential problems in the Gingin area have been identified, but as acid sulphate soil incidents are increasingly found in association with soil disturbance due to water drainage, there is an increasing risk across the region and the potential that land and waterways will be contaminated with toxic quantities of acid, aluminium, iron and heavy metals.

Current management response

The key management option is to recognise the existence of potential acid sulphate soils and contain the problem by avoiding land disturbance. Field identification of potential acid sulphate soils is possible by using various soil, water and vegetation indicators. Management depends on the existing quantities of sulphide minerals, acid loads produced and the area under threat.

Remnant Vegetation Decline

Since European settlement, clearing of remnant vegetation has continued to occur and as a result it is now surrounded by either agricultural land or urban development, which has further impacts on its natural structure, composition and density, leading to further decline. Loss of shrubby understoreys,
The strategy process identified 14 Resource Condition Targets (RCTs) associated with Agricultural Land, grouped into 4 categories: Salinity (1 RCT, 13 MATs); Farming Systems (1 RCT, 8 MATs); Biosecurity (1 RCT, 5 MATs); and Soil Condition (11 RCTs and 30 MATs associated with erosion, acidity, fertility, water-repellency, soil biology, nutrient loss and eutrophication, waterlogging, soil structure decline, sub-surface compaction, flooding and soil contamination). The first three issues were assessed very high priority: both “Essential” in the community preference/value process and “High Threat Risk” using the threat ranking process. For detail of the targets see page 123.

The three high priority areas are

- **Rising Groundwater and salinity** (LN.R1: Rising groundwater to have obtained equilibrium and all salt affected areas to be rehabilitated by 2025);
- **Farming Systems** (LN.R2: All farmers adopting profitable farming system practices that reduce the threats to agricultural land by 2025);
- **Biosecurity** (LN.R3: All land managers are implementing biosecurity measures).

There were a range of priorities and threats associated with the targets related to soil condition; the most significant was erosion control which was assessed to be “Important” and a “Medium Threat Risk”.

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Current management responses

Some of the management options available to elevate remnant vegetation decline:

- Corridors that improve upon the connectivity between remnants which have the ability to sustain viable populations of flora and fauna;
- Fencing remnants and excluding stock from remnants allows the understory to regenerate and reduce the introduction of weeds, which out compete native species; Strategic revegetation targeting specific farm and catchment issues such as groundwater discharge and recharge is another alternative; and Commercial species buffers is another option which ensures minimal weed encroachment from agricultural land and provides a way of limiting the effects of agricultural fertiliser and spray drift on remnants.

Another option that is proving feasible to the agricultural community is the establishment of commercial stands of native vegetation such as sandalwood, brushwood and oil mallees. The commercial aspect of these activities ensures that they can be established on a large scale throughout the NAR. Other native trees are also being investigated to produce products for the bush tucker and medicinal markets. More information on this issue is given in the section on biodiversity.

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**STRATEGY RESPONSES TO ISSUES FACING AGRICULTURAL LAND**

- Rising Groundwater and salinity (LN.R1: Rising groundwater to have obtained equilibrium and all salt affected areas to be rehabilitated by 2025);
- Farming Systems (LN.R2: All farmers adopting profitable farming system practices that reduce the threats to agricultural land by 2025);
- Biosecurity (LN.R3: All land managers are implementing biosecurity measures).
5.2 LAND - URBAN AND CROWN

Goal: To provide for future population and economic growth with minimal impact on agricultural resources, conservation values or landscape amenity.

5.2.1 THE CURRENT SITUATION: RESOURCE DESCRIPTION AND CONDITION

Urban Land

There are in the order of 40 recognised settlements in the NAR. These settlements are spread across 17 local government areas, vary considerably in size (from a few hundred to over 20,000 people) and provide a range of functions including:

- residential and commercial buildings;
- employment;
- service and administrative centre for surrounding communities;
- port or storage facilities;
- coastal living;
- service centre for travellers;
- holiday destination.

In the table below the figures in the ABS 1996 and ABS 2001 columns have been taken from Are our population projections on target? (WAPC, 2004). The population of the NAR has increased by approximately 6.3% over the census period. This growth is mainly being experienced by local governments that include, or are in close proximity to coastal settlements. However, they also often have many non-resident ratepayers. Local governments with mainly inland communities have experienced population decline over the census period. Dalwallinu and Moora are the exceptions. The slight decline for the City of Geraldton is not significant, as it is the centre of a “doughnut” with the surrounding urban areas of Greenough having increased substantially.

There are several threats to local urban settlements, of both human and biophysical origin. Those related to changes in demographics and developments are dealt with in the table on the next page. Issues such as salinity and surface water control, which affect the built environment, are dealt with in a later section.


<table>
<thead>
<tr>
<th>Local Government</th>
<th>ABS 1996</th>
<th>ABS 2001</th>
<th>%Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carnamah</td>
<td>998</td>
<td>804</td>
<td>-19.4</td>
</tr>
<tr>
<td>Chapman Valley</td>
<td>836</td>
<td>876</td>
<td>4.8</td>
</tr>
<tr>
<td>Coorow</td>
<td>1444</td>
<td>1375</td>
<td>-4.8</td>
</tr>
<tr>
<td>Dalwallinu</td>
<td>1767</td>
<td>1882</td>
<td>6.5</td>
</tr>
<tr>
<td>Dandaragan</td>
<td>2584</td>
<td>2940</td>
<td>13.8</td>
</tr>
<tr>
<td>Geraldton</td>
<td>20200</td>
<td>20130</td>
<td>-0.3</td>
</tr>
<tr>
<td>Gingin</td>
<td>3482</td>
<td>4257</td>
<td>22.3</td>
</tr>
<tr>
<td>Greenough</td>
<td>10701</td>
<td>12634</td>
<td>18.1</td>
</tr>
<tr>
<td>Irwin</td>
<td>2526</td>
<td>3059</td>
<td>21.1</td>
</tr>
<tr>
<td>Mingenew</td>
<td>611</td>
<td>584</td>
<td>-4.4</td>
</tr>
<tr>
<td>Moora</td>
<td>2613</td>
<td>2694</td>
<td>3.1</td>
</tr>
<tr>
<td>Morawa</td>
<td>1059</td>
<td>985</td>
<td>-7.0</td>
</tr>
<tr>
<td>Mullewa</td>
<td>1146</td>
<td>1118</td>
<td>-2.4</td>
</tr>
<tr>
<td>Northampton</td>
<td>3020</td>
<td>3333</td>
<td>10.4</td>
</tr>
<tr>
<td>Perenjori</td>
<td>695</td>
<td>612</td>
<td>-11.9</td>
</tr>
<tr>
<td>Three Springs</td>
<td>839</td>
<td>751</td>
<td>-10.5</td>
</tr>
<tr>
<td>Victoria Plains</td>
<td>991</td>
<td>970</td>
<td>-2.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>55512</strong></td>
<td><strong>59004</strong></td>
<td></td>
</tr>
</tbody>
</table>
There are significant areas of crown land (including seabed) in the NAR, such as:

- Conservation reserves (terrestrial and marine), state forests, national parks: management is usually vested in a state government department or a local government authority;
- Areas set aside for road and rail reserves, ports, easements, etc: management is usually vested in a government department or local government authority;
- Unallocated crown land.

The management responsibilities and legal status of crown land is complex and as this is not a planning document, will not be discussed further. As a result of the complexity there is a risk of such land (or water) being poorly managed. As much of it is of high conservation value, this needs to be addressed.

### 5.2.2 OPPORTUNITIES

The region is in an exciting phase of development with considerable expansion in population forecast, and expected economic spin-offs. However, it is imperative that development is sustainable and that consideration of conservation values is included in plans. We are in an excellent position to identify areas with conservation significance and to protect them as part of future planning for settlement expansion.

### 5.2.3 MANAGEMENT PRIORITIES

The rapid development of some areas means that it is imperative that steps be taken both to provide planned development, and to preserve high priority conservation areas. The following steps are suggested:

- Identify and prioritise areas of conservation significance around settlements likely to experience growth so that these values can be incorporated into future planning and be appropriately managed.
- Complete coastal management plans that reflect regional coastal planning objectives and guide authorities, landowners, and land managers in managing the coastline.
- Identify area (particularly of the coastline) that should be prioritised for acquisition and/or transfer to the conservation estate.
- Require coastal development to be setback in accordance with planning policies (WAPC, 2003).
- Require coastal development to be setback in accordance with planning policies (WAPC, 2003).
- The problems with population decline in inland areas needs to be investigated.
- Stormwater management needs to be implemented in all areas to prevent run-off affecting high value assets.

### Table 5. Threats and Responses related to urban expansion & crown land management in the region.

<table>
<thead>
<tr>
<th>Threat to Urban Land</th>
<th>Current and future response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population growth in the NAR could adversely impact on agricultural resources, conservation values, landscape amenity and/or industrial uses with off site impacts. Coastal development in the NAR could adversely affect conservation and landscape values along the coast and prevent public access to, and affect enjoyment of the coastline.</td>
<td>Identify areas where population growth is expected and define suitable sites to accommodate this growth in regional and local planning strategies. Consolidate coastal development around existing coastal settlements only where such development is sympathetic to conservation and landscape values of the coast, and where it provides for managed public access and enjoyment of the coastline. Require coastal development to be setback in accordance with Planning Policy (WAPC, 2003). Undertake an NAR Inland Communities Services Study to identify the services needed by these communities and prepare a Service Provision Plan to ensure these services are provided and maintained.</td>
</tr>
<tr>
<td>Coastal development could be exposed to risks associated with coastal processes. Important services provided to inland communities could be rationalised or discontinued.</td>
<td></td>
</tr>
<tr>
<td>Crown land may be left unmanaged and become a source of feral animals or weeds</td>
<td>Responsibilities need to be clear and management funded; more land could be vested to improve management.</td>
</tr>
</tbody>
</table>
STRATEGY RESPONSES TO ISSUES FACING URBAN AND CROWN LAND

In the strategy process one Resource Condition Target (RCT) and one Management Action Target (MAT) were specifically associated with each of Urban Land and Crown Land. In addition, three RCTs (and 4 MATs) relating to urban and coastal land were identified in relation to the management of waterscapes and one RCT (including 5 MATs) in relation to dune management (coastal geomorphic systems). Dune management was classed as “Essential”, with a variable threat rank depending on a variety of pressures. All the other issues were ranked as “Desirable” with a low or medium threat rank. The Coastal and Marine targets also contain several others (eg in relation to cultural issues and visual amenity) which have links with urban and crown land management.

The priority issue is:

• Maintenance of geomorphic systems (CM.R2: The condition and function of our coastal geomorphic systems will be maintained and improved by 2015).

Other issues:

• Balancing Urban Expansion with Environmental Values (ULN.R1: Development and urban expansion to be balanced with environmental values);
• Crown Land Management (ULN.R2: Crown land to be appropriately managed);
• Waterscape Buffers for Urban developments (WA.R8: Vegetation buffers to protect waterscapes from future urban and industrial developments enforced by 2015);
• Waste Contamination of Waterscapes (WA.R9: No solid waste contamination of high recreation waterscapes and waterscapes adjacent to urban land by 2015);
• Recreation Management for Waterscapes (WA.R10: All recreation in priority waterscapes managed by 2020).

For detail of these targets see page 126.
5.3 LAND - ABORIGINAL

Goal: To respect the rights and responsibilities of traditional land owners

5.3.1 LOCAL ABORIGINAL PEOPLE AND THE LAND

Across Australia, Aboriginal people have a spiritual and practical attachment to the land and the natural environment. The NAR is the traditional land of two Aboriginal groups. Yamaji (also spelled Yamatji) people are the traditional owners of land and coastal waters extending north from the coast at Greenhead, to Onslow and the Ashburton River. From Onslow a boundary extends east along the Ashburton to the Great Northern Highway then south through Sandstone, south west to Lake Moore and west to Greenhead on the coast. Noongar people are the traditional owners of all land south of Coorow and Lake Moore. In the NAR there are at least six distinct Yamaji language groups and at least two Noongar language groups.

Further information on Aboriginal issues is presented on p96 in a discussion of cultural heritage. There has been no traditional need for Aboriginal people to dissociate the concepts of “land” and “culture”. For Yamaji people the NAR is a place of regular weather patterns and consistent availability of food. Perhaps because of the geography of the NAR, Yamaji language groups are relatively smaller than inland groups. Collectively the Yamaji people from the Greenough, Irwin, Lockier and Arrowsmith rivers are known as Willinyu (water people); coastal Yamaji people have “Amangu” (man) as a common term in their languages. The Department of Aboriginal Affairs Yamaji Tribal Boundaries Report (2000) identifies 6 tribal/language groups. The relationship between these groups compares to historical European feudal systems.

For Noongar people, the northern end of their traditional lands is drier and less hospitable than the rest of the south-west. This may explain the low number of Noongar language groups in the NAR. The traditional lands of the Yuet or Yued people covers most of the southern half of the NAR and geographically is one of the larger Noongar language group areas.

5.3.2 HISTORY

Apart from isolated incidental contact with sailors or shipwreck survivors (French and Dutch), Noongar and Yamaji people had not been impacted on by another culture for thousands of years. Prior to European occupation, interaction between Noongar and Yamaji people probably existed through the exchange of resources using a barter system. Examples were raw material such as ochre and foodstuffs, and manufactured items such as tools and weapons. The line separating these groups is indistinct and prior to European occupation was fluid due to seasonal migration. Today the boundary between Noongar and Yamaji people is geographically defined by the region of operation of the two native title representative bodies in the NAR. Despite the ongoing interaction, the cultural rites of each group are distinctly different.

The circumstances of European settlement was profound. The agricultural region was significantly altered to accommodate European farming techniques. While there was some objection from Aboriginal people, the main issue was the social interaction between the cultures. Though the recorded history may be biased, it does show that generally local Indigenous groups were ill-equipped to resist the physical and cultural domination of European excision of their lands. An opportunistic approach to white settlement saw them gravitate away from a traditional subsistence lifestyle, dependent on the availability of natural resources, to one of reliance on the resources of the white man. This reliance was external as the people maintained their culture through the telling of stories and remained linked to the land through culturally significant sites.

Legislation allowing control over the activities of Aboriginal people severely impacted on them participating in mainstream society for many years. Today, Noongar and Yamaji people are actively involved in mainstream Australian society while maintaining a link to the land through hunting and gathering activities, and visiting and caring for sites of cultural significance, thus enabling the inter-generational transfer of Aboriginal history, knowledge and significance of land and resources. Documentation of this culture and heritage also enables the general community to understand and appreciate the unique links to, and significance of, land and resources to Aboriginal peoples.

Yamatji Land and Sea Council and the South West
Aboriginal Land and Sea Council are both important organisations in the region. They have a key role in representing and assisting Native Title claimants. In addition, the Indigenous Land Corporation assists with land acquisition and management. For the purposes of this document, “Aboriginal Land” is best described as “that land which has been acquired for the use and/or benefit of Aboriginal people”. The definition of “Aboriginal Lands” is also inclusive of all Aboriginal heritage sites.

5.3.3 NATURAL RESOURCES AND SITES

Most natural resources have historically had a special significance to Aboriginal people and there are hundreds of significant places in the region. These include burial sites on dunes, special landmarks such as pools and rivers which may have been used as water sources or camp areas, tracks that have formed the basis of traditional “Trade Routes”, the totemic and/or medicinal importance of many plants and animals, and many other examples. There is currently a great opportunity to identify and capture these special cultural issues and to build respect for the rights and responsibilities that Aboriginal people have in relation to them.

5.3.4 LAND OWNERSHIP / NATIVE TITLE

As “Aboriginal Land” is held in a variety of tenures, it is best described as “that land which has been acquired for the use and/or benefit of Aboriginal people”. In Appendix III, there is further detail on land in the NAR that Aboriginal people “own” or have a direct interest in. In addition there is the complex issue of Native Title Claims.

At the time of writing, there are 11 registered and unregistered Native Title Claims active in the NAR.

The Yamatji Land and Sea Council (YLSC) has progressively worked toward amalgamating some claimant groups. At present, YLSC represents 5 NT Claimants in the NAR:

- Naaguja - Coastal Geraldton area
- Nanda - Coastal Northampton area
- Willinyu – Irwin and Lockier Rivers
- Wajarri Elders – inland Murchison River
- Badimia – inland

Four other NT Claimants have private legal representation. These are;

- Mullewa Wadjari - Coastal Geraldton and inland to Mullewa.
- Widi Mob (unregistered) - Coastal Geraldton and inland to Mt Magnet
- Pandawn (unregistered) - Extensive claim from the Coast inland to Sandstone.
- Franks - Coastal Dongara South

In September 2003, the South West Aboriginal Land & Sea Council (SWALSC) filed a Native Title Claim on behalf of the entire Noongar population. Six sub regional working parties, made up of representatives of the prominent Indigenous families in the given region, have been established to represent Native Title interests. The Region 5 SNC Working Party encompasses the southern third of the NAR.

Table 6. Threats and Responses related to Aboriginal Land.

<table>
<thead>
<tr>
<th>Threat related to Aboriginal Land</th>
<th>Current and future response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of recognition of special traditional relationship of Aboriginal people with the land</td>
<td>• Currently some Cultural awareness training available, but this needs to be expanded, and promoted to both non-Indigenous and Indigenous people;</td>
</tr>
<tr>
<td>Lack of recognition of sites or of significance of particular sites</td>
<td>• Many sites identified but not recognised and need documenting;</td>
</tr>
<tr>
<td></td>
<td>• Aboriginal NRM reference groups established in the region (see Appendix III); their role needs to be encouraged.</td>
</tr>
</tbody>
</table>
STRATEGY RESPONSES TO ISSUES FACING ABORIGINAL LAND

RECOGNISING AND VALUING CULTURAL HERITAGE

Aboriginal land per se did not emerge as a specific target in the strategy development. However, it was seen as important that cultural and heritage sites are recognised and valued. This is reflected in two Resource Condition Targets as follows:

CM.R5: By 2010, the Aboriginal heritage of our coastal environments will be recognised and valued.

CA.R5: Cultural and heritage sites of significance to be managed so that future generations can gain from this cultural and ecological knowledge

Both these targets were identified as “Desirable” but neither were threat-ranked.

For detail of these targets see pages 136 & 139.
5.4 BIODIVERSITY - TERRESTRIAL

Goal: Species and ecological community diversity, and ecological processes, maintained, protected and enhanced for all terrestrial, aquatic and marine habitats.

5.4.1 BIODIVERSITY: A DEFINITION

The National Strategy for the Conservation of Australia’s Biological Diversity identifies biodiversity as “the variety of all life forms - the different plants, animals and micro-organisms, the genes they contain, and the ecosystems of which they form a part”. In this strategy we are focusing on “natural” biodiversity, i.e. biotic entities that exist in or are caused by nature. This excludes entities that are not native but have been introduced through human activity.

Terrestrial biodiversity essentially describes native vegetation and its associated flora and native fauna including mammals, birds, frogs, reptiles, amphibians, invertebrates and micro-organisms.

For the purposes of the Strategy the sub asset of Terrestrial Biodiversity will be divided into two classes:

- Native vegetation - this class is described in terms of broad ecological units that provide habitat to individual species and ecological communities; and
- Species and ecological communities - this class relates to individual species, populations and ecological communities of native flora and fauna. This includes both common species and those listed as threatened under the Wildlife Conservation Act 1950.

5.4.2 VALUE OF BIODIVERSITY

It is important to describe the human values of biodiversity so that people understand its impacts for them personally. While some aspects of biodiversity can be expressed in terms of direct economic return, other values are less tangible such as underpinning ecological processes and landscape services, social and ethical values.

In the NAR, biodiversity contributes to a number of human values including:

- ecosystem services; eg the contribution of native vegetation to erosion control
- productive value; eg firewood, wildflower harvesting, shelterbelts

Table 7. Statistics on remaining vegetation by current extent, association type and conservation status.

<table>
<thead>
<tr>
<th>STATISTICS</th>
<th>STATEWIDE</th>
<th>NORTHERN AGRICULTURAL REGION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-European Extent</td>
<td>252 550 000 ha*</td>
<td>7 931 210 ha</td>
</tr>
<tr>
<td>Current Extent</td>
<td>236 000 000 ha</td>
<td>3 474 559 ha</td>
</tr>
<tr>
<td>Current Extent (%)</td>
<td>93%</td>
<td>43%</td>
</tr>
<tr>
<td>Vegetation Associations</td>
<td>819</td>
<td>168</td>
</tr>
<tr>
<td>Vege Assoc (&lt;30% Cover)</td>
<td>108</td>
<td>49</td>
</tr>
<tr>
<td>Vege Assoc (&lt;10% Cover)</td>
<td>40</td>
<td>15</td>
</tr>
<tr>
<td>Vegetation in CALM Conservation Estate</td>
<td>23 015 486 ha</td>
<td>919 424 ha</td>
</tr>
<tr>
<td>Vegetation in CALM Conservation Estate (%)</td>
<td>9.11%</td>
<td>26%</td>
</tr>
<tr>
<td>Vege Assoc (&lt;30% in CALM Conservation Estate)</td>
<td>375</td>
<td>108</td>
</tr>
<tr>
<td>Vege Assoc (&lt;10% in CALM Conservation Estate)</td>
<td>239</td>
<td>65</td>
</tr>
</tbody>
</table>

* Total area of Western Australia
• spirituality and a sense of place; eg attachments to a patch of bush, coastal areas
• educational and scientific value; eg understanding our land and how it works
• amenity value; eg picnic, shady areas and
• habitat value eg the only place many native plants and animals can live is in our native bush.

The belief systems of both the Yamaji and Noongar people of the NAR are integrally linked to the natural environment. Traditionally “Aboriginal people made extensive use of many native trees, shrubs, herbs and animals for both food and medicine, internally and externally.” (Wajarri Wisdom 2002). Many of the creation stories offer explanations for relationships that occur in nature. “Since the advent of European occupation however the wealth of knowledge in the general Aboriginal population of this natural heritage has deteriorated rapidly, being retained mainly by the tribal elders and a small section of the older generation and their families.” (Wajarri Wisdom 2002). Despite the clearing of native bush for agriculture, urban and industrial development, Indigenous people continue to source traditional food and medicines from remnant vegetation. However, the clearing of the land and the infestation of introduced plants and animals has meant many of the plants and animals traditionally used by Aboriginal people are either scarce or no longer available.

5.4.3 RESOURCE DESCRIPTION AND CONDITION

With the goal for biodiversity in mind it is necessary to describe the entities (assets) that must be managed to achieve the goal. As the goal is expressed in terms of protecting and conserving biodiversity, the assets that need to be managed must be the tangible elements of biodiversity. For the purpose of this strategy the asset of Biodiversity has been divided into three sub assets; Terrestrial Biodiversity, Aquatic Biodiversity and Marine Biodiversity.

The region considered by this strategy lies entirely within the South West Botanical Province, one of 25 identified global biodiversity hotspots. This international recognition is due to the outstanding biodiversity that exists within this part of Western Australia and the level of threat occurring within the area (Myers et al. 2000). There are three National Biodiversity hotspots within the region: the Mt Lesueur – Eneabba, Geraldton to Shark Bay sand plains and Central and Eastern Avon Wheatbelt hotspots. Biodiversity hotspots are areas under immediate threat from impacts such as salinity, land clearing, weeds and feral animals, and are strongholds for large numbers of Australia’s unique plants and animals. The hotspots are home to ‘endemic’ species - in other words, native flora and fauna that are mostly restricted to one geographic locality.

Native vegetation

Native vegetation in the NAR has been described and mapped by Beard (1974, 1981) as broad structural vegetation types at a scale of 1:250 000. These are further subdivided into plant associations or communities. The conservation status of vegetation types has been described by Hopkins et al. (1996), based on modified Beard vegetation mapping.

Eight hundred and nineteen (819) vegetation

Table 8. Details on rare and endangered flora, fauna and communities.

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>STATUS</th>
<th>NUMBER IN NORTHERN AGRICULTURAL REGION</th>
<th>NUMBER WITH RECOVERY PLANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flora</td>
<td>Declared Rare Flora</td>
<td>130</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Priority</td>
<td>224</td>
<td></td>
</tr>
<tr>
<td>Fauna</td>
<td>Threatened (Schedule 1-4)</td>
<td>27</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Priority</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>Ecological Communities</td>
<td>Threatened</td>
<td>19</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Data Deficient</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Northern Agricultural Catchments Council 2005
associations have been described in Western Australia, and of these 168 occur either partially or completely within the NAR boundary and 66 of these are found exclusively in the region (Richardson et al 2004). The majority of these vegetation associations have been subject to clearing for human usage, with some having less than 10% of their original extent remaining. The National objectives and targets for biodiversity conservation 2001 – 2005 outlines that maintaining, enhancing and possibly even revegetating ecological communities that are below 10 and 30 percent of their pre-European settlement extent is a priority.

Significant areas of remaining native vegetation have been conserved in the State’s formal conservation reserve system. National and State policies aim to establish a comprehensive, adequate and representative (CAR) reserve system to ensure the long-term conservation of all native vegetation associations, ecological communities and species. Currently a significant number of vegetation associations are under-represented in the formal conservation reserve system, even though over one-quarter of remaining native vegetation in the NAR occurs in CALM managed conservation estate. Table 7 provides further details on the status of vegetation associations in the NACC NRM region. Details of those specific vegetation types that are poorly represented in the conservation reserve system are available in the WA Biodiversity Audit.

**Species and Ecological Communities**

Species (individuals and populations) and ecological communities (groups of interacting species) refer to all fauna and flora (both individuals and populations and ecological communities) including invertebrates and microorganisms.

At present, fauna may be specially protected by listing as likely to become extinct, rare or otherwise in need of special protection. Flora may be specially protected by listing as declared rare flora. Such species are then ranked informally for conservation priority, following international standards. Western Australia has adopted a common categorisation for threatened species and ecological communities in line with internationally agreed standards used by the World Conservation Union (IUCN) that include recognition of threat priorities or rankings. The listing categories for threatened species and ecological communities are:

- Extinct, for species that are extinct in the wild and destroyed for ecological communities that have been removed or irrevocably changed;
- Critically endangered, for species and ecological communities that are facing an extremely high risk of extinction or destruction in the near future;
- Endangered, for species and ecological communities that are not critically endangered but still face a very high risk of extinction or destruction in the near future; and
- Vulnerable, for species and ecological communities that are not endangered or critically endangered, but still face a high risk of extinction or destruction in the medium term.

More than 4,196 native plant taxa occur within the NAR and around 821 (20%) are endemic to the region. There are currently 1 extinct and 130 taxa of threatened flora listed in the Wildlife Conservation Act 1954 for Western Australia and a further 224 taxa listed as priority species. Nineteen Threatened Ecological Communities (TECs) are also recognised. The vertebrate fauna of the NAR is diverse, and current knowledge identifies 56 species of native mammal, 258 birds, 166 reptiles, and 23 amphibians. In addition there are a significant, though mostly unknown number of invertebrates and microorganisms such as fungi, algae, lichens and bacteria. For the entire regional fauna combined (including invertebrates) 27 of these are considered threatened and 39 as priority species (Richardson et al 2004). Details on the number of threatened flora, TECs and fauna species are presented in Table 8.

The State Wildlife Conservation Act 1954 together with the Commonwealth’s Environment Protection and Biodiversity Conservation Act 1999 are valuable tools for the protection and restoration of biodiversity, and the sustainable use of our native plants, animals and other organisms. Together these acts provide for greatly simplified and more certain application of biodiversity conservation controls from which the entire community will benefit.

**5.4.4 THREATENING PROCESSES AND MANAGEMENT RESPONSES**

Management for biodiversity conservation fundamentally involves preventing the loss of biodiversity by managing biophysical processes, i.e. by managing threats to the quality, quantity
and/or viability of particular biodiversity assets. The Environment Protection and Biodiversity Conservation Act 1999 provides a framework for some key national threats. The Act lists Key Threatening Processes which are considered to threaten the survival, abundance or evolutionary development of a native species or ecological community. There are national Threat Abatement Plans for the key threatening processes relevant to the NAR including for feral rabbits, foxes, feral goats, feral cats, feral pigs and Phytophthora dieback.

The source of biophysical threats usually stems from some change imposed by human intervention in the landscape, such as clearing of native vegetation, the collection and use of firewood, introduction of exotic plants and animals, and land uses/activities that are incompatible with the survival of natural species, populations or communities. The National approach to firewood collection and use in Australia assists in increasing the effectiveness of existing regulations and controls across Australia to protect remnant vegetation and the fauna it contains and in particular the threatened species and ecological communities from the impacts of firewood collection.

There are a number of processes threatening biodiversity in the region. Programs and projects designed to address these are at a local, regional, State and National scale. At a state and national scale biodiversity is protected by several acts some of which have been mentioned previously. The following section provides an overview of the key threatening processes and some local and regional scale management responses.

It is important to note that limited data exists for the resource condition of many biodiversity assets in the region and this gap in knowledge needs to be addressed before the impact and management of threatening processes can be monitored and evaluated.

Vegetation removal or degradation

Within the NAR extensive clearing through both active and passive methods has occurred resulting in less than 10% remaining native vegetation in some areas. Listed below are several methods that have been adopted throughout the region to address this:

- Notice of Intent process for further clearing;
- Environmental harm amendment to the Environmental Protection Act relating to clearing to protect native vegetation;
- Remnant Vegetation Protection Scheme (1989 – 2000);
- Covenanting Process (CALM, National Trust, DAWA); Woodland Watch project (WWF);
- Acquisition by CALM into formal conservation reserve system;
- Target Landscapes;
- Private landholder conservation; and
- Recovery plans for threatened flora, fauna and ecological communities.

Fragmentation

The lack of connectivity between patches of vegetation / biodiversity is particularly pronounced throughout the central and eastern areas of the region. This is exacerbated by the degradation of road reserves. Listed below are several methods that have been adopted throughout the region to address this:

- Bushcare Projects 1996 - 2003 (establishing linkages through revegetation);
- Buntine Marchagee Recovery Catchment (focal bird study);
- Action for Woodland Birds (focal bird study); and
- Private landholder revegetation for corridors.

Altered hydrology

Due to the extensive removal of native vegetation hydrological regimes have been altered considerably resulting in groundwater rise. In addition, drainage has been adopted to mitigate the problem and discharge can pose a threat to remnant vegetation and aquatic systems. This area is addressed more extensively in land and water sections of the strategy. Listed below are several methods that have been adopted throughout the region to address this:

- Catchment Demonstration Initiative (CDI);
- Engineering Evaluation Initiative (EEI);
- Fencing and protection of primary saline wetlands (Bushcare & private landholders);
- Rapid Catchment Appraisal (RCA); and
- State Salinity Strategy (Natural Diversity Recovery Program).
Pest animals and plants

Europeans have introduced several animals and plants into Australia and many have adapted so well to their new environment that they compete with the native flora and fauna for resources. Introduced animals such as the fox have made an enormous impact on the native wildlife. Some native animals such as the parrot have also become pest species due to their altered environment. The conservation value of remnant vegetation will be increased if pest animals and plants are controlled and if possible eliminated. Listed below are several methods that have been adopted throughout the region to address this:

- Northern Mallee Fowl Association (strategic baiting);
- Damage Licenses for pest native fauna (CALM);
- Agricultural Protection Board (DAWA);
- CALM Baiting and eradication program (Western Shield Program); and
- Private Landholder Baiting and eradication.

Altered Fire Regimes

Fires are an important ecological process for ecosystems in south-western Australia. Our native plants and animals have evolved several strategies, which enable them to persist in this environment. Europeans have altered the natural fire regimes considerably by altering their frequency and intensity. Uncontrolled high intensity fires can endanger human lives and do a great deal of damage to remnant vegetation. The correct use of fires can reduce this risk and be used to stimulate regeneration and regrowth in native vegetation. Listed below are several methods that have been adopted throughout the region to address this:

- CALM Prescribed burning and wildfire threat analysis;
- Landholder burning practices; and

Disease

The region has two main fungal diseases that are particularly damaging to native vegetation these are the honey fungus (Armillaria luteobubalina) and various species of the Phytopthora genus. These fungi kill a wide range of species and cause severe damage to some specific vegetation types. This loss of vegetation in turn has a severe effect on the native fauna. The disease Mundulla Yellows has been recorded in the region although its impacts are

Table 9. Interim Bio-Regionalisation of Australia (IBRA) bioregions that intersect the Northern Agricultural Region and the relative amount of vegetation remaining post clearing for agriculture and urban development.

<table>
<thead>
<tr>
<th>IBRA Sub Region</th>
<th>Total Area of IBRA (pre-European Extent) Ha</th>
<th>NAR Area of IBRA (pre-European Extent) Ha</th>
<th>% of IBRA in NAR</th>
<th>IBRA Sub-region Current Vegetation Extent Ha</th>
<th>IBRA Sub-region % Vegetation Remaining</th>
</tr>
</thead>
<tbody>
<tr>
<td>AW1</td>
<td>6520803</td>
<td>2179483</td>
<td>33</td>
<td>1125310</td>
<td>17</td>
</tr>
<tr>
<td>AW2</td>
<td>2990725</td>
<td>379346</td>
<td>13</td>
<td>258660</td>
<td>9</td>
</tr>
<tr>
<td>JF1</td>
<td>1897447</td>
<td>99689</td>
<td>5</td>
<td>1138735</td>
<td>60</td>
</tr>
<tr>
<td>SWA1</td>
<td>383274</td>
<td>361004</td>
<td>94</td>
<td>110908</td>
<td>29</td>
</tr>
<tr>
<td>SWA2</td>
<td>1128538</td>
<td>462522</td>
<td>41</td>
<td>464223</td>
<td>41</td>
</tr>
<tr>
<td>GS1</td>
<td>825892</td>
<td>190248</td>
<td>23</td>
<td>803676</td>
<td>97</td>
</tr>
<tr>
<td>GS2</td>
<td>1969241</td>
<td>1901815</td>
<td>97</td>
<td>792378</td>
<td>40</td>
</tr>
<tr>
<td>GS3</td>
<td>1173217</td>
<td>1173217</td>
<td>100</td>
<td>522280</td>
<td>45</td>
</tr>
<tr>
<td>YAL1</td>
<td>4252358</td>
<td>1145957</td>
<td>27</td>
<td>4174678</td>
<td>98</td>
</tr>
<tr>
<td>MUR2</td>
<td>6981246</td>
<td>36329</td>
<td>1</td>
<td>6981246</td>
<td>100</td>
</tr>
</tbody>
</table>

largely unquantified. Listed below are the methods that have been adopted throughout the region to address this:

- Limited Survey of *Phytophthora* spp (CALM); and
- Limited survey of Mundulla Yellows.

**Climate Change**

Maintaining healthy landscapes and sustainable use of natural resources requires ongoing efforts to prevent and reverse natural resource degradation. Climate change presents further challenges, as well as opportunities for activities that target complementary greenhouse and natural resource outcomes. Natural resource management in Australia, particularly

*Figure 7. Remnant Vegetation and Interim Bio-Regionalisation of Australia (IBRA) bioregions in the Northern Agricultural Region of WA.*
### Table 10. State and national responses to threatening processes affecting terrestrial biodiversity

<table>
<thead>
<tr>
<th>THREAT</th>
<th>RESPONSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altered Hydrology</td>
<td>- National Action Plan for Salinity and Water Quality</td>
</tr>
<tr>
<td></td>
<td>- National Dryland Salinity Program</td>
</tr>
<tr>
<td></td>
<td>- Natural Diversity Recovery Catchments Program (Department of Conservation and Land Management)</td>
</tr>
<tr>
<td></td>
<td>- State Salinity Strategy (2000)</td>
</tr>
<tr>
<td>Vegetation removal/ degradation</td>
<td>- Comprehensive, Adequate and Representative (CAR) conservation reserve system</td>
</tr>
<tr>
<td>Pest animals and plants</td>
<td>- Conservation and Land Management Act (1984)</td>
</tr>
<tr>
<td></td>
<td>- Draft State Biodiversity Conservation Strategy (still in development)</td>
</tr>
<tr>
<td></td>
<td>- Environment Protection and Biodiversity Conservation Act (1999)</td>
</tr>
<tr>
<td></td>
<td>- Environmental Protection Act (1996) and Amendment Bill (2002)</td>
</tr>
<tr>
<td></td>
<td>- Natural Heritage Trust Act (1997)</td>
</tr>
<tr>
<td></td>
<td>- National Feral Animal Control Program</td>
</tr>
<tr>
<td></td>
<td>- National Objectives and Targets for Biodiversity Conservation 2001-2005</td>
</tr>
<tr>
<td></td>
<td>- National Strategy for Ecologically Sustainable Development</td>
</tr>
<tr>
<td></td>
<td>- National Weed Strategy (1997)</td>
</tr>
<tr>
<td></td>
<td>- Natural Resource Management Ministerial Council (NRMMC)</td>
</tr>
<tr>
<td></td>
<td>- Register of the National Estate</td>
</tr>
<tr>
<td></td>
<td>- Soil and Land Conservation Act (1945)</td>
</tr>
<tr>
<td></td>
<td>- State Weed Strategy (2001)</td>
</tr>
<tr>
<td></td>
<td>- Town Planning and Development Act (1928)</td>
</tr>
<tr>
<td></td>
<td>- Western Shield (1996)</td>
</tr>
<tr>
<td>Climate change</td>
<td>- Indian Ocean Climate Initiative</td>
</tr>
</tbody>
</table>
STRATEGY RESPONSES TO ISSUES FACING TERRESTRIAL BIODIVERSITY

In the strategy process eleven Resource Condition Targets (RCTs) representing forty six Management Action Targets (MATs) were developed in relation to Terrestrial Biodiversity. The targets were linked together in 5 groups: Native Vegetation; Threatened Species and Communities; Salinity Risk; Environmental Weeds and Pests; and Capacity.

One of the RCTs (Extent of Native Vegetation) is of very high priority, being assessed to be “Essential” and a “High Threat Risk”. Several others were identified to be “Important” and/or a “High Threat Risk”.

The priority issue is:

- **Extent of Native Vegetation** (BD.R1: Maintained and increased native vegetation extent (other than approved clearing applications)..... by 2025).

Other significant issues (Important, High Threat Risk):

- **Threatened species and communities** (BD.R4: No major losses to meta populations of threatened species and communities... and to increase and improve populations...)

- **Environmental weeds and animal pests** (BD.R8: A yet to be determined reduction in the density and distribution of significant environmental weed species...; and BD.R9: A ...reduction in biodiversity impacts of significant invasive animals (native and exotic)...)

Other significant issues (Desirable, High Threat Risk):

- **Protecting vegetation associations** (BD.R2 A yet to be determined increase in protection and condition by 2020 of poorly represented, ...restricted associations, ...and biodiversity hotspots)

- **Landscape Conservation** (BD.R3: At least three representative landscapes being managed for conservation of biodiversity by 2020).

- **Protecting key habitats** (BD.R5 ... increase in the protection and enhancement of key habitats by 2020 ...)

- **Salinity / biodiversity** (BD.R6 ... reduction of biodiversity assets at risk from secondary salinity by 2015)

For detail on targets relating to terrestrial biodiversity see page 123. Terrestrial Biodiversity is also a key factor in many targets associated with Land, Water and Coastal and Marine assets, and the reader is also directed to these sections for further detail.
5.5 BIODIVERSITY - AQUATIC

Goal: Species and ecological community diversity, and ecological processes, maintained, protected and enhanced for all aquatic habitats

5.5.1 AQUATIC BIODIVERSITY: A DEFINITION

Aquatic biodiversity as a sub asset comprises all natural surface water ecosystems, including rivers, streams, estuaries, river pools, floodplains, freshwater lakes, wetlands, salt lake systems and the flora and fauna associated with these habitats. This section provides a description of the different types of aquatic biodiversity in the NAR. The resource condition and major threats to waterscapes (including aquatic biodiversity) is discussed under the Waterscapes section p58.

5.5.2 RESOURCE DESCRIPTIONS

Aquatic ecosystems are generally considered to be as complex as terrestrial ecosystems, but our knowledge of them is noticeably poorer. Marine, estuarine and freshwater ecosystems are under as much threat as terrestrial ecosystems from human activities, both directly through loss of habitat, and indirectly through contamination, sedimentation, and changes in hydrology, which alters flow regimes (Environmental Protection Authority, 2004b). In order to effectively manage the processes threatening aquatic biodiversity in the NAR, it is important that the current lack of understanding and baseline information be addressed.

Wetlands

The Wetlands Advisory Committee (1977) defines wetlands as areas of seasonally, intermittently or permanently waterlogged soils or inundated land, whether natural or otherwise, fresh or saline, including waterlogged soils, ponds, billabongs, lakes, swamps, tidal flats, estuaries, rivers and their tributaries.

The NAR is characterised by a diverse system of waterscapes. Saline lakes occur in the eastern reaches of the region where drainage lines consist of broad palaeochannels with mosaics of flat channels and small episodically filled playa lakes. To the west are a variety of groundwater fed wetlands, coastal dune wetlands, swamps, springs, karst limestone cave pools, river systems and associated pools and estuaries. The knowledge of these systems varies considerably and there is a need for more research on baseline ecology.

Ten types of wetlands have been identified in the NAR (V & C Semeniuk, 1994; Halse et al, unpublished) using the geomorphic wetland classification system (Semeniuk and Semeniuk, 1995). These are shown in Table 11.

There are nine wetlands/ areas of wetlands listed on the Directory of Important Wetlands (Environment Australia, 2001) and five wetlands listed as sub-regionally significant (Desmond and Chant, 2003). Fifteen suites of wetlands were identified by the Semeniuk Research Group (V & C Semeniuk, 1994), and these areas have been selected for conservation (see Table Waterscapes of National, State and Regional Significance). Further classification and evaluation work is required for these suites of wetlands to be regionally or even nationally recognised.

As part of the State Salinity Strategy an analysis for wetlands in the wheatbelt is close to completion (Halse et al, unpublished). This analysis has studied 197 wetlands across the southwest to establish biodiversity patterning and has identified 16 types of wetlands and 22 assemblages of co-occurring species. However, information continues to be fragmented and incomplete and there is considerable information that needs to be compiled on the biodiversity of waterscapes in the NAR.

Waterways and Estuaries

There are nine major waterways in the NAR and the majority of these are ephemeral. Annual rainfall in the region ranges from 200 – 500 mm, so it is usual for waterways to flow only after it rains. The lower reaches of most rivers have perennial pools that provide important habitat and refuge areas for many aquatic organisms. Waterscapes Resource Description and Condition p58 contains geographical
information for the major waterways, wetlands and estuaries in the region.

**Floodplains**

River floodplains contain a high level of biodiversity and are important components of river ecosystems. When floodplains become inundated, large areas of nutrients are available, plankton blooms develop and invertebrates thrive (Environmental Protection Authority, 2004b). Flow regulation or structural measures that restrict the frequency and magnitude of flooding of the floodplain can have serious adverse impacts on floodplain ecology. It is appropriate to consider floodplains and waterways an essential part of most catchments and waterways (Department of Environment, 2002).

**Fish**

Eight endemic freshwater fish have been recorded in the south west of Western Australia (Gill and Morgan, 1999), but there is little information on the current distribution, particularly in the NAR. There are anecdotal reports that fishing used to be a significant pastime across most of the NAR, but sedimentation, water quality decline and changes in hydrology have limited this recreation to the estuaries. Crustaceans are still collected by recreational fishers in several parts of the region, however these species are not endemic to the NAR.

**Birds**

Wetlands in the NAR are an important resource for native and migratory water birds. The Environment Protection and Biodiversity Act 1999 has a list of migratory bird species for protection and conservation in Australia, of which five are found in the NAR (see Table). This national List of Migratory Species also consists of species listed under the International Conventions: Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA), and Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) (Department of Environment and Heritage, 2004b).

Both the JAMBA and CAMBA agreements require the parties to protect migratory birds from take or trade (except under limited circumstances), protect and conserve habitats, exchange information, and build cooperative relationships. The JAMBA agreement also includes specific provisions for cooperation on conservation of threatened birds. Australian government officials and non-government representatives meet every two years with their Japanese and Chinese counterparts to review progress in implementing the agreements and to explore new initiatives to conserve migratory birds (Department of Environment and Heritage, 2004c).

**Table 11. Wetland types in the NAR classified using the germorphological classification system.**

<table>
<thead>
<tr>
<th>WATER LONGEVITY</th>
<th>LANDFORM</th>
<th>BASIN</th>
<th>CHANNEL</th>
<th>FLAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent inundation</td>
<td>Lake</td>
<td>River</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Seasonal inundation</td>
<td>Sumpland</td>
<td>Creek</td>
<td>Floodplain</td>
<td></td>
</tr>
<tr>
<td>Intermittent inundation</td>
<td>Playa¹</td>
<td>Wadi</td>
<td>Barlkarra</td>
<td></td>
</tr>
<tr>
<td>Seasonal waterlogging</td>
<td>Dampland</td>
<td>-</td>
<td>Palusplain</td>
<td></td>
</tr>
</tbody>
</table>

Frogs

Ten species of frogs have been recorded in the NAR: two tree frogs and eight ground dwelling frogs (see Table 13). Research has shown that populations of amphibians have been declining rapidly over the last few decades and due to their sensitive skin and aquatic habit, they are extremely useful as indicators of the state of our environment. In the NAR, it is believed that species losses are predominantly due to habitat destruction, pollutants; including pesticides and herbicides, and the chytrid fungus, which is killing frogs right across the southwest of Western Australia.

Other causes for decline, include climate change, parasitic infestation, introduction of non-indigenous predators/competitors, infectious diseases, and urban encroachment. Concern is so great for the phenomenon of amphibian declines, that the International Union for the Conservation of Nature (IUCN) has set up the Declining Amphibian Populations Task Force (DAPTF) to investigate the matter. Yet despite rapid losses in amphibian populations, none of the species found in the NAR are listed as threatened under the Wildlife Conservation Act (2001).

Table 12. Migratory birds recorded in the Northern Agricultural Region.

<table>
<thead>
<tr>
<th>COMMON NAME</th>
<th>SPECIES</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long-toed Stint</td>
<td>Calidris subminuta</td>
<td>Small waders who forage in wet grassland and on mudflats, mainly picking up food by sight. They mostly eat small crustaceans, insects and snails.</td>
</tr>
<tr>
<td>Red-necked Stint</td>
<td>Calidris ruficollis</td>
<td></td>
</tr>
<tr>
<td>Curlew Sandpiper</td>
<td>Calidris ferruginea</td>
<td>Small waders who forage in soft mud on marshes and the coast, mainly picking up food by sight. They mostly eat insects and other small invertebrates.</td>
</tr>
<tr>
<td>Wood Sandpiper</td>
<td>Tringa glareola</td>
<td></td>
</tr>
<tr>
<td>Common Greenshank</td>
<td>Tringa nebularia</td>
<td>A wader who feeds on small invertebrates, but will also take small fish.</td>
</tr>
</tbody>
</table>

Table 13. Frog species recorded in the Northern Agricultural Region.

<table>
<thead>
<tr>
<th>COMMON NAME</th>
<th>SPECIES</th>
<th>DISTRIBUTION IN NAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humming Frog</td>
<td>Neobatrachus pelabatoides</td>
<td>Whole of NAR</td>
</tr>
<tr>
<td>Kunapalari Frog</td>
<td>Neobatrachus kunapalari</td>
<td>Whole of NAR</td>
</tr>
<tr>
<td>Lea’s Frog</td>
<td>Geocrinia leai</td>
<td>Dandaragan through to Swan Coastal Plain</td>
</tr>
<tr>
<td>Moaning Frog</td>
<td>Heleioporus eyrie</td>
<td>Irwin River through to Swan Coastal Plain</td>
</tr>
<tr>
<td>Orange-Crowned (Western) Toadlet</td>
<td>Pseudophryne occidentalis</td>
<td>Kalbarri through to Morawa</td>
</tr>
<tr>
<td>Quacking Frog</td>
<td>Crinia georgiana</td>
<td>Swan Coastal Plain</td>
</tr>
<tr>
<td>Slender Tree Frog</td>
<td>Litoria adelaidensis</td>
<td>Swan Coastal Plain</td>
</tr>
<tr>
<td>Western Banjo (Pobblebonk) Frog</td>
<td>Limnodynastes dorsalis</td>
<td>Whole of NAR</td>
</tr>
<tr>
<td>Western Green Tree Frog</td>
<td>Litoria moorei</td>
<td>Lower Murchison River through to the Swan Coastal Plain</td>
</tr>
<tr>
<td>Western Spotted Frog</td>
<td>Heleioporus albopunctatus</td>
<td>Kalbarri through to south east Morawa</td>
</tr>
</tbody>
</table>

(Tyler, Smith and Johnson, 1994)
Stromatolites
Lake Thetis is one of few lakes where both submerged benthic microbial mats and developing microbial structures occur. The shallow pools on the south western shore provide the perfect environment for the growth of micro-organisms, particularly cyanobacteria, which are the building blocks for stromatolites, the regions only example of ‘living fossils’. Stromatolites – layered rocks – are the oldest form of life on earth dating 3.5 billion years, although the Lake Thetis structures are relatively new, being about 2 000 years old. Stromatolites grow in Lake Thetis because of the extreme salinity of the seawater, the limited circulation of the water, and the occurrence of calcium carbonate. Lake Thetis is a very important site in the region and a significant example of a specialised form of aquatic biodiversity.

5.5.3 THREATENING PROCESSES AND MANAGEMENT RESPONSES
The majority of waterscapes and associated aquatic biodiversity in the NAR are impacted by urban and rural landuse resulting in high levels of erosion, sedimentation and nutrients. Few fresh streams remain in the Greenough and Murchison basins and many are increasing in salinity as a result of catchment clearing. The condition of fringing vegetation is generally moderate to poor and continues to deteriorate from land uses such as grazing (see Waterscapes: Threatening Processes and Management Responses p62 for more information). See Table 19 for State and National polices and programs that relate to aquatic biodiversity.

Landholders have been establishing deep rooted woody perennial vegetation across the NAR that assists in alleviating some of the negative impacts that poor land management has on waterways. The vegetation established helps prevent sedimentation of waterways by reducing the impact of heavy rains upon fragile soils and by reducing the velocity of surface waters. Trees also provide a water filtration service and reduce the amount of nutrients entering the groundwater.

STRATEGY RESPONSES TO ISSUES FACING AQUATIC BIODIVERSITY

Protecting habitat of aquatic fauna
One Resource Condition Target (RCT) deals with aquatic biodiversity and is focussed on protecting habitat of freshwater fauna. This RCT was assessed to be “Desirable” and “High Threat Risk”. (WA.R7: Maintain or improve the ecological function of priority waterscapes by 2020)

For more detail see page 130.
5.6 BIODIVERSITY - MARINE

Goal: Species and ecological community diversity, and ecological processes, maintained, protected and enhanced for all marine habitats.

5.6.1 MARINE BIODIVERSITY: A DEFINITION

Marine biodiversity refers to the diversity of plant and animal life in the NAR, between the coast and three nautical miles offshore. This section also deals with the marine waters and habitat of the NAR.

5.6.2 RESOURCE DESCRIPTION

Marine environment & biodiversity

The shallow water marine biota of Western Australia (WA) can be divided into three distinct biogeographical regions. The north coast of the continent, from North West Cape to the Great Barrier Reef is part of the vast ‘Indo-West Pacific’ biogeographical zone. From Cape Leeuwin to the east coast of Australia is the ‘Southern Australian Warm Temperate’ region. The third region contains the NAR, and is an area of biogeographical overlap, where tropical and temperate biotas mix in varying proportions.

At a finer biogeographical scale, three meso-scale regions are recognised as occurring within the NAR.

- Zuytdorp - The marine habitat offshore of the Kalbarri cliffs are part of this bioregion. Little is known about the marine flora and fauna.
- Abrolhos Islands - Most southerly coral reef system in the Indian Ocean with a mixture of temperate and tropical species and very high species diversity.
- Central West Coast - Extends from Kalbarri to Perth and is one of the largest temperate limestone reef systems in Australia. Contains a mix of temperate and tropical marine fauna and flora and highest species diversity of seagrass in the world (IMCRA Technical Group, 1998).

Much of the marine biogeographical overlap and endemism in the NAR is attributable to the profound effects of the Leeuwin current. In contrast to the current patterns on west coasts of other continents, the Leeuwin Current flows poleward along the outer continental shelf of WA (Cresswell and Golding, 1980). This allows tropical species to spread much further south than they otherwise would (Morgan & Wells 1991). Because the current flows along the outer continental shelf, the Abrolhos Islands have a more tropical marine biota than inshore areas such as Geraldton.

Inshore, the continental coastline of the NAR comprises a unique combination of offshore reefs, islands and sheltered lagoons. Inside the 20m depth contour, elongated limestone reefs run parallel to the shore, and form part of the largest continuous temperate limestone reef in Australia. Although the inshore fauna is regarded as predominantly temperate, a recent CALM survey found that tropical species comprised 35% (CALM 2003). The same survey indicated that the marine biota was diverse (105 invertebrates and 250 species of fish), and recorded species that are not yet described and ‘new’ to science. A small proportion of biota endemic to WA (about 10% of shallow water fauna) are superimposed on the tropical-temperate distributions. While this is a small proportion, these species (such as the western rock lobster Panulirus cygnus) may be economically and/or ecologically important. The diversity of habitats and species in the Central West Coast bioregion is well-represented in the Jurien Bay Marine Park (CALM, 2003).

Biological productivity

Lacking the major upwelling found off the west coasts of the other continents, oceanic waters off the west coast of Western Australia are nutrient poor, with associated implications for the types of commercial fishing undertaken in the region (see Fish Resources section p81). Due to the low concentrations of nutrients in the oceans off Western Australia, most of the primary production is by benthic plants (seagrass and seaweeds). It is thought that a tight recycling of nutrients is required to maintain production levels of benthic macrophytes. Drift algae and seagrasses in the water column and wrack thrown up on the beaches are thus ecologically important both for nearshore ecology and for nearshore fisheries. Recent work has demonstrated that intermittent small-scale upwelling offshore can contribute significantly to nutrient processes. (Rochford 1980; Pearce 1991; 1997).

Houtman Abrolhos Islands (Abrolhos)

The Houtman Abrolhos Islands are a significant asset in the NAR, and were declared the State’s first Fish Habitat Protection Area under the Fish Resources
The islands are the southernmost area of major coral reef development in the eastern Indian Ocean, and one of the highest latitude coral reef systems in the world. The 122 islands are all low lying and composed of relic reef crests, reef flats, lagoons and corals. These habitats are important in their own right, but are also host to globally significant biodiversity.

A recent study (Roberts et al. 2002) examined worldwide distributions of coral reef associated fauna. Eighteen hotspots of coral reef biodiversity were found. The west coast of Western Australia, between Ningaloo and Rottnest Island, was a key centre of biodiversity. Not only was it ranked 7th in total diversity and 2nd in restricted range species, it is away from human population centres and major industrial activity, and ranked 15th in terms of threat.

The Abrolhos are one of four reef systems that constitute the hotspot. Of the target groups studied, the Abrolhos’ total diversity is second to Ningaloo Reef, but has far more restricted range species.

Research has documented: 184 species of coral in 42 genera (Veron and Marsh 1988), 172 species of echinoderms (Marsh 1994), 492 molluscs (Glover & Taylor 1997; Wells & Bryce 1997), 234 marine benthic algae (Huisman 1997), and limited meadows of seagrass in the Abrolhos containing several species (Walker & Prince 1987; Brearley 1997).

The Abrolhos are also one of the most important breeding sites for seabirds in the world (Fuller et al. 1981). Over a million breeding pairs of the Wedge-Tailed Shearwater (*Puffinus pacificus*) live on the Abrolhos, and the islands are the largest known Western Australian habitat for breeding pairs of nine seabird species (CALM 1994). In addition, the terrestrial biodiversity is also significant, with the following floral communities requiring special consideration (Fisheries WA, 1998): mangroves (*Avicennia marina*), Atriplex cinerea dwarf shrubland, and saltbush flats. Other important species of terrestrial fauna include two indigenous mammals, and twenty six species of terrestrial reptiles. Two of these (carpet python *Morelia spilota imbricata* and spiny-tailed skink *Egernia stokesii stokesii*) are declared to be rare or otherwise in need of special protection.

Aboriginal links with the sea

Aboriginal people have a spiritual and physical connection to the marine environment, with the creation of stories of Noongar and Yamaji people containing many references to the sea and its inhabitants. According to the creation mythology of many Yamaji language groups, a battle took place between the Rainbow Snake and a mythological marine creature (some say shark others say serpent). Some local language groups believe this battle took place near the mouth of the Murchison River and the Abrolhos Islands were created as a result. As the Abrolhos are not visible from the mainland and the local Aboriginal groups are not seafarers, knowledge of the existence of the Abrolhos Islands may come from a time when the sea level was lower. Noongar people maintain their cultural link to the coastline with mythological explanations for the existence of the many coastal islands. Cultural caveats exist on many of these islands, with access to an island and its resources often restricted to particular members of the community (eg Some of these islands are designated womens’ places).

Although there is a long history of use of the coastal areas by Aboriginal people, a better understanding of the significance Aboriginal people place on the marine environment in the Northern Agricultural Region is still required. The existence of fish traps and the number and contents of middens provide evidence that marine molluscs and fish were an important food source. There are native title claims that cover inshore marine areas of the region, and there may have been use of what are now offshore islands during periods of lower sea-level.

5.6.3 RESOURCE CONDITION

Details of gaps in information required to make condition assessments are included in the ‘threats and responses’ section below.

Marine environment

The coastline of the NAR is open and exposed, with substantial current and wind-driven water movements. The population is also small, with only about 60,000 people living in the NAR, half of whom are resident in the Geraldton area. There is little heavy industry along the coastline. These features combine to ensure that, while relatively few measurements have been made, overall water quality is thought to be non-impacted.

However, the recent sediment plume from the Port Enhancement Project of the Port of Geraldton illustrated how quickly threats can increase. The dredging created a plume up to 80 km long, causing...
some loss of seagrass. It is not yet known whether
the loss is permanent or the habitat will regenerate.
The experience of the sediment plume serves as a
timely warning that threats can develop rapidly.

The marine habitats and their condition have
been mapped to some extent through work at the
Abrolhos, Jurien Bay and as part of environmental
approvals for development, but the extent and detail
of information is limited.

**Marine biodiversity**

Less information on the marine flora and fauna is
available for the inshore continental coastline than
for the Abrolhos. It is known that some of the most
extensive seagrass beds in the world occur inshore,
and macroalgae are also common (Walker and
Prince, 1987). There is a critical need for integrated
studies on the marine biodiversity of the inshore
NAR.

**Marine fauna**

At least 14 species of cetacean (six toothed and
eight baleen whales) and three species of turtles
have been reported from waters off the NAR (CALM
2003). Five of the whale species are listed under the
EPBC Act as rare or likely to become extinct. Other
specially protected species that can occur in the
region include several species of sharks, sygnathids
(seahorses and sea dragons), dolphins, dugongs
and turtles and seabirds.

The Abrolhos is a major nesting area for seabirds
of international significance, but populations are lower
than they were before European settlement. At least
15 species of seabirds breed on the islands of the
Jurien Bay Marine Park, including the Roseate tern,
whose numbers have increased considerably in
recent years (Gaughan et al. 2003). Australian sea-
lions (Neophoca cinerea) are also often-seen, with
some of the northernmost and important breeding
sites of the Australian sea-lion including North
Fisherman, Buller, East Beagle and the Abrolhos
Islands. Approximately 800-1000 occur on the west
coast (Gales et al. 1994) and this species is protected
under the Wildlife Conservation Act 1950.

More detailed lists of threatened species are available
in the supporting documentation: the Coastal and
Marine report, and the Biodiversity report.

**Abrolhos**

The marine environment of the Abrolhos is widely
regarded as being near pristine. There is good
information on the environmental impact of fisheries
operating in the vicinity of the Abrolhos, and
considerable information exists for the Western Rock
Lobster fishery. However, given the significance of the
Abrolhos, there is a need for further direct research.

The human population is small (about 900) and
occupation is limited to 22 islands during a season
of 3.5 months. Substantial parts of the islands,
including presently uninhabited islands, were
extensively disrupted by the guano industry. The
22 inhabited islands and parts of islands have been
extensively disturbed, with feral plants and animals a
significant issue on some islands. There is also debris
associated with the rock lobster industry, particularly
near inhabited islands. There is an absence of data
on the number of tourists visiting the islands and the
effects they have on the environment and no data on
the recreational finfish catch in the islands.

5.6.4 **THREATENING PROCESSES AND
MANAGEMENT RESPONSES**

**Information gaps**

Incomplete information exists on marine habitat
and species distribution, and structure of marine
communities. There is a need to integrate and
expand on the available information to better assess
the relative magnitude of threats.

**Current management response**

There is ongoing research funded through a variety
of sources and undertaken by state government
agencies (CALM, Department of Environment,
Department of Fisheries), educational institutions
(UWA, Murdoch, James Cook University, Curtin,
ECU) and other organisations (ROC Oil, Geraldton
Port Authority, AIMS, CSIRO).

**Land-based human impacts**

Threats to water quality include:

- Turbidity caused by: dredging and blasting for
  shipping channels and port development, oil
  and gas exploration, and seasonal discharges
  from rivers.
- Eutrophication due to: sewage, septic tanks,
  agricultural catchments, aquaculture feeding,
  rock lobster processing outfalls, and urban
  stormwater runoff.
Toxicant inputs: spills, hull antifouling of boats, pesticides and herbicides from agricultural catchments, urban stormwater, oil spills from shipping/petroleum production, and metals from historic mining activities.

Litter and waste: commercial and recreational boating, urban stormwater runoff.

Current management response
CALM has established a baseline for condition, and continues to monitor physical and chemical water quality in the Jurien Bay Marine Park. Limited studies of the marine environment have occurred in conjunction with development proposals: Landcorp at Oakajee, Ardross Estates at Jurien, the Marine Centre of Excellence in Geraldton, and Aquaculture at the Abrolhos. Water quality data has also been collected near settlements at Leeman, Lancelin and the Abrolhos.

Impacts of marine recreation and industries
Recreational activities such as boating, diving, island visitation and reef walking have potential to impact on the marine environment and biodiversity e.g. direct physical disturbance, pollutants/toxicants, and mooring and anchoring scouring habitat. Recreational usage of the NAR marine environment is likely to increase in the future. In addition, there are a number of current and future resource extraction and infrastructure projects which may negatively impact on the condition of the marine biodiversity asset. See the Fish Resources section of this strategy for further detail on impacts of fishing.

Current management response
Management plans have been developed for marine parks and marine protected areas by the Departments of Fisheries and Conservation and Land Management (see threats and responses in Table 14 for further detail). Educational programs addressing these impacts have been implemented by government agencies, non-government organisations and community/user groups. There are also broader initiatives such as the Interim Marine and Coastal Regionalisation for Australia (IMCRA, 1997) and bioregional marine planning process which will create a framework for improved management of the marine environment.

Threats to marine fauna
Marine mammals are protected, and whaling no longer occurs in Australia. The primary anthropogenic danger to whales is occasional entanglement in fishing gear or collisions with boats. Australian sea lions occasionally enter rock lobster pots and become trapped.

Habitat degradation, recreational activities and increased human presence can adversely impact on marine fauna; and island fauna (seabird breeding, sea lions colonies). Fishing may also pose a threat to some species (refer to Fishery Resources section). In addition, seabirds and marine fauna are at risk from shipping, and accidental oil spills associated with offshore petroleum exploration and production activities (CALM 2001, 2003). In general, threats are low in the NAR, but since population levels of some species are also low, any increase in threat can be significant.

Current management response
Development of by-catch reduction devices, and education programs delivered to users in conjunction with signage at sensitive sites play a key part in reducing impacts. Special protection has been given to a number of species in the region which have been assessed as being at risk. Table 14 of the Coastal and Marine technical report shows the conservation status of species listed by the Commonwealth or Western Australian governments. A separate management plan has been prepared for the islands off the West Midlands sub-region, which are host to a number of significant fauna (CALM 2003).

Threats to the Abrolhos
The major threats to the marine environment of the Abrolhos are largely those recorded previously for the continental coastline of the NAR (Coastal systems section of this strategy), albeit at a smaller scale due to the greater isolation of the islands and lower population pressure. Although, this pressure can be intense at certain locations in peak periods.
Table 14. Threat and current responses related to marine biodiversity.

<table>
<thead>
<tr>
<th>THREAT</th>
<th>RESPONSE</th>
</tr>
</thead>
</table>
| Accelerated change in the distribution and functioning of marine systems | • Jurien Bay Marine Park (CALM 2003) and consideration of other areas for other multiple use marine parks. There has been a commitment to a National Representative System of Marine Protected Areas, through the New Horizons Policy and Marine Parks and Reserves Selection Working Group Report (1994). See figure for the candidate areas in the NAR.  
• Fish Habitat Protection Areas in the Houtman Abrolhos Islands (Fisheries 1998, 2000, 2001), Lancelin Island Lagoon (Fisheries 2001) and one being considered for Kalbarri. See figure 9 for the FHPAs in the NAR. |
| Pollution, Toxicants and Debris                                         | • A recommendation to the International Maritime Organisation for the declaration of a Particularly Sensitive Sea Area (PSSA) is being developed, and covers part of the NAR.  
• Control of contamination entering the marine environment through the Western Australian Marine (Sea Dumping) Act 1981.  
• National Plan to Combat Marine Pollution of the Sea by Oil and other Noxious and Hazardous Substances.  
• Pollution of Waters by Oil and Noxious Substances Act 1987. |
| Direct disturbance to marine habitats                                   | • Assessment of developments that may have a significant impact on the environment in or adjacent to a marine park or other conservation estate.  
• Implementation of management plans for marine parks / protected areas (as above), with establishment of sanctuary zones within marine parks.  
• Several areas in the NAR are listed on the Register of the National Estate.  
• Draft Seagrass Habitat Protection Guidance – No 22 (Environmental Protection Authority, 1998) and Benthic Primary Producer Habitat Protection – No 29 (EPA, 2003). |
| Threats to marine fauna (including endangered species – see list included in strategy supporting documents on CD) | • Threatened Species Action, Recovery and Threat Abatement Plans under the EPBC Act 1999 e.g. Drafting of Threat Abatement Plan for Marine Debris.  
• The Wildlife Conservation Act 1950 provides legislative protection for flora and fauna.  
• Establishment of protected areas through the Conservation and Land Management Act 1984.  
• Many species of migratory seabirds are listed under an Australia-Japan agreement for the protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA) and a similar agreement with the government of China (CAMBA). |
| Commercial and Recreational Fishing                                     | • Assessment and management of fishing activities through the Fisheries Management Act 1991 and Fish Resources Management Act 1994.  
• Establishment of fully protected marine parks or sanctuary zones.  
• Most of the NAR (shallower than 200m) is permanently closed to trawling and vessels’ positions are remotely monitored.  
• Under the EPBC Act 1999 fisheries must demonstrate they are ecologically sustainable to be exempt from export controls. Almost all fisheries in WA have been assessed.  
• Marine Stewardship Council Certification of the Western Rock Lobster fishery.  
• SeaNet environmental extension service. |
Figure 8. Marine bioregions, boundaries and habitats of the Northern Agricultural Region.
Figure 9. Current and potential marine conservation tenure of the Northern Agricultural Region.

The report of the Marine Parks and Selection Working Group (CALM, 1994) identified a number of marine areas of the NAR as potential Marine Protected Areas. The State government’s implementation of the recommendations of this report has resulted in the creation of the Jurien Bay Marine Park. In addition, the Abrolhos have been declared a Fish Habitat Protection Area.
Figure 10. The Houtman Abrolhos Islands Fish Habitat Protection Area (state waters) with Reef Observation Areas (Marine Protected Areas) highlighted.
Current management response

Formation of Friends of the Abrolhos; funded projects to monitor impacts and educate visitors about the fragility of flora and fauna; projects to control weeds and rehabilitate vegetation; and development of sustainable tourism plans to guide commercial visitation.

Accelerated change in the distribution and functioning of marine systems due to Enhanced Greenhouse Effect

This is a long-term threat that affects marine systems as much as terrestrial systems, especially given potential impacts on the Leeuwin current and numbers of endemic species in this area of biogeographical overlap. Coral Bleaching is a threat associated with the Enhanced Greenhouse Effect, with at least one bleaching event having occurred at the Abrolhos. Coral bleaching occurs as the sea temperatures rise, this increases the stresses on coral populations and causes them to release the symbiotic algae from their tissues. The corals lose their colour and if the bleaching is minor the corals will recover, but in major bleaching events the corals will die. Macroalgae then replace the coral and the reef is lost.

Current management response

Impacts on biodiversity can be managed through other measures previously described which relate to ensuring that species and habitats are protected. Further detail on preventative responses to this problem are detailed in the ‘Air and Climate’ section.

STRATEGY RESPONSES TO ISSUES FACING MARINE BIODIVERSITY

Three Resource Condition Targets (RCTs) cover marine habitat (CM.R8 Marine Sea-bottom and CM.R12 Marine water; C.R16 Houtman Abrolhos Islands) and interact with marine biodiversity, but two are specifically focussed on biodiversity, and one on fish resources. All three were assessed to be Desirable but with a Variable Threat Risk.

A summary of these targets:

- **Management of marine biodiversity** (CM.R9: By 2015, marine biodiversity will be sustainably managed and programs in place to guard against the introduction of pest species; CM.R10: By 2015, marine fauna will be sustainably managed)

- **Sustainable management of fish resources** (CM.R11: By 2010, fish resources will be sustainably managed and programs in place to guard against the introduction of pest species.

For detail of these targets see page 135.
5.7 WATER - WATERSCAPES

Goal: To conserve, maintain and enhance the ecological processes and species richness of waterscapes, and minimise the impacts to water quality

5.7.1 WATERSCAPES: A DEFINITION

Waterscapes as an asset comprise all natural surface water resources, including rivers, streams, estuaries, river pools, floodplains, freshwater lakes, wetlands linked to streams and salt lake systems. Waterscapes have been further divided into waterways and wetlands for the purpose of the strategy.

5.7.2 VALUE OF WATERSCAPES

The majority of waterscape assets in the NAR have numerous values associated with them. These values have been grouped into three broad categories as outlined below:

Environmental

Uniqueness: some habitats and ecosystems are representative of environmental systems that are no longer widespread and are therefore unique. Ecological function: waterscapes have the ability to mitigate floods, increase water quality, cool the land and provide habitat for organisms. Biodiversity: waterscapes and the riparian zone host a variety of species and ecosystems that are essential to human health and survival. Other values include: provision of habitat, aesthetics, natural land drainage, flood protection, water quality and quantity and biological filtering.

Economic

Value of land: there is a potential for diversification into areas such as nature based tourism which in turn means an increase in the capital value of land. Water quality: a number of estuaries, permanent river pools and wetlands have high water quality and biodiversity values which give potential to aquaculture ventures and support inland fisheries. Other values include: recreation, flood protection and employment.

Social

Recreation and tourism: wetlands, rivers and the riparian zone are an important recreational resource for fishing, swimming, bird watching, boating and other pursuits. Spirituality and culture: wetlands, rivers and foreshores are often places of spiritual and cultural significance for both indigenous and non-indigenous communities. Other values include: education, aesthetics and landscape, experience of nature and lifestyle.

5.7.3 RESOURCE DESCRIPTION AND CONDITION

At the broadest level, the surface water resources of the NAR can be divided into two drainage divisions: the Indian Ocean Drainage Division, which covers the northern portion of the NAR, and the South West Drainage Division which covers the remainder. As illustrated by Figure 11, the Indian Ocean Drainage Division can be further subdivided into the Murchison and Greenough Drainage Basins, while the South West Drainage Division can be further subdivided into the Moore-Hill and Yarra Yarra Drainage Basins.

There are a number of waterways, wetlands and estuaries in the NAR with high environmental values. These waterscapes are biologically diverse, some containing species of rare flora, and are a significant habitat for migratory birds. Waterscapes of National, State and regional significance are illustrated in Table 15. This list is not comprehensive as a broad inventory of wetlands in the region has not been undertaken and it is likely there are more regionally or nationally significant wetlands that need to be evaluated.

Murchison Drainage Basin

The most prominent waterway in the Murchison Drainage Basin is the Murchison River. The lower reaches of the Murchison River have been listed on the Australian Nature Conservation Agency’s (ANCA) Directory of Important Wetlands, as the area has outstanding natural beauty and near pristine permanent river pools such as Bully Pool and Woonana Pool. Major tributaries are the Hope, Yalgar, Roderick and Sandford Rivers. The Murchison River gorge is the only known location of the primitive fern Psilotum nudum (Water and Rivers Commission, 2004).

The Murchison River enters the ocean at Gantheaume Bay and due to dredging at the mouth is permanently open to the ocean. Its estuarine reach varies between 12 to 20 kilometres, depending upon the weather, tides and streamflow.
Figure 11. Waterscapes and drainage basins in the Northern Agricultural Region of Western Australia.
**Greenough Drainage Basin**

*Waterways*

There are four prominent waterways in the Greenough Drainage Basin: the Chapman, Greenough, Irwin and Arrowsmith Rivers.

The Chapman River originates east of Yuna and drains the farming areas of the Chapman Valley. The river enters the ocean within the northern suburbs of Geraldton. The estuary is only open to the ocean during winter flows.

The Greenough River originates in the pastoral region north east of Mullewa, and flows through the farming areas of the Northern Perth Basin and Northampton Block to the Greenough Flats, featuring numerous pools including Eradu, Beetaljinna and Ellendale. The river enters the ocean at Cape Burney, south of Geraldton. The sandbar across the estuary is only opened by significant flows.

The Irwin River originates east of Mullewa, and has middle and lower reaches with perennial flow due to discharge from the groundwater systems. The river enters the ocean at Dongara and the mouth of the river is a coastal lagoon system, which is blocked by a sandbar for most of the year.

The Arrowsmith River commences near Arrino, north west of Three Springs. It has no clearly defined ocean outlet, and instead drains into a subterranean cave system. It is thought that the Arrowsmith was once a tributary of the Irwin River.

Other significant waterways include the Hutt, Bowes, Oakabella, Oakajee and Bulwer Rivers. The Hutt and Bowes Rivers drain the farming areas in and around the Waterloo Range. They have small estuaries, with average depths of less than 3 metres. They are only open to the ocean for a few days, mainly during the months of June and August.

<table>
<thead>
<tr>
<th>DIRECTORY OF IMPORTANT WETLANDS IN AUSTRALIA (DIWA)</th>
<th>WETLANDS OF SUBREGIONAL SIGNIFICANCE</th>
<th>AREAS RECOMMENDED FOR CONSERVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake Logue/Indoor System</td>
<td>Greenough River Pools</td>
<td>Conservation Area A – S; which includes the lower reaches of the Hill and Irwin Rivers, Minyulo Brook, Mullering Brook, Nambung River and associated damplands and sumplands, Munibinea Creek, Coomallo Brook, Cockleshell Gully and Boothendara Creek.</td>
</tr>
<tr>
<td>Guraga Lakes</td>
<td>Freshwater Springs in Northampton area</td>
<td></td>
</tr>
<tr>
<td>Karakin Lakes</td>
<td>White and Green Lakes</td>
<td></td>
</tr>
<tr>
<td>Lake Thetis</td>
<td>Saline lakes of Coolimba – Jurien</td>
<td></td>
</tr>
<tr>
<td>Murchison River (Lower Reaches)</td>
<td>Wetlands of the Swan Coastal Plain</td>
<td></td>
</tr>
<tr>
<td>Wannamal Lake System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chandala Swamp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hutt Lagoon System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lancelin Defence Training Area</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Environment Australia (2001)
2 Desmond and Chant (2003)
3 Department of Environment (2004)
4 V & C Semeniuk Research Group (1994)
Table 16. Geographic information for major waterscapes within the NAR.

<table>
<thead>
<tr>
<th>RIVER</th>
<th>LENGTH/ SIZE (KM)</th>
<th>CATCHMENT AREA (KM²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Murchison¹</td>
<td>300</td>
<td>14,850</td>
</tr>
<tr>
<td>Chapman</td>
<td>80</td>
<td>1,644</td>
</tr>
<tr>
<td>Greenough</td>
<td>306</td>
<td>12,568</td>
</tr>
<tr>
<td>Hutt</td>
<td>50</td>
<td>1,254</td>
</tr>
<tr>
<td>Bowes</td>
<td>50</td>
<td>715</td>
</tr>
<tr>
<td>Irwin</td>
<td>160</td>
<td>6,072</td>
</tr>
<tr>
<td>Arrowsmith</td>
<td>82</td>
<td>1,605</td>
</tr>
<tr>
<td>Hill</td>
<td>124</td>
<td>3,721</td>
</tr>
<tr>
<td>Moore</td>
<td>288</td>
<td>13,540</td>
</tr>
<tr>
<td>Gingin Brook</td>
<td>46</td>
<td>1,370</td>
</tr>
<tr>
<td>Yarra Yarra and Monger Lakes²</td>
<td>350</td>
<td>17,700</td>
</tr>
</tbody>
</table>

1 The NAR covers approximately 14% of the Murchison Drainage Basin. The Rangelands covers the remaining area. The overall length of the Murchison River is 450 km and the overall catchment area is 104,073 km².

2 The NAR covers approximately 42% of the Yarra Yarra Drainage Basin. The Avon Region covers the remaining area. The overall length of the Yarra Yarra and Monger Lakes system is 477 km² and the catchment area is 41,824 km².

Wetlands

The Hutt Lagoon System has been listed on the Department of Environment and Heritage (DEH) Directory of Important Wetlands as an excellent example of a coastal brine lake and is an important site for migratory waders. Research on commercial production of beta carotene in brine lakes has been conducted at Hutt Lagoon. Beta carotene is a natural food-colouring agent derived from the alga Dunaliella salina. Continuing on from this research, there is limited production of beta carotene continuing at a 50 ha complex of ponds (Department of Environment and Heritage, 2004).

Moore - Hill Drainage Basin

Waterways

Despite the Moore – Hill Drainage Basin covering more than 200 kilometres of coastline, only the Hill and Moore Rivers flow to the ocean. The lower reaches of both these rivers are also groundwater fed. The coastal strip of sand dunes and limestone, forms a barrier to other streams in the area, which terminate in small fresh or saline lakes and swamps, sometimes overflowing into caves. One of the more pristine waterways in the NAR is Cockleshell Gully, which drains one of the few remaining areas of the northern coastal scrub heath, north of Jurien. It does not reach the coast, instead draining into coastal lakes.

The Hill River originates east of Badgingarra and enters the ocean halfway between Cervantes and Jurien. The estuary is blocked by a sandbar for most of the year and the rivers major tributaries are the Munbinea, Coomallo, Boothendarra and Winjardie Creeks.

The Moore River is composed of two main branches which come together near Mogumber; the Moore River East, which originates near Dalwallinu, and the Moore River North which commences east of Coorow. The major tributaries are the Coonderoo River and Gingin Brook. The Moore River enters the ocean at Guilderton and the estuary is only open to the ocean for a few weeks each year.

Gingin Brook is a regionally significant waterscape as it is the only remaining freshwater creek passing over the Swan Coastal Plain and is in the Conservation
Reserves for Western Australia System 6 region (Department of Conservation and Environment, 1983). The brook has almost permanent flow since it is fed by springs as well as general groundwater, see page 68. As such, it is in high demand for water supply (Mayer, Muirden, Ruprecht and Bari, 2004).

**Wetlands**

Four wetlands in the basin have been listed on the DEH Directory of Wetlands. These include the Lake Logue-Indoon System, Karakin Lakes, Guraga Lake and Lake Thetis.

The Lake Logue-Indoon System consists of Lake Logue (a large historically fresh water lake which is now brackish), Lake Indoon (a smaller permanent historically fresh water lake which is now brackish) and smaller, ephemeral wetlands and intermittent creeks and drainage lines to the north and south of Lake Logue. The System acts as a major feeding stop-over, staging area for dispersal and a drought refuge for waterbirds (Department of Environment and Heritage, 2004). A population of the declared vulnerable plant Eremophila microtheca (Nv, Sr) occurs on seasonally waterlogged flats (Department of Environment and Heritage, 2004). The area was listed on the DEH directory because it is an example of a suite of seasonal wetlands.

Karakin Lakes are an example of a freshwater marsh dominated by low sedges and grasses while Guraga Lake is an example of a large brackish to saline lake. Both sites are major drought refuge area for waterbirds (Department of Environment and Heritage, 2004). Lake Thetis is distinguished by the presence of both a variety of benthic microbial communities (mats) and stromatolites. It is one of only a few lakes where submerged benthic microbial mats and developing microbial structures occur (Department of Environment and Heritage, 2004).

**Yarra Yarra Drainage Basin**

Yarra Yarra Lake is the terminal point for an extensive chain of salt lakes. The major lakes in the system include Nullewa Lake, Weelhamby Lake, Mongers Lake, Lake Goorly, Lake DeCourey and Lake Hillman. No detailed descriptions exist for these wetlands.

Due to the basin’s flat terrain, drainage is generally uncoordinated, with each lake having its own internal drainage system. However, in wet years the lakes overflow along a broad drainage line, ending up in Yarra Yarra Lake. It is uncertain if there is a surface or groundwater connection between Yarra Yarra Lake and the Coonderoo River, a tributary of the Moore River. Interestingly, it is believed that during the Eocene Epoch (40 million years ago) the system drained southwards, along the Darling Fault, to discharge through the Brockman River Valley.

**5.7.4 Threatening Processes and Management Responses**

There are a number of processes threatening the ecological integrity of waterscapes. Programs and projects designed to address these are at a local, regional, State and National scale. The following section provides an overview of the major threatening processes and some local and regional scale management responses. Table 19 outlines the State and National management responses.

It is important to note that limited data exists for the resource condition of waterscape assets and this gap in knowledge needs to be addressed before the impact and management of threatening processes can be monitored and evaluated. Foreshore assessment studies have been undertaken for a number of priority waterways however there has been little inventory or assessment work carried out for wetlands. Identification, classification and evaluation of the regions wetlands need to be carried out before a comprehensive priority list can

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**Table 17. Summary salinity statistics for gauged rivers in the NAR.**

<table>
<thead>
<tr>
<th>Waterway</th>
<th>Area (km²)</th>
<th>Clearing (%)</th>
<th>Salinity status</th>
<th>Salinity (mg/L)¹</th>
<th>O/I ratio ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moore River</td>
<td>9 602</td>
<td>60</td>
<td>Saline</td>
<td>7 200</td>
<td>18</td>
</tr>
<tr>
<td>Hill River</td>
<td>1 141</td>
<td>-</td>
<td>Brackish</td>
<td>1 800</td>
<td>0</td>
</tr>
<tr>
<td>Gingin Brook (1)</td>
<td>1 370</td>
<td>-</td>
<td>Slightly Brackish</td>
<td>800</td>
<td>2</td>
</tr>
<tr>
<td>Gingin Brook (2)</td>
<td>1 064</td>
<td>65</td>
<td>Fresh</td>
<td>440</td>
<td>6</td>
</tr>
<tr>
<td>Chapman River</td>
<td>1 579</td>
<td>65</td>
<td>Moderately Saline</td>
<td>3 000</td>
<td>5.2</td>
</tr>
<tr>
<td>Greenough River</td>
<td>11 732</td>
<td>50</td>
<td>Moderately Saline</td>
<td>3 800</td>
<td>2.4</td>
</tr>
<tr>
<td>Arrowsmith River</td>
<td>810</td>
<td>60</td>
<td>Moderately Saline</td>
<td>2 900</td>
<td>3.3</td>
</tr>
<tr>
<td>Irwin River</td>
<td>5 262</td>
<td>70</td>
<td>Moderately Saline</td>
<td>3 200</td>
<td>11</td>
</tr>
<tr>
<td>Murchison River</td>
<td>86 743</td>
<td>6</td>
<td>Brackish</td>
<td>1 200</td>
<td>1.8</td>
</tr>
</tbody>
</table>

¹ Salinity = Mean annual flow weighted salinity TDS mg/L. ² O/I = Mean annual O/I, where O/I denotes salt load export from catchment divided by salt input from rainfall.

(Source: Mayer, Muirden, Ruprecht and Bari, 2004).
be established (see ‘Prioritisation of Waterscapes page for more information).

Changes to hydrological regime

In the NAR, widespread clearing of remnant vegetation has led to excess water in the landscape, which has resulted in more runoff from catchment areas and greater recharge to groundwater systems. Runoff has also increased with the construction of drains, especially in the Moore-Hill and Yarra Yarra Drainage Basins. This excess runoff and rising groundwater has resulted in increased flooding of waterways and wetlands, and has contributed to the deterioration and death of associated riparian vegetation. For example, historical records indicate that prior to 1962 Lake Indoon was semi-permanent and usually dried completely by December each year. Clearing of the surrounding catchment has increased runoff and the lake has become permanent (Northern Agricultural Integrated Management Strategy Group, 2000).

Current management responses

A reduction in the peaks of surface water runoff from catchments is required to alleviate damage to waterscapes. In response, landholders in the NAR are managing livestock grazing to ensure adequate ground cover, farming on the contour, using no till cultivation and constructing grade banks to slow the flow of water down the catchment. Revegetation with native trees and shrubs is enabling excess water to be utilised, slowing the water hence reducing its erosive potential and peak flows, and regulating the amount entering wetlands. Specific projects addressing changes to hydrological regime include the Koojan/ Gillingarra Catchment Demonstration Initiative (CDI).

Salinity

Rising water tables, increased runoff and drainage of saline surface and groundwater has transported large amounts of salt into receiving waterways and wetlands in the NAR. Rising watertables and increasing groundwater discharge has also caused inundation and waterlogging of streamlines and valley floors. When the salinity levels within waterscapes start to rise, the riparian vegetation is replaced by more salt tolerant species and macroinvertebrate diversity is reduced.

Before native vegetation was cleared, it is believed that nearly all waterways in the NAR were fresh or marginal (NAIMS Situation Statement, 1999). Some waterways would have been marginal or brackish during low flow periods. Overflow from naturally saline wetlands may have increased stream salinity, however this would have been an uncommon event. Currently, the rivers of the Moore-Hill River Basin range from fresh to saline, the rivers of the Greenough River Basin are all moderately saline and the lower Murchison is brackish (see Table 17).

Current management responses

The mitigation of stream salinity requires action at the catchment scale. Funding through the State Salinity Action Plan has enabled vast areas of revegetation to control groundwater rise, fencing to exclude stock and rehabilitation of saline areas with salt tolerant natives. The targeted planting of recharge areas with perennial pastures and tree crops is enabling farmers to remain profitable whilst addressing the need for large scale perennial cover. Harvesting of water for on farm use is helping to reduce the amount of recharge whilst addressing issues of rural farm water supply. Drainage of saline groundwater is lowering groundwater levels across catchments however care needs to be taken to prevent increases in stream salinity. Specific projects addressing salinity include the Morawa and Pithara Engineering Evaluation Initiatives (EEI).

Erosion

As a result of widespread loss of riparian vegetation and increased runoff in the NAR, river channels have widened to adjust to the new amount of flow, and have often scoured and collapsed when increased runoff is combined with flooding events. The process has often lead to an oversized channel where there is little vegetation for bank protection and support (Muirden, Pen and Leybourne, 2003). In rural areas, domestic and feral animals are causing erosion even in uncleared catchments. Livestock graze and trample unprotected vegetation, often on the banks of streams where they gain access to water (Muirden, Pen and Leybourne, 2003). Along with livestock damage, the Hutt River has sections of banks which have been trampled and eroded by feral pigs.

Table 18 outlines the state of erosion for the Greenough, Chapman and Hutt Rivers, according to Foreshore Assessment projects that have been carried out by the Department of Environment. The waterways are categorised according to the percentage of the river that has stream banks in a very good to very poor condition.
Urbanisation is increasing the percentage of land surface that is impervious to infiltration by the construction of roofs, driveways, walkways and roads. Increases in impervious area lead to an increase in speed and volume of runoff which can affect the stability of riverbanks and the quality of water (Earth Tech Engineering Pty Ltd, 2002b). For example, surface runoff from roads in the Geraldton area entering the Chapman river has caused considerable head cutting and channel bank erosion (Muirden, Pen and Leybourne, 2003).

**Sedimentation**

The effects of sedimentation are widespread in the NAR. In particular, the Irwin, Chapman, Moore and Greenough rivers have extensive problems, as do the estuaries, which is a result of significant sediment inputs from the contributing rivers (Dept of Environment, pers. comm.).

Widespread clearing in the NAR has altered sediment regimes through the influx of fine silt and clay particles from soil erosion. Deposition of sediment from the channel or through broad catchment erosion has caused the filling of river pools, smothering of aquatic habitat, reduction of channel capacity and channel avulsions (a new channel breaking out adjacent to the old channel) (Muirden, Pen and Leybourne, 2003). Artificial drainage systems built throughout the region also contribute considerable quantities of sediment to waterscapes, as many of these structures are poorly maintained and erode rapidly (Muirden, Pen and Leybourne, 2003).

**Current management responses**

River restoration projects aimed at alleviating the extent of erosion and sedimentation involve stabilising banks with native trees and shrubs, fencing to exclude stock and realignment of large woody debris to improve flow. Management of feral animals, for example pigs and goats, is not widely undertaken but necessary to reduce damage, as is vigilant management of stock access to fragile banks. Foreshore assessments have been developed for the Chapman and Greenough Rivers and are being developed for the Hutt and Hill Rivers. These plans make management recommendations for restoration of these rivers. Long term management requires addressing the cause of the increased surface water runoff and this needs to be done on a catchment scale.

**Loss of riparian vegetation**

The ecological sustainability of waterscapes is largely dependent on the presence of healthy foreshore vegetation and sound water quality. Despite widespread clearing in the NAR, narrow bands of native vegetation still remain along major waterways, yet the extent of riparian vegetation surrounding wetlands is largely unknown. In most instances, however, this vegetation has been damaged by salinisation, waterlogging, grazing and trampling by domestic and feral animals and invasion by weeds, and is continuing to deteriorate. Stock access to rivers and streams is generally unrestricted and has resulted in severe loss of fringing vegetation with subsequent erosion and sedimentation.

The Hill River estuary has areas of high quality riparian vegetation and is the only near pristine estuary on the West Coast (NAIMS Draft Regional Strategy, 1999). There are also a large number of coastal wetlands with high biodiversity value such as the Hutt Lagoon System, Karakin and Guraga Lakes and the Lake Logue/Indoon System. However the majority of these lakes are experiencing extensive deterioration of fringing vegetation due to increasing salinity, waterlogging and nutrient enrichment.

Table 18 outlines the condition of riparian vegetation for the Greenough, Chapman and Hutt Rivers, according to Foreshore Assessment projects that have undertaken but necessary to reduce damage, as is vigilant management of stock access to fragile banks.

<table>
<thead>
<tr>
<th>BANK STABILITY</th>
<th>RIPARIAN VEGETATION CONDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition</td>
<td>Good (%)</td>
</tr>
<tr>
<td>Waterway</td>
<td></td>
</tr>
<tr>
<td>Greenough</td>
<td>18</td>
</tr>
<tr>
<td>Chapman</td>
<td>23</td>
</tr>
<tr>
<td>Hutt</td>
<td>16</td>
</tr>
</tbody>
</table>
been carried out by the Department of Environment. The waterways are categorised according to the percentage of the river that has riparian vegetation in a very good to very poor condition. The table shows that the condition of most of the riparian vegetation along these waterways is poor. Without healthy riparian vegetation communities, the waterscapes in the NAR are susceptible to erosion, nutrient enrichment, flooding and high sediment loads.

**Current management responses**

Current river and wetland restoration projects involve fencing and management of stock grazing, removal of invasive weeds and re-establishment of the riparian zone. Management of feral animals is required to reduce damage, as is broader scale sustainable management of livestock. As mentioned previously, foreshore assessments have been and continue to be developed for priority rivers in the region and these make management recommendations for improvement of riparian vegetation condition. Yet for any of these restoration projects to be viable requires addressing the threat of waterlogging, flooding, salinity, erosion and sedimentation, which needs to be done at a catchment scale.

**Contamination**

Major contributors to point source contamination entering waterscapes in the NAR include former mine sites, landfills and heavy industry. An old mine site at Galena is leaching heavy metals from tailings into a tributary of the Murchison River. Similar mine sites occur on tributaries of the Hutt, Greenough, Chapman and Bowes Rivers and moderate contamination of heavy metals has been recorded. Lead contamination from Nokenina Brook has also been recorded in the Bowes River. As estuaries within the NAR are popular recreation sites it is necessary that water quality does not drop below National Health and Medical Research Council Recreational Water Quality Guidelines.

Diffuse source contamination by herbicides and pesticides from agricultural land is another potential contributor, but is difficult to pinpoint and manage. Leakage from septic tanks, underground storage of petrol and accidental spills along haulage roads are other potential sources, as is contamination from acid sulphate soils and acid groundwater. There is limited understanding of the geochemical processes of acid generation within saline aquifers and of the environmental risks posed by acid discharge occurring via rising saline groundwater (see ‘acid groundwater’ and ‘acid sulphate soils’ under the Land Asset section page 29 for more information).

**Current management responses**

There is currently limited response to contamination in waterscapes due to a lack of baseline information restricting targeted management responses from being developed. Funding was obtained to contain the Galena mine site and prevent further contamination however no long term management or monitoring has been undertaken.

**Eutrophication**

Nutrients enter waterscapes either attached to soil particles or dissolved in water. A significant contribution to nutrient enrichment in the NAR results from animal waste and fertilisers. Point sources of nutrient enrichment arise from animal feedlots/ abattoirs and septic tanks. Eutrophication and resultant algal blooms can have an impact on aquatic flora and fauna through oxygen starvation and on vertebrate fauna through toxicity and the reduction in food resources.

Waterscapes throughout the NAR are routinely affected by eutrophication. Gingin Brook feeds very high levels of soluble phosphorus into the Moore estuary, causing regular summer macroalgae blooms. The Chapman estuary also has high nutrient levels and experiences a consistent algal bloom. Intermittent river flow mobilises large amounts of animal waste which results in offensive smelling algal blooms in river pools. Wetlands such as Lake Indoon are becoming increasingly eutrophic, as a result of increased runoff in the catchment transporting extra nutrients from farming areas.

**Current management responses**

While most landholders manage fertiliser application according to soil type, sandy soils are conducive to leaching which is a considerable problem in the Gingin horticultural area. Revegetation projects along waterscapes are assisting by taking up nutrients however there is rarely enough buffer zone to do this effectively. Nutrient load caused by livestock is being prevented where rivers are fenced, however the majority of channels are regularly used for stock resting.

**Flooding**

Flooding occurs when sufficiently heavy or prolonged rainfall produces run off which overflows the banks
Table 19. State and National responses to threatening processes affecting waterscapes.

<table>
<thead>
<tr>
<th>THREAT</th>
<th>RESPONSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changes to hydrological regime</td>
<td>• Draft State Floodplain Management Strategy (Department of Environment, 2002)</td>
</tr>
<tr>
<td>Flooding</td>
<td>• Manual for Managing Urban Stormwater Quality in Western Australia (Water and Rivers Commission, 1998)</td>
</tr>
<tr>
<td></td>
<td>• National Action Plan for Salinity and Water Quality</td>
</tr>
<tr>
<td></td>
<td>• National Dryland Salinity Program</td>
</tr>
<tr>
<td></td>
<td>• Natural Diversity Recovery Catchments Program (Department of Conservation and Land Management)</td>
</tr>
<tr>
<td></td>
<td>• State Salinity Action Plan (1996)</td>
</tr>
<tr>
<td></td>
<td>• State Salinity Strategy (2000)</td>
</tr>
<tr>
<td>Salinity</td>
<td>• A Guide to Managing and Restoring Wetlands in Western Australia (Department of Environment et al, still in development)</td>
</tr>
<tr>
<td></td>
<td>• Australia Wide Assessment of River Health</td>
</tr>
<tr>
<td></td>
<td>• Bilateral migratory bird agreements (JAMBA &amp; CAMBA)</td>
</tr>
<tr>
<td></td>
<td>• Conservation and Land Management Act (1984)</td>
</tr>
<tr>
<td></td>
<td>• Directory of Important Wetlands in Australia (DIWA)</td>
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<tr>
<td></td>
<td>• Environmental Protection (Swan Coastal Plain Lakes) Policy (Environmental Protection Authority, 1992)</td>
</tr>
<tr>
<td></td>
<td>• Draft Revised Environmental Protection (Swan Coastal Plain Wetlands) Policy and Regulations (Environmental Protection Authority, 2004)</td>
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<tr>
<td></td>
<td>• Draft State Biodiversity Conservation Strategy (still in development)</td>
</tr>
<tr>
<td></td>
<td>• Draft Statewide Waterways Management Framework (Department of Environment, still in development)</td>
</tr>
<tr>
<td></td>
<td>• Draft Statewide Waterways Management Policy and Strategy (Department of Environment, still in development)</td>
</tr>
<tr>
<td></td>
<td>• Environment Protection (Clearing of Native Vegetation) Regulations (2004)</td>
</tr>
<tr>
<td></td>
<td>• Environment Protection and Biodiversity Conservation Act (1999)</td>
</tr>
<tr>
<td></td>
<td>• Environmental Protection Act (1996) and Amendment Bill (2002)</td>
</tr>
<tr>
<td></td>
<td>• National Feral Animal Control Program</td>
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<td></td>
<td>• National Framework for Management and Monitoring of Australia’s Native Vegetation (2001)</td>
</tr>
<tr>
<td></td>
<td>• National Objectives and Targets for Biodiversity Conservation 2001-2005</td>
</tr>
<tr>
<td></td>
<td>• National River Health Program</td>
</tr>
<tr>
<td></td>
<td>• National Rivercare Program</td>
</tr>
<tr>
<td></td>
<td>• National Strategy for the Conservation of Australia’s Biological Diversity (1996)</td>
</tr>
<tr>
<td></td>
<td>• National Weed Strategy (1997)</td>
</tr>
<tr>
<td></td>
<td>• Natural Resource Management Ministerial Council (NRMMC)</td>
</tr>
<tr>
<td></td>
<td>• River Restoration Training and Demonstration Program (Department of Environment)</td>
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<tr>
<td></td>
<td>• Rivercare, Ribbons of Blue/ Waterwatch WA Programs (Department of Environment)</td>
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<tr>
<td></td>
<td>• State Weed Strategy (2001)</td>
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<td></td>
<td>• Wetlands and Waterbirds Taskforce (Government of Australia)</td>
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<td></td>
<td>• Wetlands Conservation Policy for Western Australia (1997)</td>
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<tr>
<td></td>
<td>• Wildlife Conservation Act (1950)</td>
</tr>
<tr>
<td>Loss of riparian vegetation</td>
<td>• Australian and New Z ealand Guidelines for Fresh and Marine Water Quality (2000)</td>
</tr>
<tr>
<td>Erosion and sedimentation</td>
<td>• Draft State Algal Management Strategy (still in development)</td>
</tr>
<tr>
<td></td>
<td>• National Water Quality Management Strategy (1992)</td>
</tr>
<tr>
<td>Loss of ecological integrity and habitat</td>
<td>• State Water Quality Management Strategy (2001)</td>
</tr>
<tr>
<td>Declining populations of aquatic biodiversity</td>
<td>• National Strategy for the Management of Coastal Acid Sulphate Soils (1999)</td>
</tr>
<tr>
<td>Contamination</td>
<td></td>
</tr>
<tr>
<td>Eutrophication</td>
<td></td>
</tr>
</tbody>
</table>
of the waterscape. Flood problems in the NAR arise where settlement has taken place in floodprone areas along rivers and coastlines, for example Moora and Dongara. Floodplains continue to be under pressure from more intensive uses despite the significant flood risk and this pressure is increasing as land becomes scarce. Severe floods do not happen frequently in the NAR, however when flooding does take place the resulting damage to property, infrastructure and land can be considerable. Known major flooding has occurred as per Table 20.

Current management responses

Table 20. Major flooding in rivers in the NAR.

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<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Murchison</td>
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<td></td>
</tr>
<tr>
<td>Moore</td>
<td>1995</td>
<td>1999</td>
<td></td>
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</tbody>
</table>

As a result of floodplain mapping undertaken in the Shires of Moora and Greenough, the Moora Floodplain Management Strategy (1999) has been produced and the Greenough strategy is still in production. Levee banks have been constructed at the Greenough Flats as a mitigation measure to reduce the frequency and impact of flooding, but it is the only structural mitigation measure used in the region. Flood forecasting and flood warnings are other measures used widely.

STRATEGY RESPONSES TO ISSUES FACING WATERSCAPE ASSETS

The strategy process identified 8 Resource Condition Targets (RCTs) and 50 Management Action Targets (MATs) associated with Waterscape assets, grouped into 5 categories: Surface Water Control; Surface Water Allocation; Waterscape Condition; Surface Water Quality; Water Quality; Aquatic Biodiversity; Ecological Integrity; Urban and Coastal Land.

Two waterscape RCTs were classified as “Essential” and “High Threat Risk”. For detail of the waterscape targets see page 130.

The two high priority areas are:

- **Surface Water Control** (WA.R1: A reduction in the peaks of surface water runoff from catchments by 2020);
- **Riparian Vegetation** (WA.R3: Increase the current extent and improve the condition of riparian vegetation along targeted sections of priority waterscapes by 2020, commencing immediately)

Other significant waterscape issues (High Threat Risk, and Important or Desirable):

- **Salinity levels of waterscapes** (WA.R4: Maintain current salinity levels in historically fresh and brackish priority waterscapes by 2020)
- **Surface water allocation** (WA.R2: Equitable allocation of surface water between social, environmental and economic requirements by 2020)
- **Ecological function** (WA.R7: Maintain or improve the ecological function of priority waterscapes by 2020)
5.8 WATER - GROUNDWATER

Goal: Water resources managed to facilitate regional development, enable sustainable allocation, and maintain environmental values

5.8.1 GROUNDWATER: A DEFINITION

Groundwater as an asset comprises all potable and industrial water supply and groundwater dependent ecosystems. Groundwater is generally readily available in a number of aquifers throughout most of the NAR, but the quality and quantity varies considerably.

5.8.2 VALUE OF GROUNDWATER

As with waterscapes, the values of groundwater have been grouped into three broad categories as outlined below:

Environmental

Ecological function: groundwater can maintain water levels or base flows in wetlands, lakes and perennial streams. Aesthetics: some groundwater areas contribute to the regional landscape, for example springs and cave lakes, and are therefore important to the aesthetic value of the area. Others include: water quality and intrinsic values.

Economic

Water supply: groundwater is readily available in a number of aquifers throughout the region, with much of it being of high potable quality. Potable water supply: the aquifer formations of the Perth Basin are a major water resource for the region, holding large quantities of high quality water. Industrial water supply: there are large provisions of groundwater in groundwater allocation areas for agricultural production (including horticulture, aquaculture) and mineral processing.

Social

Recreation and tourism: groundwater fed lakes and rivers, and the riparian zone, are an important recreational resource for fishing, swimming, bird watching, boating and other pursuits. Spirituality and culture: some groundwater fed wetlands, rivers, cave lakes and springs are places of spiritual and cultural significance for both indigenous and non-indigenous communities. Other values include: public health and amenity, provision for garden bores and education.

Figure 12. Groundwater usage in the NAR.

5.8.3 RESOURCE DESCRIPTION AND CONDITION

West of the Darling and Urella Faults in the Perth Basin, groundwater occurs in extensive multi-layered aquifers, which generally contain large supplies of potable water, with salinity increasing with depth and closeness to the coast. To the east of the Darling Fault and in the Northampton Block area, groundwater occurs in the superficial sediments of river valleys, fractures in the basement rocks and within the weathered profile of the basement rocks. The groundwater resources of the NAR are utilised in a variety of ways, including public drinking water, and supply for agriculture, horticulture, aquaculture and industry. The resources are important to many ecosystems and wetlands, which are hydraulically linked and dependent on water supply. Figure 12 illustrates the current (April 2004) allocation of groundwater in the NAR.

The NAR incorporates the Arrowsmith and Jurien Groundwater Areas, and portions of the Gingin and Gascoyne Groundwater Areas (see Figure 13). They are all Proclaimed Groundwater Areas under the Rights in Water and Irrigation Act (1914), and as such access and use of groundwater is subject to licensing through the Department of Environment. Provisions exist for the exemption of stock and domestic supplies from licensing requirements in
certain cases. Appendix XI outlines the allocation of groundwater from the Arrowsmith, Jurien and Gingin Groundwater Areas, as at April 2004. It is important to note the sustainable allocation limits set for all Groundwater Areas in the NAR do not take into account environmental and social requirements.

Following a review of the Arrowsmith and Gingin Groundwater Area Management Plans (1993) and the Jurien Groundwater Area Management Plan (1995), groundwater management is now carried out in accordance with the Interim Sub-regional Allocation Strategies for Gingin, Jurien and Arrowsmith (2002) until the Sub-regional Groundwater Management Plans are developed and implemented. The Gascoyne Groundwater Area does not currently have a management plan.

**Arrowsmith Groundwater Area**

The Arrowsmith Groundwater Area (AGA) spans 10,300 km² of land and has a total groundwater availability of 188 million m³/ year (see Appendix XI). Groundwater usage in the AGA is moderate, with 38% of resources currently allocated. The largest groundwater aquifers occur in the Yarragadee and Parmelia formations that together receive over 80% of the total direct rainfall recharge in the AGA. The Superficial formation is an important resource near the coast, although the quality and quantity of the groundwater is variable. The remaining formations have limited water supply potential due to factors including high groundwater salinity and relatively small area of the formation.

**Jurien Groundwater Area**

The Jurien Groundwater Area (JGA) spans 5,027 km² of land and has a total groundwater availability of 98 million m³/ year (see Appendix XI). Groundwater usage in the JGA is moderate, with 50% of resources allocated. The Yarragadee formation has the largest areal extent of any of the formations. There are also significant amounts of groundwater available in the Parmelia, Leederville, and Dandaragan Sandstone formations. The superficial formation and Lesueur Sandstone are important resources near the coast, although the quality and quantity of groundwater is variable. The groundwater supplies are limited in the Eneabba formation and Cattamarra Coal Measures (high salinity).

**Gingin Groundwater Area**

The Gingin Groundwater Area (GGA) spans 6,445 km² of land and has a total groundwater availability of 222 million m³/ year (see Appendix XI). Usage in the area is high, with 71% of resources allocated. The aquifers containing the largest volumes of accessible groundwater are found within the Superficial, Leederville, Leederville-Parmelia and Yarragadee formations. Groundwater is generally fresh except in most aquifers along the Darling Scarp in the east, and in the Yarragadee aquifer in the coastal area south of Lancelin.

**Gascoyne Groundwater Area**

The Gascoyne Groundwater Area (GaGA) extends north to Kalbarri and bounds the Arrowsmith Groundwater Area east to pastoral country. The total groundwater availability is currently unknown as the Department of Environment is reassessing sustainable yields based upon geologic units of the area. The largest groundwater aquifer occurs in the Yarragadee Formation, which has an estimated yield of 22.5 million m³/year. For the fractured rock aquifers of the Northampton Block and Yilgarn Area, sustainable limits are difficult to quantify and are generally based on pump tests.

### 5.8.4 THREATENING PROCESSES AND MANAGEMENT RESPONSES

There are a number of processes threatening the quality and quantity of groundwater resources in the NAR. Programs and projects designed to address these are at a local, regional, State and National scale. The following section provides an overview of the major threatening processes and some local, regional scale management responses. Table 21 outlines the State and National management responses.

**Groundwater overuse**

Groundwater licenses in the NAR are issued under Part III of the Rights in Water and Irrigation Act (1914), in accordance with Department of Environment policy which is to license water use up to sustainable limits only where there is an immediate need and efficient water use can be demonstrated (Water and Rivers Commission, 2002a).

Overall allocation of groundwater in the NAR is within allocation limits, however the groundwater
resources in some sub areas are either fully allocated, approaching full allocation, or the demand exceeds supply. For example, the Mirrabooka aquifer in the Gingin Groundwater Area has 261 390 m³ of groundwater allocated over the allocation limit while the Leederville aquifer has 1 391 450 m³ over allocated (data obtained 21st April 2004). Over abstraction can affect groundwater dependent ecosystems, groundwater quality, and the future supply of potable and industrial water in the region, primarily through deeper saline water rising and replacing the fresher water and reduction of water available to waterscapes.

The NAR public water supply demand for groundwater will be substantially increased in the future due to population increase, and industrial, horticultural and mining land uses are also predicted to rise. Determination of Environmental Water Requirements (EWRs), Ecological Water Provisions (EWPs) and Social Water Requirements (SWRs) is critical to ensure both community development and asset protection.

### Current management responses

The Department of Environment operates a comprehensive system of water allocation planning and licensing of water use. Allocation plans are prepared, in consultation with the community and key stakeholder groups, at a range of scales and to different degrees of detail. The Gingin-Dandaragan Water Resource Management Committee is one such community based committee that provides advice to the Department of Environment on the sustainable and equitable allocation of groundwater in the Gingin and Jurien groundwater areas. The allocation plans range from regional scale plans that can include several river basins or geological provinces, to plans that cover individual surface water or groundwater management areas. Allocation plans identify the water resources and water regimes to be protected and define the water use licensing policy for the area of application of the plan.

Yet despite the depth of allocation planning, some aquifers in the NAR remain over allocated. Sub-regional Groundwater Management Plans are being devised for all groundwater areas in the NAR. These management plans will update current sustainable limits, and hopefully address any over allocation issues. Hydrogeological studies are being carried out to investigate the groundwater potential of the NAR, and potentially discover new resources for allocation.

### Reduced groundwater availability to waterscapes

Prior to 2002, groundwater allocation limits did not take into account the water requirements of dependent ecosystems (including wetlands, river pools, cave lakes and riparian and terrestrial vegetation) or social water requirements. Groundwater fed pools on Moore and Hill Rivers are drying out, with loss of aquatic fauna that repopulate the river during flow.

In response, future allocation limits under the Sub Regional Allocation Management Plans for the Arrowsmith Jurien and Gingin Groundwater Areas will take into account the EWRs for groundwater dependent ecosystems as well as long term economic sustainability of the region (Water and Rivers Commission, 2002a). Currently, the Interim Allocation Plans have interim EWRs set at 20% of rainfall recharge.

### Current management responses

To date there are no ecosystem EWRs or SWPs determined in the region, however the Department of Environment is currently undertaking an EWR/SWR project on the Moore River and Gingin Brook and an EWR project on the Hill River. As discussed, the Sub-regional Groundwater Management Plans will take into account the environmental water requirements of groundwater dependent ecosystems and this will ensure Sustainable Limits take into account more than just economic water requirements.

### Increased demand for water in rural areas

The sustainability of primary industry relies heavily on the supply of quality groundwater, and the demand for water resources is increasing. Threats such as climatic change, increasing salinity, reduced tillage in cropping programs, and replanting of arable land to tree crops are ensuring the rural hydrogeological environment is not only changing from year to year, but changing permanently (Department of Environment, 2004). These factors affect the amount and quality of surface run-off, and the depth and quality of groundwater. The impact is not only on the viability of existing on-farm and station water supplies, but also on the potential for new on-farm and station supplies. The management of these issues requires close liaison between the various stakeholders in rural water supply matters.

### Current management responses

A network of strategic public water supply facilities exists throughout most of the NAR and it is anticipated that those supply points will be
Figure 13. Groundwater Areas of the Northern Agricultural Region.
maintained to provide emergency sources of water which can be accessed by farmers in times of on-farm water deficiency. In addition to the strategic public supplies, there are many more non-strategic agricultural area (AA) dams and tanks which are now surplus to requirements. A process is underway to rationalise the AA dams network and arrange for disposal of surplus supplies.

Yet despite these reserves there are still isolated pockets in NAR where there are water shortages for stock and domestic purposes which require improvement in infrastructure for water security.

**Salinity**

Groundwater salinity varies between different aquifers, and to date it has not significantly impacted on water supplies. Future salinity threats are liable to arise from over-pumping of groundwater causing deeper saline water to be drawn up and contaminating the previously fresh aquifer. Excessive abstraction may also cause decreasing groundwater through-flow, resulting in the saltwater interface from the coast moving into and displacing the potable aquifer. On the Moore River there is evidence that upstream saline water is recharging previously fresh water near Karakin Lakes (Stelfox, 2001). Groundwater resources are also at risk from rising saline groundwater and associated acid groundwater. Further research is required as there is currently limited understanding of the geochemical processes of acid generation within saline aquifers and of the threat to groundwater resources from rising water tables (see ‘acid groundwater’ and ‘acid sulphate soils’ under the Land Asset section p29 for more information).

**Current management responses**

Water level monitoring in groundwater areas is currently undertaken by the Department of Environment, yet there is limited water quality monitoring. Management responses are currently limited to specific licensed premises that are required to carry out monitoring and management of salinity. The future threat of primary and secondary salinity has been acknowledged by the Department of Environment and management responses need to be devised.

**Contamination**

As the NAR relies on quality groundwater for drinking water supply, the protection of Drinking Water Supply Areas from inappropriate landuse and recreational activities is imperative. Major contributors to point source contamination of groundwater resources in the NAR arise from former mine sites, landfill and heavy industry. The Department of Environment has a comprehensive licensing system to control pollution from prescribed premises. Industries are categorised and licensed, and work approvals or registrations are issued according to the design capacity. As the principle supplier of groundwater in the region, the Water Corporation monitors all its water supplies and ensures uncontaminated water is available to residential and industrial clients.

Diffuse source contamination by herbicides, fertilisers and pesticides from agricultural land is another potential contributor, but is difficult to pinpoint and manage. Monitoring by the Department of Agriculture has shown moderate levels of atrazine in the groundwater in some parts of the region, presumably from agricultural applications. The implications are currently unknown and require further research.

**Current management responses**

The Department of Environment is primarily responsible for defining, proclaiming and protecting the catchments of Public Drinking Water Source Areas (PDWSAs). Water Source Protection Plans have been devised for all water reserves in the NAR, and these plans identify sources of contamination that should be investigated and set out programs for management of the resource. For all water supply areas that fall outside PDWSAs, there is currently limited response to contamination due to a lack of baseline information restricting targeted management responses from being developed.

**Climate change**

Climate change may pose a future risk to water supply in the NAR, but predicting the degree of impact is made difficult by long response times and large uncertainties. Groundwater allocation limits have been calculated using current climate knowledge, but it is acknowledged that a long term shift to drier years may affect recharge characteristics and ultimately reduce availability of water. This in turn could result in a reduction of the allocation limits, which may require a corresponding reduction in water entitlements and water use. Conversely, a shift to wetter years could have the opposite effect. Response times to climate change would be greater for confined aquifer systems. Whilst there is no solid evidence of an immediate threat from climate change, the enhanced greenhouse effect is forecast to cause
reduced rainfall levels for the NAR in the future. All waters users need to be aware that climate change may impact on the way water is allocated and used in the future.

Table 21. State and National responses to threatening processes affecting groundwater.

<table>
<thead>
<tr>
<th>THREAT</th>
<th>RESPONSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced groundwater availability to waterscapes</td>
<td>- Country Areas Water Supply Act (1947)</td>
</tr>
<tr>
<td></td>
<td>- Environment Flows Initiative</td>
</tr>
<tr>
<td></td>
<td>- Environment Protection and Biodiversity Conservation Act (1999)</td>
</tr>
<tr>
<td></td>
<td>- Environmental Water Provisions Policy for Western Australia (2000)</td>
</tr>
<tr>
<td></td>
<td>- Farm Water Grants Scheme</td>
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<tr>
<td></td>
<td>- Rights in Water and Irrigation Act (1914)</td>
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<tr>
<td></td>
<td>- State Rural Farm Water Plan (2004)</td>
</tr>
<tr>
<td></td>
<td>- Water Reform Framework (Council of Australian Governments, 1994)</td>
</tr>
<tr>
<td></td>
<td>- Western Australian State Sustainability Strategy (Government of Western Australia, 2003)</td>
</tr>
<tr>
<td>Salinity</td>
<td>- National Action Plan for Salinity and Water Quality</td>
</tr>
<tr>
<td></td>
<td>- State Salinity Strategy (2000)</td>
</tr>
<tr>
<td>Contamination</td>
<td>- Drinking Water Source Protection Plans (Department of Environment)</td>
</tr>
<tr>
<td></td>
<td>- State Water Quality Management Strategy (2001)</td>
</tr>
</tbody>
</table>

**STRATEGY RESPONSES TO ISSUES FACING GROUNDWATER ASSETS**

In relation to Groundwater assets, the strategy process identified 4 Resource Condition Targets (RCTs) and 15 Management Action Targets (MATs) grouped into 3 categories: Allocation, Supply and Quality.

Two RCTs related to groundwater allocation were classified as “High Threat Risk”, one of them, Equitable Allocation, was deemed to be “Essential”. Groundwater quality was assessed to be “Important” with the threat risk variable depending on the particular pressure. For detail of the groundwater targets see page 130.

The highest priority groundwater issues are:

- **Groundwater allocation** (WA.R11: Sustainable Use of groundwater resources between economic, environmental and social requirements by 2020; WA.R12: Progressive increase in water use efficiency practises by users of allocated water by 2020)
- **Groundwater quality** (WA.R14: Maintain current water quality in groundwater supply areas within National Water Quality Management Strategy guidelines by 2015)
5.9 COASTAL & MARINE - COASTAL SYSTEMS

Goal: To maintain and rehabilitate coastal and marine natural systems to optimise social, environmental and economic benefits.

5.9.1 DEFINITION

The coastal systems described in this section include: estuaries, dunes and cliffs, nearshore sand movement and coastal biodiversity. The coastal zone of the NAR can be broadly visualised as the area between the low water mark on the beaches and the highway running parallel to the coast.

5.9.2 RESOURCE DESCRIPTION

Coastal and Marine assets, are dealt with in several places throughout the strategy e.g. marine biodiversity and the Houtman Abrolhos Islands are dealt with under Biodiversity, and some aspects of coastal biodiversity are included in Terrestrial Biodiversity. The fish resources asset is covered in the next section.

Geomorphology

The NAR has approximately 400km of coastline, and includes the “Central Coast” from Guilderton to Dongara and the “Batavia Coast” from Dongara north to Kalbarri. The coast in the NAR is defined as the narrow strip of mainly sandy deposits of Holocene age along the coast, varying in width between one and 10 km, with most areas being about 5 km.

The coastline has a generally-linear north-south alignment, consisting of curved beaches backed by low dunes, with intervening sand promontories or points, rock headlands, and low to high cliffs. The sandy deposits are generally underlain by a limestone platform, and have variously formed dune fields, sandy plains, and mobile sand sheets (e.g. mobile parabolic dunes in Greenough and north of Lancelin). There are several exceptions to these sandy landforms. North of Horrocks Beach, a dissected sandstone/limestone plateau lies close to the coast forming high cliffs towards Kalbarri. In the vicinity of Cliff Head south of Dongara, an escarpment of Tamala limestone rises directly behind the beach and forms headlands between the bays and contains cave systems. In some places, such as in the Greenough River, and near Port Gregory, the barrier imposed by dune fields have caused the formation of elongate alluvial floodplains, seasonal wetlands and lagoons.

In the nearshore zone, longshore sediment transport is an important process for the movement of sand on beaches in the region. During storm events, the steep waves and high water levels cause sand to be rapidly eroded from the beach and carried offshore. In more severe storms, the vegetation line may retreat 5 to 10 m and 20 to 50 m in very extreme storms. As the weather shifts into a summer pattern, the beach profiles are generally restored through accretion of sand stored offshore.

There are many relatively unspoilt beaches, dune systems, and impressive coastal cliffs. However, human pressures on the coast are increasing and degradation of these areas is emerging as a major issue. The attractions of the coastal and marine environments are driving resident population growth, and increased visitation for tourism and recreation. The consequence of this rapidly increasing use is the potential for further damage to natural resources and deterioration in environmental, social and economic values. Recognition of these trends for the coastal lands has been an important driver for the large number of studies, strategies and plans that have the general aim of ensuring sustainable use and management of these important assets.

Islands

The coast of the NAR is taken to include the offshore islands, but not the Abrolhos Islands. There is a series of 38 medium-sized, offshore limestone islands with varied geomorphology that are surrounded by intertidal rock platforms. The islands are grouped into 12 nature reserves managed by CALM to conserve their: conservation, recreational, commercial,
educational and cultural, and research values. The islands are host to a number of endangered fauna and are important examples of island habitats within the Central West Coast marine bio-region (CALM, 2004).

Coastal biodiversity

Further detail on coastal terrestrial biodiversity can be found in the Terrestrial Biodiversity section of this strategy.

The coastal area of the NAR includes three areas that correspond to the biogeographic sub-regions. The characteristics of these sub-regions are presented in Table 22. This table and description of the assets, threats and responses divides the NAR coastline into the Central and Batavia Coasts. These roughly correspond to the NACC sub-regions of the West Midlands (Central Coast) and Greenough (Batavia Coast).

Batavia Coast: The whole Batavia Coast area lies within the South West Botanical Province, within the Geraldton Hills Biogeographic Sub-Region. The coastal foredune vegetation includes grasses and shrubs (*Spinifex longifolius*, *Olearia axillaris*, *Aristida isotidea* and *Scaevola crassifolia*). Areas with sand over sallow rock support quite dense acacia and banksia tall shrubland, with the distinctive smelling *Acacia rostellifera* and *Melaleuca cardiophylla* forming thickets on limestone ridges. Further inland the array of low and tall shrubs increases, with eucalypts and acacias prominent. Further north, a CALM survey recorded 1,071 plant taxa in Kalbarri National Park, including over 200 range limited species (NACC 2002a). Twenty-one plant species are endemic to the Kalbarri National Park, mainly in the coastal cliff tops and gorge country. natural value and are important socially, culturally and economically.

Central Coast: The whole Central Coast area lies within the South West Botanical Province, within the Leseur Sandplains (GS3) and Perth (SWA2) biogeographic sub-regions. In the Quindalup dunes, which occur from the southern extremity of the region north to Green Head, there are three plant communities from the beachfront, moving inland. They are: pioneering plants on the beach and foredunes, clumped low shrubland in the swales and secondary dunes, and dense, tall shrubland further inland. The coastal wetlands and limestone areas support their own distinct vegetation communities. The coastal areas between Lancelin and Guilderton, and between Cliff Head and Illawong are an important area for limestone endemics.

The coastal lands are important for the conservation

Table 22. Biogeographic Regionalisation along the coastline.

<table>
<thead>
<tr>
<th>COASTAL AREA</th>
<th>BIOGEOGRAPHIC SUB-REGION</th>
<th>PHYSICAL RESOURCES</th>
<th>BIOLOGICAL RESOURCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>The ‘Batavia Coast’ - Dongara to Kalbarri</td>
<td>Geraldton Hills (GS2)</td>
<td>Limestone plateaux and sandplains, dissected streams</td>
<td>Low and tall shrublands of acacia and banksia in coastal areas and on deep sands, woodlands along streamlines</td>
</tr>
<tr>
<td>The ‘Central Coast’ - Leeman to Dongara</td>
<td>Leseur Sandplains (GS3)</td>
<td>Limesand dunes, sandy plains, wetlands and coastal dune fields</td>
<td>Low shrublands on deep sands, with acacia and eucalypt tall shrublands on soils over limestone</td>
</tr>
<tr>
<td>The ‘Central Coast’ - Guilderton to Leeman</td>
<td>Perth (SWA2)</td>
<td>Sandplains and dunes of varying age</td>
<td>Eucalypt woodland on younger dunes over limestone, acacia and banksia shrublands on deep grey and white sands</td>
</tr>
</tbody>
</table>
of heath-dwelling mammals, including dibblers and dunnarts. The Central Coast is rich in bird species, with 17 species of seabirds, plus seven other aquatic and terrestrial species. The heathlands are important as habitat for fairy-wrens and honeyeaters, and saltlakes and wetlands support waders and ducks. Reptilian fauna is rich.

The Mt Lesueur/Eneabba/Badgingarra (northern sandplain) area is renowned as one of three major areas of species richness in WA. Botanical studies have recorded almost 2,000 plant taxa of which about 20% are either geographically restricted or rare (Griffin 1994). The Lesueur National Park, east of Jurien Bay, has exceptionally diverse flora: more than 820 species including many plants found nowhere else in the world, and represents 10 per cent of the State’s known flora and a third of the taxa in the Irwin Botanical District (NACC 2002a). At least 124 bird species also rely on this flora, and the area is critically important to the survival of hole-nesting species such as Carnaby’s black-cockatoo.

Estuaries

Estuaries are defined as semi-enclosed coastal water bodies that represent the mixing zone between marine-derived saltwater and terrestrially derived freshwater. Tides, wind, waves and river flows are important physical processes that influence variations in estuary shape and ecology. Estuaries are often host to large amounts and a wide variety of plants, birds, crustacea and fish: fish production per unit area is probably higher than in any other natural water bodies.

The NAR estuaries tend to be small (a few km in length) with low and seasonal rainfall in the catchments combining with the wave-dominated coast causing the mouths to be blocked by sandbars most of the year. Though tides continue to influence circulation when the bars are closed, limited exchange between estuaries and the open ocean means they are vulnerable to water quality impacts associated with increased nutrient, toxicant and sediment loads from the catchments.

Drawing on studies of the Moore, estuarine biodiversity is high: twenty-five species of fish are known to occur in the estuary and there are about 14 freshwater species in the Moore River and Gingin Brook (Siemon 2000). Relatively little is known about most of these estuaries, though the Moore is under significant pressure, and has therefore received a relatively large amount of research and management attention. Estuaries in the region are also significant for their social (e.g. recreation and Aboriginal heritage) and economic values.

Landscapes and Seascapes

The coastal region of the NAR is characterised by vistas of cliffs, bays, lagoons, islands, reefs, beaches and the open sea. These are major aesthetic values of the region. These attributes can be appreciated from the shore, from boats from high vantage points, and lookout points along coastal roads or designated viewing areas, and the hinterlands where broader panoramic views can be enjoyed. The popularity of both natural and artificial lookouts with local residents and visitors alike indicates that the land and seascapes over the region are a prized natural value and are important socially, culturally and economically.

In addition, submerged seascapes are a key asset in the NAR. The Houtman Abrolhos in particular, has a unique mixture of tropical, temperate and Western Australian endemic species. The abundance of coral, macroalgae, invertebrates and fish provide a spectacular setting for diving and snorkeling. Along the continental coastline (e.g. Jurien Bay Marine Park, subtidal reefs, limestone drop-offs, macroalgae and seagrass beds in sandy areas also provide outstanding submerged seascapes. Wreck diving is popular, and dive trails are being set up in some areas (Jurien Bay and Abrolhos) to highlight local features.

Aboriginal links with the coast

There is evidence of Noongar and Yamaji people occupying various parts of the coast for extensive periods of time. Stone artefacts have been found in caves in the Jurien Bay region, and the area between Greenhead and Jurien Bay has the largest number of midden deposits in the south-west of Western Australia. Coastal dunes throughout the region were also used as burial sites, and skeletal remains have been exposed by dune blowouts. The mouths of rivers and estuaries tend to be particularly significant, especially Bowes River. Changes in tenure, management and development in the coastal zone should protect the environmental, cultural, spiritual and historic values of these areas.

5.9.3 RESOURCE CONDITION

Geomorphology

A good proportion of the coast, especially between
Lancelin and Dongara, is contained in Nature Reserves and National Parks and managed in accordance with current management plans by CALM. Other areas are managed by Local Government, a mix of organisations (e.g. Unallocated Crown Land - UCL), or by private landowners. The actual on-ground management of coastal areas ranges from excellent (e.g. CALM and some LGAs) to poor/none (e.g. some UCL, local government and private land).

Because of the inherent infertility and instability of the sandy soils, little coastal land was ever cleared for agriculture. However, where these areas have been heavily used for access to beaches or rocky headlands, or for building beachfront holiday shacks, accelerated erosion is evident in the sandy soils. In some cases, the erosive forces have led to dune blowouts. Harder surfaces (limestone and sandstone) are less affected by traffic and human settlements, but vegetation loss and physical damage to cliffs is evident.

Areas of high activity (nodes) along the NAR coast have been heavily affected by increased use of 4WD vehicles on the foredunes and beaches. The most severely disturbed areas are adjacent to towns, but accessing of more remote surfing, fishing and camping spots along the coast has caused significant degradation.

Areas of the coast such as Seabird and Horrocks are experiencing shoreline retreat due to natural causes. Other foreshore areas, such as the northern beaches of Geraldton, are experiencing significant change in the shoreline that is at least partially attributable to construction of coastal infrastructure. Changes to climate and sea level are predicted to accelerate coastal erosion throughout the region.

Batavia Coast: The condition of the coast in this sub-region varies from fair in areas with limited human access to poor in areas that is subject to heavy, poorly managed human use. The latter areas include parts of the coast immediately north and south of Geraldton, and near Port Gregory, Halfway Bay, Horrocks Beach (Bowes), Coronation Beach, Greenough River (Cape Burney) and around Dongara.

Central Coast: Around the major formalised settlements (e.g. Jurien, Cervantes, Leeman) and the minor informal squatter settlements (e.g. Cliff Head, Little Mexico), inappropriate siting of infrastructure, uncontrolled vehicular traffic, camping and pedestrian use has degraded soils and vegetation. Overall, condition of the coastal lands in this sub-region is fair to very good (e.g. in areas that are actively managed to reduce human impacts). However, condition is fair to poor in areas that have experienced land use change, and increased human use.

Islands

Given their Nature Reserve Status and management by CALM, the islands are generally in good condition. There are several sites that are highly disturbed (e.g. Wedge Island) resulting in degradation of vegetation and geomorphology, introduction of weeds and reduction in landscape amenity (CALM, 2001). The islands are a fragile, valuable natural asset and will require strong management measures to limit the impacts from increasing visitor pressure.

Biodiversity: flora and fauna

Much of this condition is the same as for the description of the condition of coastal geomorphology, with vegetation degraded and fragmented whenever substrates are disturbed.

Land use change, recreational use and introduced flora and fauna have been the major contributors to current condition of coastal biodiversity. As a consequence of human-borne introductions and site disturbance, some areas now support a large number of exotic plant species. Weed species of note include African boxthorn (Lycium ferocissium), wild oats (Avena fatua), wild radish (Raphanus raphanistrum), and Geraldton carnation weed (Euphorbia terracina). Areas also support feral animals including rabbits, cats, foxes, small rodents and pigs and goats. These impose pressure on habitat for native fauna, and feral grazing reduces the health and density of the native flora.

Vegetation loss has not only occurred on dunes, but also on some areas of limestone and sandstone. Evidence of other contributors to degradation of vegetation include: uncontrolled traffic, illegal waste disposal, fire (Lancelin, Cervantes), illegal residency, resource exploration south of Dongara, and firewood poaching.

Localised fauna, localised surveys have shown that native mammals are rare, and in the case of the echidna, declining. The principal cause is likely to be loss of habitat due to land use change, site disturbance and inappropriate fire regimes. The populations of coastal mammals (e.g. dibblers and
dunnarts) are being impacted by feral predation (foxes and cats) and loss of habitat due to grazing by rabbits. Reptilian fauna are more common and this section of the coast is an important transition zone with species of geckos, lizards and skinks common to the south west of the State close to the northern limits of their distribution, and species from the arid areas to the north reaching their southern limit.

**Estuaries**

Estuaries form at the mouth of the following rivers: a descriptor of the condition of their catchments is included in brackets (Oz Estuaries; Mel Clinch pers. comm.):

- Moore (Extensively modified)
- Hill (Modified),
- Irwin (Extensively modified),
- Greenough (Extensively modified),
- Chapman (Extensively modified),
- Oakajee (Modified),
- Bowes (Modified),
- Hutt (Modified),
- Murchison River (Modified).

The condition of the immediate environment of the estuaries varies: Moore’s south bank is undisturbed, the Hill’s lower reaches have minor disturbance, with other estuaries (Greenough, Irwin, Chapman) having lost riparian vegetation and ecological function as a consequence of recreational, agricultural and urban use.

Investigations of the Moore River Estuary by the Water and Rivers Commission (1999 to 2002) is the only program that has contributed useful water quality information. Monitoring of water quality in the Moore River, showed highly elevated levels of Phosphorous and Nitrogen. Groundwater also contributes to maintenance of the estuarine environments, and monitoring of areas interfacing with the Moore also show human impacts.

The Waters and Rivers Commission (now the Department of Environment) has prepared Water Resource Management Reports for the Chapman and Greenough Rivers. The key findings of both the Chapman River and Greenough River studies was that the Rivers’ health ranged from Very Poor to Very Good. The very poor rating related to poor bank stability, loss of native vegetation, lack of stream cover, reduced habitat diversity, and difficulties associated with managing stock access (Waters and River Commission 2001a, 2001b).

**Landscapes/Seascapes**

As a general rule the quality of regional land and seascapes remains high, as there are relatively few sites of human development that negatively distract from the natural values. Unplanned tracks and roads, vegetation damage and associated sand drifts, illegal camping sites, squatter shacks, solid waste on beaches and dunes has compromised the aesthetic value of otherwise undeveloped areas. Beacons and other man made objects on prominent locations, such as headlands, may also affect aesthetic values. Beaches congested with 4WD vehicles are, to some people, a visual impact.

There has been some impact on seascapes at the Abrolhos due to aquaculture operations. Impacts on land and seascapes are often incremental, and without any systematic means of assessing their condition can quickly become degraded.

**5.9.4 THREATENING PROCESSES AND MANAGEMENT RESPONSES**

**Threats to nearshore and estuarine environments**

Identification of threats overlap with those described in the Marine Biodiversity; p49. Threats to estuarine water quality are further explored in the Land and Water sections of this strategy. Nearshore areas of the coast are generally naturally highly variable, however human impacts such as anchoring, reef-walking and access for recreation (surfing, fishing) can heavily impact on the flora and fauna of nearshore reef platforms and shorelines.

Increased nutrients, toxicants, sediment and litter all impact benthic primary producer habitats and invertebrate and fish communities. Increased nutrient loading may contribute to the creation of favourable conditions for microagal blooms, for example Nodularia, blocking sunlight to benthic seagrasses and macroalgae and creating anoxic conditions.

Loss of riparian vegetation fringing estuaries can also have a profound influence on the ecology of estuarine systems, and may be caused by clearing, grazing, weed infestation or recreational use of the shoreline. Estuaries are small with heavy usage and increasing threats; impacts associated with increased boating activity can include oil, sewage, noise and excessive moorings (Landvision et al. 1999).
Current management response

Water quality and sediment studies have been conducted at selected sites. Management plans have been prepared for all conservation reserves and most of the coast managed by local government. At specific locations, community groups have formed to address some of these threats in conjunction with land managers. Their actions include education and signage programs, and projects to protect and restore nearshore ecosystems.

Visitation of coast and islands

Impacts from recreational access to coastal environments are a major and increasing threat. The impacts of vehicle and pedestrian use of coastal areas include: de-stabilisation of dunes, islands, headlands and rivermouths; fragmentation of habitat; introduction of weeds; and deterioration in landscape amenity (littering and inappropriate development). These activities, especially the impacts of vehicles, are a major concern for all coastal managers and communities, and require a strong, coordinated approach to management to ensure sustainable use of the coast. However, complex coastal land tenure and limited resources has resulted in severe degradation at some coastal nodes. These nodes of activity (squatting, fishing, surfing, boat-launching, estuaries) are under increasing pressure for development and management, though there is apprehension about changing the informal nature of these nodes.

Current management response

Coastal activity and development nodes have been the focus of land use planning and coastal management at regional, shire and site/reserve scales. These plans have resulted in management responses by the local authorities to mitigate the threats, and include: access control; fencing and signage; rehabilitation; track rationalisation and repair; and educational material targeted at particular activities or areas.

Coastal development: infrastructure and land use

Increase in permanent communities and high levels of tourism are resulting in more infrastructure (roads, parking areas, buildings, drains, boating facilities and groynes) being located in the coastal zone of the NAR. Coastal landscapes are amongst the most dynamic on earth, and human interference in dune or beach processes can often produce unwanted effects.

Coastal infrastructure (marinas, ports, groynes and boat ramps) affect nearshore circulation patterns and sand movement, and need to be designed to accommodate likely climatic events and interaction with coastal dynamics. Areas where there has been a visible impact on coastal processes include Jurien, Dongara and Geraldton.

There is generally considerable effort put into planning land use change; and the siting and setbacks of settlement expansion. However, the capacity of local government to pro-actively incorporate natural resource outcomes into planning is limited. Management of private land abutting the coast and agricultural activities (especially the impacts of land clearing and weed introduction) continue to be a concern.

Current management response

Regional strategies, shire and agency coastal management plans, and local site plans all make recommendations about how to manage coastal development and land use issues. Developers, community groups and the agencies/LGAs implement these recommendations and rehabilitate degraded areas where appropriate.

Threats to Landscapes/Seascapes

All the above biophysical threats have impact on the amenity and social values of coastal landscapes and seascapes. Major threats to land and seascapes values are inappropriately located and designed residential, tourist, port and industrial facilities and associated infrastructure such as roads, tracks, power cables and buildings. Illegally disposed solid waste, such as car wrecks and fishing related debris, also threaten land and seascapes.

Current management response

Siting and design guidelines are commonly included in coastal management and site plans. Particularly significant areas may be heritage registered to ensure their unique character is not lost.
## Table 23. State and National Responses to threatening processes affecting coastal assets.

<table>
<thead>
<tr>
<th>THREAT</th>
<th>RESPONSE</th>
</tr>
</thead>
</table>
| Coastal infrastructure, land use and development | • The Coastal Planning Program (through the Department of Planning and Infrastructure); Town Planning Schemes, Local Planning Strategies and Coastal Management Plans/Strategies (developed through LGAs), all guide activities in the coastal zone.  
• The state Draft Coastal Zone Management Policy sets out the broad policy framework, while Statements of Planning Policy (e.g. SPP 2 & 2.6) and the Country Coastal Planning Policy (Development Control Policy 6.1) guide the siting, and nature of coastal development.  
• The DPI is also in the process of developing landscape guidelines for coastal areas.  
• Broader recommendations regarding planning and management in the coastal zone are made in the State Sustainability Strategy and the State Planning Strategy.  
• Control of pollution and other impacts, control of land clearing, and assessment of developments through the EP Act (1986).  
• The State Government Squatter Policy facilitated the removal of many squatter shacks in the NAR.  
• Port Authorities prepare and implement management plans relating to the impacts of the port on the surrounding environment. |
| Coastal visitation                   | • Programs such as ‘Weedbusters’, ‘Coastcare Week’ etc. Some LGAs have environmental weeds programs.  
• Designation of Parks and Reserves under the CALM Act (1984). Eventually the entire coast between Lancelin and Dongara will be managed by CALM. CALM has responsibility for managing fire and weeds on some Unallocated Crown Land (UCL), and is also responsible for managing impacts on terrestrial and marine native fauna.  
• The Coastal Planning and Management Manual, and the Adopt-a-Beach Kit outline on-ground management and educational activities appropriate to the coastal zone.  
• The Coastwest program provides monies for on-ground works in the coastal zone.  
• All tourism operators in areas managed by CALM must get approval.  
• The Control of Vehicles (Off-road areas) 1978 (under review) describes where vehicles can be used and is enforced by Local Government Authority (LGA) rangers. Rangers also enforce any local by-laws relating to LGA management of coastal reserves (e.g. sandboarding, litter). |
5.10 COASTAL & MARINE - FISH RESOURCES

Goal: To optimise ecological, social and economic outcomes from sustainable use of fish resources by recreational and professional fishers.

5.10.1 DEFINITION

This section of the strategy describes the condition, threats and responses of marine species that are exploited by commercial and recreational fishers within State waters (3 nautical miles offshore, and including the Abrolhos Islands).

5.10.2 RESOURCE DESCRIPTION

Despite the nutrient poor status of the sea surface waters, commercial and recreational fishing are major activities on the west coast of Western Australia. The fisheries focus on low volumes of high value species. Instead of catching open water pelagic fish, most of the valuable species caught in Western Australia are benthic, or bottom dwelling, invertebrates such as western rock lobster, prawns, scallops and abalone. Even the high value finfish caught on the west coast of WA are demersal species, living near the bottom. Most of the information in this section was sourced from the 2003 State of the Fisheries Report (Penn et al. 2003).

Commercial Fisheries

Rock Lobster: The fishery for the western rock lobster Panulirus Cygnus is the largest rock lobster fishery in the world and the largest single species fishery in Australia. The fishery operates on the west coast of Western Australia between Shark Bay and Cape Leeuwin. Rock lobster fishers established many of the coastal towns and settlements on the west coast of the State, and their local economies are still largely based on the fishery. The average catch over the last 10 years has been 11,300 tonnes.

The West Coast Demersal Scale fishery targets bottom living fish using hand lines and drop lines. The NAR is a small geographic component of the fishery, but it includes the Abrolhos Islands and Geraldton sector, both of which are important. Overall, pink snapper, the Western Australian dhufish and baldchin groper account for the majority of the catch. Other snapper and coral trout are caught largely by Geraldton based boats. These are all high value fish species, with the total commercial catch being worth $5.3 million.

The major scallop fishery for Amusium Balloti in WA is in Shark Bay, though smaller catches occur in a number of other areas, such as the Houtman Abrolhos Islands. Scallops have extremely variable recruitment, which results in catches that vary considerably from year to year. In 2002 195 tonnes of scallops (whole weight) were caught, along with 1.1t of king prawns and 0.6t of coral prawns in the Port Gregory area. High recruitment in 2002 led to a catch of about 5500 tonnes in 2003. The prediction for 2004 is 30-50 tonnes (M. Kangas, pers. comm.).

The abalone Haliotis Roei occurs from Victoria across the southern part of Australia and up the west to the Z stydorp Cliffs north of Kalbarri. Two (Areas 7 and 8) of the abalone fishery areas occur in the NAR, with 12 tonnes taken in Area 8 around Kalbarri. The total value of the fishery is $4 million.

Other fisheries include:

- Pilchards and Sardinella: Fish caught in the West Coast Purse Seine Managed Fishery are used for a variety of purposes, including human consumption, bait for both recreational and commercial fisheries, food for tuna growout operations, and pet food. The fishery operates from near Lancelin to Mandurah, with a single operator working north of Lancelin.
- Blue swimmer Crabs: The major areas for the fishery are Cockburn Sound and Warnbro Sound. Little, if any, of the catch comes from the NAR.
- West Coast Bait Fishery: The West Coast Bait Managed Fishery is a small whitebait fishery three licensees of which operate along the lower west coast from Tim’s Thicket north to the Moore River.

Aquaculture: Pearls are the main focus for aquaculture in the NAR. Most other forms of aquaculture in WA are in their infancy, and more details on aquaculture can be found in the Opportunities section of the Strategy.
• Black Lip Pearls: Companies have been trialing production of blacklip pearls, Pinctada margaritifera, which are grown widely in the Pacific. Several companies now have leases in the Abrolhos, including all three island groups.

• Beta Carotene: Micro algae are grown in a land-based operation at Port Gregory for the production of beta carotene. This facility has the largest area of algae cultivation in the world (440ha).

Recreational Fisheries

Fishing is one of the most popular recreational activities in Western Australia. Every year an estimated 600,000 people fish at least casually, contributing an estimated $570 million to the economy annually. Three types of fishing dominate recreational fishing in the NAR: catching western rock lobster, finfish and abalone. People living in the local towns along the coast and tourists coming to the area on holidays undertake fishing. As there are a limited number of shore access points by vehicle, it is likely that fishing is concentrated in areas readily accessed from boat ramps.

Western Rock Lobster: A licence is required for fishers catching western rock lobster, and across the State 26,989 recreational rock lobster licences were issued in 2002/03, showing how popular this type of fishing is. In 2002/03 recreational fishers took an estimated 550 tonnes of rock lobsters, or about 6% of the total catch. Fishing by diving is allowed and recreational fishers are limited to two pots per licence and eight rock lobsters per day. In addition, there is a boat limit of 16 rock lobsters per boat, with fishing by diving allowed.

Finfishing in the NAR can be divided into two groups of fish: demersal (bottom dwelling) and pelagic (those that live near the surface). Recreational fishers take about 30% of the total catch of finfish on the west coast. The major bottom living fish species caught in the region are the same as those targeted by commercial fishers, with a large number of other species caught. Hook and line is the primary method of fishing, either from boats or from the shore. About 30% of the demersal fish are caught by recreational fishers. Tailor (Pomatomus saltatrix) is an extremely popular recreational fish which makes its appearance along Perth’s metropolitan beaches during summer and autumn where it is keenly sought by thousands of anglers each year. It is estimated that recreational fishers took more than 80% of the 230 tonnes caught in 2000/01. Australian salmon is another species that is targeted seasonally during migrations.

Abalone: As with the commercial fishery, Roe’s abalone Haliotis roei is the dominant species caught. Because of the tremendous public interest in recreational fishing, very strict management mechanisms have been in place since 1982. In addition to size and licence restrictions, there is a very limited season, one of the shortest in the world, for the main fishing areas between Cape Bouvard and Wedge Island and in the Greenough area. Overall, it is estimated that recreational fishers take 40 to 45% of the total abalone catch.

Freshwater fish: Introduced species targeted in the rivers and estuaries of the NAR include marron, yabbies, gligies, koonacs and freshwater fish (e.g. trout, perch, cobbler). The Hutt and Moore rivers have recently been declared as ‘Marron waters’ by the Department of Fisheries, with the relevant restrictions on fishing applying. Total WA catch of marron, for example, has declined from 100 to 17 tonnes due to environmental factors leading to habitat loss; low rainfall; and pressure from fishing. Catch per unit effort data collected suggests this fishery is unlikely to return to historic levels.

Aboriginal fisheries

Fish are valued by Aboriginal people both health, cultural and economic reasons, with traditional fishing techniques being an important part of traditional Aboriginal culture. An Aboriginal Fishing Strategy (Franklyn, 2003) has been developed by the Department of Fisheries. Fish resources will be allocated to customary fishing as part of Integrated Fisheries Management processes, and will be given priority over commercial and recreational allocations. The strategy made specific recommendations to ensure that Aboriginal people have adequate access to fish resources, whilst maintaining sustainable levels of fish stocks. It also set out strategies for increasing the capacity of Aboriginal people to effectively engage in planning and management of marine areas.

5.10.3 RESOURCE CONDITION

In general, it is thought that Western Australian fisheries are among the best managed in the world. In contrast to the decline of most of the world’s major fisheries, the fishery for the western rock lobster was the first in the world to be certified as sustainable.
by the London-based Marine Stewardship Council. Other WA fisheries have since received similar accreditation. Full details of the ecological sustainability assessments and improvements required for the next assessment period are available on the Commonwealth Department of Environment and Heritage website.

However, all fisheries are ‘fully exploited’, suggesting significant challenges remain in ensuring sustainable use of fish resources and conservation of marine biodiversity. There is also an ongoing requirement to address issues associated with fishing settlements, waste disposal and research into impacts on non-target species and habitats.

There are gaps in the information required to ensure sustainable use of fish resources into the future. The management of WA fisheries has traditionally been based on the commercial fishers. Detailed log books have been kept for up to 40 years, providing a world class database on the commercial fisheries. However, as the population of Western Australia has grown and people have more free time and disposable incomes, the recreational fishery has increased substantially but there is little data available on the recreational fishery.

5.10.4 THREATENING PROCESSES AND MANAGEMENT RESPONSES

Threats to the fishery resource are generally the same as those previously described for the marine environment.

However, there are three specific issues regarding fisheries in the NAR:

**Fully exploited stocks**

The State of the Fisheries Report (Penn et al. 2003) outlines the commercial fisheries operating in the NAR, which have been discussed above. A consistent feature of the report is that fishery after fishery is cited as being fully exploited. All fisheries, except for the wetline fishery (which is currently under review), are ‘limited entry’ that serves to cap the fishing effort. However, recent technological advances such as the introduction of colour sonar and global positioning systems (GPS) mean that fishers are better able to target the stocks. Estimations of fishing effort must take into consideration these increases in the effectiveness of fishing methods when reviewing management arrangements, and this has been a topic of discussion at the annual Rock Lobster Industry Advisory Council’s coastal tour.

**Current management response**

There have been management initiatives developed to reduce fishing pressure to maintain breeding stocks at sustainable levels. Previously the rock lobster season ended on 15 August, but the end of the season has been moved to 30 June. More recently there have been substantial reductions (totalling 18%) in the number of pots allowed. A maximum size has also been imposed to protect large, productive females.

Management plans are in place for all of the major fisheries, and there are Management Advisory Committees for all fisheries. Considerable resources are devoted to providing information about the fisheries through basic research and using the information for management.

**Resource sharing**

As the population of Western Australia continues to grow, more and more people are expected to undertake recreational activities such as fishing. The growing population will be in more close competition with professional fishers leading to increased, and sometimes heated, debates about resource sharing arrangements. Recreational fishers have already largely replaced commercial fishing in the southwestern estuaries. A formal arrangement has been agreed to for resource sharing of the blue swimmer crabs in Cockburn Sound. More such agreements can be expected in the future.

**Current management response**

The WA Department of Fisheries is currently developing programs in Integrated Fisheries Management, which will combine the presently separate approaches to commercial and recreational fisheries.

**Ecological sustainability**

Recreational and commercial fishing has the potential to deplete fish and invertebrate populations, which in turn can lead to habitat modification (CALM 2001, 2004). Bottom trawling can damage fragile benthic habitats, as well as kill many non-target organisms. Fishing can also disrupt ecosystems by shifting the age structure of some fish populations, and affect predator-prey relations, which can indirectly lead to trophic shifts. Marine mammals and reptiles are totally protected in Australia. Every year turtles and other such species are caught up in trawl nets and killed.
Current management response

Traditionally fisheries have been managed as single species to ensure there is sufficient egg production from one generation of fish to maintain the population at sustainable levels in future years. E.g. For Western Rock Lobster a system of monitoring puerulus larval settlement has been developed to estimate catches four years later with a considerable degree of reliability. Management of the fishery is geared to maintaining 20 to 25% of the egg production that occurred in the baseline year of 1980.

However, it is now recognised that single species cannot be effectively managed on their own. The most effective management possible will not ensure the continuance of the population if the environment in which the fish lives is destroyed.

Accordingly, fisheries managers worldwide have been developing principles for ensuring the fisheries are ecologically sustainable, and the WA Department of Fisheries is a leader in this field. A recent study on interactions between fisheries and seabirds (Gaughan 2003) is an example of the broader approach now being adopted by the Department of Fisheries. Trials are currently under way in Shark Bay to document the number of such kills and to develop alternative structures on nets to reduce the mortality. Vessels in the Abrolhos Islands and Mid West Trawl Fishery have introduced compulsory by-catch reduction devices to reduce the number of marine fauna caught and injured.

Through its administration of the Environmental Protection and Biodiversity Conservation Act (1999), the Commonwealth Department of Environment and Heritage (DEH) now requires fisheries departments in Australia to demonstrate that their fisheries are ecologically sustainable. A number of WA fisheries have now been certified by the DEH. In fact, in 1999/00 the Western Rock Lobster Fishery was the first in the world certified by the Marine Stewardship Council based in London.

<table>
<thead>
<tr>
<th>THREAT</th>
<th>RESPONSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full exploitation of stocks</td>
<td>• Licensing, limited entry (most fisheries) and catch limits.</td>
</tr>
<tr>
<td></td>
<td>• Research and modeling to predict sustainable catch levels for future seasons.</td>
</tr>
<tr>
<td></td>
<td>• Monitoring of fishing effort, and adjusting management in response to increased effort or efficiency (e.g. from technological advances).</td>
</tr>
<tr>
<td>Resource sharing</td>
<td>• Introduction of integrated fisheries management.</td>
</tr>
<tr>
<td></td>
<td>• Quantification of recreational fishing impacts on stocks.</td>
</tr>
<tr>
<td>Ecological sustainability</td>
<td>• Assessment and management of fishing activities through the Fisheries Management Act 1991 and Fish Resources Management Act 1994.</td>
</tr>
<tr>
<td></td>
<td>• Establishment of fully protected marine parks or sanctuary zones (CALM, Fisheries).</td>
</tr>
<tr>
<td></td>
<td>• Most of the NAR (shallower than 200m) is permanently closed to trawling and vessels’ positions are remotely monitored.</td>
</tr>
<tr>
<td></td>
<td>• Under the EPBC Act 1999 fisheries must demonstrate they are ecologically sustainable to be exempt from export controls. Almost all fisheries in WA have been assessed.</td>
</tr>
<tr>
<td></td>
<td>• Marine Stewardship Council Certification of the Western Rock Lobster fishery.</td>
</tr>
<tr>
<td></td>
<td>• SeaNet service to research and extend tools and techniques that reduce environmental impacts of fishing.</td>
</tr>
</tbody>
</table>
STRATEGY RESPONSES TO ISSUES FACING COASTAL AND MARINE ASSETS

In the strategy process sixteen Resource Condition Targets (RCTs) representing fifty two Management Action Targets (MATs) were developed in relation to Coastal and Marine assets. Some of these have been mentioned before in relation to other assets (eg see Marine Biodiversity). The targets were linked together in 11 groups: Governance; Coastal Land; Coastal Biota; Estuarine and Wetland Systems; Coastal Aesthetics and cultural issues; Marine Seabottom; Marine Biodiversity; Fish Resources; Water; Marine Aesthetics and cultural issues; and Houtman Abrolhos Islands.

Five of the issues are classified as either “Essential” or “Important”, most with a “variable” threat risk ranking, as there are a wide range of different threats to coastal and marine assets.

The key issues are:

• Coastal and Marine Governance (CM.R1:By 2015, changes to the economic, social and governance systems are implemented to facilitate better management of our coastal and marine natural resources.)

• Coastal Land (CM.R2: The condition and function of our coastal geomorphic systems will be maintained and improved by 2015)

• Houtman Abrolhos Islands (CM.R16: Preserve current integrity of Abrolhos natural systems by 2010)

• Estuarine and Coastal Wetland Systems (CM.R4: The condition and function of our estuarine and coastal wetland systems will be maintained and improved by 2015)

• Fish Resources (CM.R11: By 2010, fish resources will be sustainably managed and programs in place to guard against the introduction of pest species.

For detail on targets relating to Coastal and Marine assets see page 135.
5.11 ATMOSPHERE - AIR QUALITY

**Goal:** Air quality maintained by limiting threatening developments

5.11.1 RESOURCE DESCRIPTION AND CONDITION

**The Greenhouse effect**

The Greenhouse effect, which mainly results from increasing levels of certain gases in the earth’s atmosphere, causes a rise in the temperature of the earth because heat emitted from the earth is unable to leave the atmosphere. Most emissions result from fossil fuel use, ruminant digestion and land clearing. Fertiliser application, waste decomposition and industrial processes are also significant sources. There are several types of emissions: methane, nitrous oxide and carbon dioxide from agriculture and various chemicals, including ozone and nitrogen dioxide from other sources including motor vehicles. 18% of agricultural emissions are nitrous oxide, with 11% methane (Bennett and Flugge, 2003). Emissions from non-agricultural industries in the NAR are likely to be very small, though a lack of monitoring makes this hard to estimate.

**Air Quality in the NAR**

In general terms, it is known that smoke from open burning - wildfires and fires for hazard reduction or asset management, e.g., stubble burning, is an issue of concern at times. Poorly managed heavy industry could be a potential problem wherever it occurs in the region, but because there is currently only one large population centre, most of the information about regional air quality is for Geraldton.

**Geraldton air quality**

The airshed for the Geraldton Region does not extend far beyond the fringes of the city because there is not expected to be significant generation of photochemical smog products (ozone and nitrogen dioxide) due to Geraldton’s emissions, which would warrant monitoring further from the city. However increasing population pressures may require this to be re-visited if suburban sprawl develops. Motor vehicles are the primary contributor. There are two likely sources of significant emission concentrations in the city of Geraldton, namely wind blown crustal material, and smoke from bushfires, hazard reduction or stubble burning and possibly home fires.

**Air quality monitoring history**

The Department of the Environment (DoE) (and equivalent former agencies) has not conducted air quality monitoring at Geraldton to date, because it is not required for the current population of about 25,000. However, a performance monitoring station is required and the DoE proposes to install one for the purpose of campaign monitoring over a period of two years. A determination will then be made on the need for ongoing performance monitoring. A site for campaign monitoring has not been selected.

**Industry developments**

Potential industries that could pose air pollution problems are a gas turbine 5km east of Geraldton, a synthetic rutile plant at Narngulu, 8 km south-east of Geraldton, and a proposed iron and steel project at Oakajee, 20 km north of Geraldton. However, at this stage there has not been a comprehensive emissions inventory undertaken for Geraldton. Consequently, the only emissions estimates that will be directly used in the assessment of monitoring requirements are those for the industries above. In the future it is possible there will be other proposed heavy industry areas that will need to be considered.

5.11.2 THREATENING PROCESSES AND MANAGEMENT RESPONSES

Air quality is acknowledged as economically important due to its effects on the health of the population and its importance to primary production (eg in relation to photosynthesis and respiration). Air quality also has an impact on lifestyle and is important for industries such as tourism.

Air quality is not an environmental issue of great concern in the rural regions of the NAR due to low population density, low industry density and relatively few cars. Where these pressures are greater, such as in the City of Geraldton, air quality should be monitored regularly. However, limited data exists for the resource condition of air quality in the NAR and this gap in knowledge has to be addressed before the impact and management of threatening processes can be monitored and evaluated.
Emissions from Vehicles

Emissions from vehicles come from two sources:

- Exhaust-related emissions include carbon monoxide (CO), carbon dioxide (CO₂), nitrous oxides (NOₓ), hydrocarbons and particulates. In high enough concentrations these gases can cause health problems to members of the community. Some gases emitted by vehicles are also greenhouse gases, which contribute to the greenhouse effect and global warming.

- Evaporative emissions are vapours which are released into the atmosphere without being burnt and can indirectly lead to health problems in the community. Photochemical smog arising from motor vehicles can lead to lung irritation, shortness of breath and coughing. As population, distance of car travel and numbers of cars owned per person are all predicted to increase in the future, increased levels of car emissions will continue to be an environmental issue.

Current management responses

Management responses to car emissions have been limited in the NAR. Within Geraldton, increased education and community initiatives such as Walk to Work (Pedestrian Council of WA) promote decreased usage of vehicles. The Carbon Neutral Program encourages companies to offset the carbon produced by emissions for company vehicles by donating money to planting native trees at sites that are affected by salinity or erosion. In the future, cities and towns of the NAR will need to address car emissions through effective town and transport planning.

Particulates – Smoke and Dust

Haze is the name given to the collections of tiny particles from smoke which make the sky look brown. Major sources of smoke in the NAR include bushfires, wood fires and burning of stubble and other wastes. The particles can cause respiratory problems when inhaled. Dust arising mainly from industry and agriculture also add to haze.

Current management responses

Responses to particulate air quality are limited due to difficulties associated with measurement, monitoring and policing levels of smoke and dust created by individuals. The Department of Environment actively polices licenced premises by ensuring that licence conditions include methods to minimise dust. The DoE has also created guidelines to help reduce the air pollution from wood burning heaters.

Toxins from Industry

Of concern to many individuals is the impact to air quality from industry. Industry can produce a variety of emissions depending on the processes it utilises. Emissions of concern include dust, sulphur dioxide, carbon dioxide, carbon monoxide, nitrous oxides and hydrogen sulphide. In high concentrations these gases can cause health problems as well as increasing levels of greenhouse gases.

Current management responses

Most industries in the NAR carry out their own monitoring, the results of which are collected by the National Pollutant Inventory. All industry must comply with the conditions of their licence as required under the Environmental Protection Act 1986. The requirements of each licence are specific to each premises and the processes that take place there. Although a lot of controversy arises due to pollution from industry-related pollution, the effects in the NAR are in most cases very small in comparison with the amount produced collectively from individual homes, properties and cars.
5.12 ATMOSPHERE - CLIMATE CHANGE & SEASONAL VARIABILITY

Goal: Risk management implemented to predict and account for climate

5.12.1 RESOURCE DESCRIPTION AND CONDITION

Climate change resulting from the enhanced greenhouse effect is a major challenge for Australia (including the NAR) and its current global status has been summarised by the Intergovernmental Panel on Climate Change (Foster 2003). A CSIRO simulation study has indicated that average annual temperatures are likely to rise by up to 2°C by 2030 over most of Australia, accompanied by higher evaporation rates, with the effects greatest in spring. The effects on temperature will be slightly less in coastal regions. Rainfall is projected to decline over WA from autumn to spring by as much as 20%, with a weakening or lower frequency of cold fronts. Tropical cyclone incidence may potentially be stronger, and sea levels are predicted to increase by 9 and 88cm (median 38cm) over the next 100 years (Foster 2003).

These projections show some similarity to climate trends that have occurred over the past three decades in WA. The main phenomenon has been rainfall decline, particularly along the lower west coast, and particularly in May-July (Foster 2003). Trends in late season rainfall (Aug-Oct) have been small. Figures for Mingenew are shown in Table 25.

In addition average temperatures are rising, with the mean winter latitude of the subtropical wind maximum (an indicator of the positions of the high-pressure belt) has moved southwards since 1975, suggesting a shift of climate zones. There has been a weak trend in daily minimum temperatures, but a stronger trend in daily maximum temperatures. Accumulation of thermal time for chilling is declining, while accumulation of thermal time above 12°C is increasing. However, seasonal temperatures still exhibit notable variability from year to year.

Climate variability across the south west of Western Australia is accountable to the Southern oscillation Index (SOI) and Indian Ocean Seas Surface Temperatures (SSTs). The Southern Oscillation has some influence on atmospheric pressures across the Australian region. Strong correlations between surface atmospheric pressure and May-July rainfall are evident particularly in the South West Region. Conversely, the direct relationship between rainfall and SOI in the south-west, is weakly correlated. Rainfall decreases since the mid 1970s partly reflects large scale changes in the El Nino – Southern Oscillation. However, little change in the SOI in recent decades cannot explain the additional decreases in rainfall, suggesting other unknown factors are also responsible. Indian Ocean SSTs appear to be correlated with south-west rainfall, with warm temperatures usually being associated with dry conditions. Both warming of the Indian Ocean and declining rainfall in the past few decades only show trends, but do not suggest any physical or causal link between these trends (Indian Ocean Climate Initiative 2002).

While decreased rainfall and associated atmospheric circulation changes resemble the climate change and most climate models project for an enhanced greenhouse effect; this has not been proved beyond reasonable doubt and may simply reflect natural climatic variability. However, it is likely that both natural variability and the enhanced greenhouse effect have contributed to climate change (Indian Ocean Climate Initiative 2002). Further research to more accurately quantify the causes and implications of climate change should be a high priority. For more information please see the Indian Ocean Climate

Table 25. Numbers of wet years for Mingenew in various seasons for two epochs, 1952-76 and 1977-2001. A wet year or season is defined as rainfall in decile 8 or above.

<table>
<thead>
<tr>
<th>Season</th>
<th>Decile 8 rainfall (mm)</th>
<th>1952-76</th>
<th>1977 – 2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual</td>
<td>491</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>May - Oct</td>
<td>412</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>May - Jul</td>
<td>283</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>Nov - Apr</td>
<td>119</td>
<td>8</td>
<td>5</td>
</tr>
</tbody>
</table>
5.12.2 THREATENING PROCESSES AND MANAGEMENT RESPONSES

There are a number of processes contributing to climate change and seasonal variability. The following section provides an overview of the major threatening processes and some local and regional scale management responses. Table 26 outlines the State and National Management responses.

The climate projections outlined above clearly have major implications for all natural resources in WA agriculture particularly in relation to seasonal variability. Rainfall changes are of particular concern. For example, in relation to broad acre agriculture, possible impacts on winter crops, include a later start to the growing season, a shorter season, increased variability in yields and lower wheat protein, with the lower rainfall zones particularly vulnerable to inadequate rainfall.

There is likely to be a major issue with water supply, with both on and off-farm sources being affected by changes in the frequency and duration of runoff events. There has been a 50% decrease in average annual streamflow into metropolitan dams over 1975-2001 compared with 1911-1974. This could mean less water being available for agricultural use as more water is diverted to the metropolitan region. Farm dam catchments are also likely to be affected.

Although the rate of spread of salinity may decrease under a drier, more evaporative climate with fewer wet winters, groundwater rise has generally continued through the period of recent rainfall decline. This suggests that land use options will continue to be the dominant factor affecting recharge rates.

Remnant vegetation faces the possibility of extinction of many species that have a restricted range. Recent studies on the potential change in distribution of some native plant species under greenhouse scenarios have shown the sensitivity of those species that have either a restricted natural range, or that are confined to remnants and reserves. However, increased CO$_2$ concentrations and lower frost risk may offset some of these effects. Reduced accumulation of chilling time may affect some horticultural crops.

Changes in cyclone intensity and frequency, along with sea level rise, could cause periodic and chronic shoreline retreat, with significant long-term implications for coastal ecosystems, communities and infrastructure. The low lying Abrolhos Islands, and coastal estuaries and wetlands could be particularly vulnerable. Reductions and/or restrictions in agricultural, fisheries and industry output, along with increased insurance premiums could have negative implications for local and regional communities and economies. Impacts of climate change on terrestrial and aquatic ecosystems could also have strong ramifications for tourism and community amenity (Pittock 2003).

Current management responses

- Biofuels and alternative energy sources: Biofuels offer Western Australia an opportunity to reduce its greenhouse emissions, as they produce fewer greenhouse gases. It is estimated that biodiesel produces 75% less accountable greenhouse emissions than diesel.
- Agro-forestry and carbon sinks/trading: Commercial opportunities identified in the zone, along with medium and low rainfall zones, include broombush, oil mallees and sandalwood. Furthermore, these plants, as well as other salt tolerant species, may provide a source of revenue through carbon trading by acting as carbon sinks (Department of Agriculture 2003a; Kingwell 2003; Department of Agriculture 2003b).
- New crop and pasture varieties: With the low rainfall zones in the NAR potentially the most adversely affected by climate change, farmers in these areas should consider switching to short growing season cereal and oilseed crop varieties, and low rainfall pasture varieties. Modern selection and breeding techniques are resulting in continual improvements in the genetic qualities of crop and pasture varieties that are most suitable to particular agronomic circumstance (Department of Agriculture, unpublished).
- Revised water allocation plans: The Department of Environment and Water Corporation have accelerated investigations into new water supply sources. They have also developed programs to encourage more efficient use of existing supplies of water.
- Efficiency of energy use: Government and non-government organisations are promoting increases
### Table 26. State and National responses to threatening processes affecting the atmosphere.

<table>
<thead>
<tr>
<th>THREAT</th>
<th>RESPONSE</th>
</tr>
</thead>
</table>
| **Emissions**   | • Alternative Fuels Program: Designed to maximise the emission reduction and running costs through the advantages of using alternative fuels. The programs incorporated within this strategy are:  
    - Alternative Fuels Conversion Program (Australian Greenhouse Office)  
    - Energy Grants Credits Scheme (Australian Taxation Office);  
    - The National Mandatory Renewable Energy Target (MRET) which has been set at 9500 gigawatt hours by 2010; and  
    - The 1998 WA State of the Environment report suggested that local government authorities should take energy efficiency issues into account in:  
      - planning decisions  
      - conduct energy audits of city facilities, and  
      - educate householders and businesses to  
      - reduce greenhouse gas emissions. |
| **Greenhouse Gases** | • Independent verifiers for the Greenhouse Friendly Program;  
    • Cool Communities Program;  
    • Greenhouse Science Program. This facilitates Australian participation in two significant international programs through the Australian Academy of Science:  
      - International Geosphere Biosphere Program  
      - World Climate Research Program;  
    • The Greenhouse Science Program supports International Project Office of the Global Change and Terrestrial Ecosystems (GTCE) project, which is part of the International Geosphere – Biosphere Program  
    • The National Greenhouse Strategy. This extends the program of action launched by all governments in Australia through the 1992 National Greenhouse Response Strategy (NGRS). Adaptation planning for several key sectors or areas which have been identified as sensitive to the direct effects of climate change needs to be undertaken. These sectors include:  
      - coastal and marine environments  
      - agriculture (including pests and diseases),  
      - biodiversity,  
      - forests, and  
      - human health;  
    • The State Greenhouse Strategy. This sets out state strategies for: reducing greenhouse emissions, increasing sequestration, exploring new opportunities, adapting to changes and facilitating further action at all levels of government;  
    • The WA Greenhouse Council was established in 1998 to provide advice to government regarding State, National and International developments in greenhouse matters and to aid implementation of the National Greenhouse Strategy. Six technical panels provide support to the Council. Local government is not directly involved;  
    • The Environmental Protection Act 1986 established the Environmental Protection Authority. In accordance with the Act, the EPA can require proponents to minimise greenhouse gas emissions from new proposals as part of the environmental impact assessment process; and  
    • Men of Trees - Carbon Neutral Program. |

*Cont. over next page...*
in the efficiency of energy use. Actions relate to encouraging alternative transport options (through education and planning), reducing energy use in homes and offices, encouraging use of greenpower, investigating organic and geological sequestration options, and monitoring and reducing energy use by industries.

- Inland aquaculture: Due to potentially adverse conditions developing in the marine environment as a result of climate change, it is possible that aquaculture ventures may be relocated to the mainland where conditions can be greater controlled. There is some potential for aquaculture ponds using saline groundwaer, including finfish, algae and brine shrimp. Freshwater species such as yabbies, marron and silver perch have also been successfully produced commercially (Kingwell 2003; Agricultural Western Australia 2000).

- Climate forecasting and decision support tools: Climate variability is a significant issue for agriculture. Good management of climate risks is vital for making a profit and remaining in business. Developments in climate forecasting abilities along with a number of climate related decision support tools, such as Australian Rainman and Potential Yield Calculator, provide information to landholders that enable them to adjust their farming practices and inputs according to how their season is tracking (Department of Agriculture 2004).
In relation to Climate Change and Air Quality assets, the strategy process identified two Resource Condition Targets (RCTs). None were assessed in the threat ranking process, but addressing climate change and seasonal variability was deemed to be “Essential”. A third RCT in the Community Assets section is also related. The three issues are:

- **Climate Change and Seasonal Variability** (AR.R1: The NAR capable of managing climate change and seasonal variability, therefore reducing the risk of major environmental, economic or social outcomes from drought or coastal land impacts)
- **Air Quality** (AR.R2: Maintain the quality of air within the region)
- **Sustainable Industry** (CA.R7: All industry to be economically, socially and environmentally sustainable through facilitation of industry change)

For detail on targets relating to Atmosphere assets see page 134.
5.13 COMMUNITY - REGIONAL ECONOMY

Goal: Opportunities developed that balance economic, social and environmental outcomes

5.13.1 OVERVIEW

The regional economic base is dominated by agriculture, retail, mineral sands mining, tourism, fishing, manufacturing industries and petroleum. There is also significant manufacturing, as well as processing, of mining and fishing products. The economic issues are:

- Aging electricity infrastructure, poor telecommunications, and roads and buildings deteriorated by salinity;
- A workforce becoming concentrated near the coast;
- Balancing development with conservation of the environment; and
- Developing sustainable industries to reduce degradation of the resources.

While Table 27 indicates some threats to the economy, in reality the region is likely to expand rapidly and there are numerous economic opportunities.

5.13.2 FUTURE DEVELOPMENTS

Major new developments will focus around sustainable energy (wind farms), horticulture (olive groves, fruit and vegetables) and mining (oil/gas and mineral sands). Farming, fishing, pastoral and tourism will still be the main sectors of the economy. There are enormous opportunities in environmental tourism.

The trend to corporate farming and farm amalgamation continues, aided by relatively cheap prices for productive land and a search for international competitiveness, resulting in fewer farms and more absentee landowners. This will maintain a trend to an aging and declining rural population. Livestock numbers will increase, partly because of agistment by Rangelands pastoralists. Intensified agriculture will expand, based on the availability of, and access to, ground water (particularly in the vegetable, olive and viticulture sectors).

The Indian Ocean Drive on the coast will impact on the economy, with Jurien Bay expanding to become a regional centre. On the coast, various impacts of population and visitor growth will be felt. For the elderly, the provision of health and leisure services will determine choice of retirement location, whereas the young will be influenced by job opportunities, housing and education services.

The recent sealing of the Mt Magnet-Leinster Road, the Southern Transport Corridor and Geraldton Port Enhancement project, provide resource proponents to the east with a cost-effective transport option from mineral source to markets.

International competitiveness will be enhanced by new opportunities in research, development and information technology. These include:

- Geraldton Universities Centre, and Combined Universities Centre for Regional and Remote Health;
- the construction of a Marine Precinct and a Food Science Centre;
- International Radio Quiet Array (IRQA) and the Square Kilometre Array (SKA) - located in the Murchison region, but boosting the NAR economy and telecommunications infrastructure;
- Gravity Discovery and Cosmos Centre, Gingin – part of the Australian International Gravitational Observatory (AIGO), an international search for gravity waves – also for education on science, technology and innovation.
- World Wide Wattle website - linked to the Dalwallinu Environmental Interpretive Centre project. This will deliver authoritative information on Australian Acacia species, biodiversity and sustainable agriculture.

Table 27. Threats and responses to the Economy.

<table>
<thead>
<tr>
<th>Threats to the economy</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insufficient and ageing infrastructure</td>
<td>Need ongoing investment into infrastructure</td>
</tr>
<tr>
<td>Insufficient venture capital</td>
<td>This remains a vexed problem</td>
</tr>
</tbody>
</table>
5.14 COMMUNITY - BUILT ENVIRONMENT

Goal: Built environment to enhance environmental values and to be protected from environmental threats

5.14.1 BUILT ENVIRONMENT: RESOURCE CONDITION

In the Overview of the Region (p 8) and in the section on Urban Land assets (p 31) the region’s built infrastructure was outlined. The main public components are towns, transport corridors (rail and road), communication and power networks, and tourist facilities on beaches and in reserves. Water supply schemes and sewerage are also components of the infrastructure of towns. The gas pipeline from the North West also traverses the region. The defence base near Lancelin is a case of specialised “infrastructure” that interacts with the local environment, to the mixed response of residents.

Having a limited population, one of the main constraints to maintenance of the built environment in the NAR is the low rate base for local government authorities. More support from the State and Commonwealth would be welcome.

The poor state of the NAR power network is a serious issue, with anecdotal evidence that some farms lose power, sometimes for over 24 hours, more than 20 times per year. It is often claimed such problems are caused by natural causes such as salt, wind, rain, thunderstorms or dust, but, low investment in maintenance is also relevant. If the region’s built environment is to be valued and improved, there needs to be increased investment in these areas. A recent announcement by the State of a Rural Power Improvement Program is expected to help address these concerns. Another important infrastructure issue, with links to natural resources, is the placement of infrastructure corridors such as power lines and roads. There is a tendency for infrastructure departments to pay scant attention to the importance of native vegetation or the risks of fragmenting it or introducing edge effects for weed invasion.

The NAR has over 40 townships, most with less than a thousand people. Many of the inland towns are declining. One of the most serious threats to them is caused by rising watertables and salinity, which are damaging infrastructure and causing increased maintenance requirements and physical degeneration of assets. In a study analysing the cost of salinity on infrastructure in representative WA towns, damage costs (for 30 years) were calculated to be an average of $1.5million per town (WADA, 2001). In the NAR six towns are seriously impacted (Table 28) and 3 shires - Perenjori, Moora and Morawa - are willing to contribute financially to the cost of Remedial Action Plan. Poor surface water control / drainage is a related problem for the built environment.

Table 28. Prioritisation of Towns at Risk from Salinity in the NAR.

<table>
<thead>
<tr>
<th>Town</th>
<th>Pop.</th>
<th>Yrs to Impact (watertable &lt;1.5 m)</th>
<th>Risk Index (pop/yr impact)</th>
<th>Rank within Region</th>
<th>Rank within State</th>
<th>Priority high/medium/low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mullewa</td>
<td>700</td>
<td>5</td>
<td>140</td>
<td>1</td>
<td>11</td>
<td>medium</td>
</tr>
<tr>
<td>Moora</td>
<td>1,800</td>
<td>14</td>
<td>129</td>
<td>2</td>
<td>12</td>
<td>medium</td>
</tr>
<tr>
<td>Morawa</td>
<td>600</td>
<td>5</td>
<td>120</td>
<td>3</td>
<td>13</td>
<td>medium</td>
</tr>
<tr>
<td>Perenjori</td>
<td>250</td>
<td>6</td>
<td>42</td>
<td>4</td>
<td>22</td>
<td>low</td>
</tr>
<tr>
<td>Piawinga</td>
<td>10</td>
<td>1</td>
<td>10</td>
<td>5</td>
<td>32</td>
<td>low</td>
</tr>
<tr>
<td>Carnaham</td>
<td>410</td>
<td>217</td>
<td>2</td>
<td>6</td>
<td>38</td>
<td>low</td>
</tr>
</tbody>
</table>

Table 29. Threats and responses to (and from) built infrastructure issues in the NAR.

<table>
<thead>
<tr>
<th>Threats associated with built infrastructure</th>
<th>Current response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damage to native vegetation and habitat</td>
<td>Need to tighten planning considerations</td>
</tr>
<tr>
<td>Damage to infrastructure, and surrounding biodiversity, from salinity or drainage</td>
<td>Rural Towns program needs to be ongoing to be effective</td>
</tr>
<tr>
<td>Intermittent damage to networks for power and communications from climatic vagaries</td>
<td>Programs such as the Rural Power Improvement Program may help; ongoing maintenance critical</td>
</tr>
</tbody>
</table>
5.15 COMMUNITY - HUMAN CAPACITY

5.15.1 COMMUNITY

Goal: Self-reliant, informed and active communities able to identify, direct and implement change to protect and improve our natural resources

The NAR has a total population of 60,000 and is characterised by many small communities and one city. Most communities have fewer than 1,000 people in them. A positive aspect of this is that there is a very strong sense of community, a willingness to be involved, and a proud image of the sense of “place”. The region is renowned for its independent, “can-do” attitude and strong individuality. Due to the pressure of declining populations, inland communities are under immense social pressure, trying to maintain the social cohesion and function of the community they value. In contrast, coastal communities are growing rapidly, becoming increasingly diverse and sophisticated, and there is pressure due to the demands of coping with rapid change. Indigenous communities have a strong spiritual connection to natural resources such as land and water. However, there is little knowledge or appreciation of these values in the wider community.

The “bottom-up” approach used in this strategy, and the involvement of many community members in developing the aspirations, targets, actions and priorities, has shown what a wealth of experience and commitment there is in the local community in relation to natural resource management.

An interesting aspect of the strategy development was the large number of actions suggested in relation to capacity building within the community.

5.15.2 GOVERNANCE

Goal: “Enabling” governance structures provided to support the community processes

The concept of “governance” covers a range of processes and attributes which support decision-making, administration, accountability and implementation. These include legislation, development of strategic direction, financial allocation and management, and leadership of change. Governance concepts are discussed further in the legislative section (p 141).

In a rural area there are several layers of governance that are important with respect to NRM, for example:

- State and Commonwealth Governments, their departments and representatives;
- Local Government Authorities, of which there are 17 in the NAR;
- the Northern Agricultural Catchments Council (NACC) and corresponding sub-regional groups;
- local catchment, landcare, farm management, and environmental groups.

A key issue is that legislation needs to be put in place on environmental issues that is fair to all parties, that enables a sensible balance between development and conservation, and that is responsive to change.

In line with the “can-do” attitude of this community there is an expectation that those with “governance” responsibilities will work cooperatively with all stakeholders and assist with the rapid facilitation of solutions to problems. In addition, there is an expectation that the various governance bodies will work together with a common aim and that there will be a minimum of duplication and negative synergy.

The recent “State Sustainability Strategy” (Govt of WA, 2002) is expected to help address these concerns.
5.16 COMMUNITY - CULTURAL AND NATURAL HERITAGE

Goal: Cultural aspects of natural heritage to be respected and enhanced

5.16.1 ABORIGINAL CULTURAL HERITAGE

The NAR forms a culturally and environmentally significant part of the traditional lands of both the Yamaji and Noongar people. Aboriginal mythological creation stories are based around the Wagyl (Noongar) and Bimara (Yamaji). These are the names of the "rainbow snake" that, according to Aboriginal mythology, shaped the landscape and created plants, animals, and humans.

Although the cultural relationship between the Yamaji and Noongar people is not well documented, it is believed that certain resources were shared and or traded. The geographic boundary between Noongar and Yamaji people is indistinct, but the cultural boundary is clearly defined by language and cultural rites.

Aboriginal people have a deep attachment to the land and the natural environment. This “spiritual” dimension is a special attribute that could significantly expand the wider community’s understanding of NRM. In this region we are all (Aboriginal and non-Aboriginal) conscious of the need to give greater recognition to spiritual connections, and to educate both the wider community, and parts of the Aboriginal community itself, in the special cultural values of our natural resources.

5.16.2 EUROPEAN CULTURAL HERITAGE

European settlement of the region began in the mid 1800s, but has been most pronounced in the last 80 years with the continued opening up of agricultural land. The main non-Aboriginal heritage, originally British, now includes a range of cultures such as Italian, Vietnamese and Cocos Island Malay. However, values that were expressed in the community interview process of this strategy were not ethnologically based community-minded, friendly, honest, country lifestyle. Visual amenity and appreciation of beauty were strong values, and safety and health were important. We see ourselves as hard-working, conscientious, generous, open and laid-back. Maintenance of lifestyle, community and family values was heard as a constant need in all consultations.

5.16.3 NATURAL HERITAGE

As emphasised in many parts of this document, the natural heritage and environmental assets of the NAR are very special, and still in excellent shape. The values of our natural heritage need to be more widely recognised throughout the community and at all levels and in all sections of government.

Table 30. Threats and responses associated with the human elements (Community, Governance, Culture and Heritage)

<table>
<thead>
<tr>
<th>Threats associated with human elements</th>
<th>Current and future responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of partnerships, both financially and in relation to capacity building, from the various layers of government.</td>
<td>NHT, NAP, and support for NRM strategies positive; More capacity building would be welcome; Greater involvement of a wider range of stakeholders will aid synergies</td>
</tr>
<tr>
<td>Lack of coordination between various “governance” entities such as state and federal departments, and local government. Legislation poor, or not utilised effectively</td>
<td>At some levels this works well, but coordination is not consistent</td>
</tr>
<tr>
<td>Lack of appreciation of Aboriginal heritage and spiritual connection to the land Lack of appreciation by the wider community of our natural heritage and assets</td>
<td>Recent opportunities in cultural awareness training have been useful; there needs to be more emphasis on this. This NRM strategy is a good start; there needs to be greater public awareness-building of the value of our natural heritage</td>
</tr>
</tbody>
</table>
In the strategy process a very large number of actions were developed in relation to community assets. This resulted in seventy four Management Action Targets (MATs) grouped into seven Resource Condition Targets (RCTs).

**One issue was assessed to be Essential:**

- **Regional Economy** (CA.R7: All industry to be economically, socially and environmentally sustainable through facilitation of industry change).

**Two issues were assessed to be Important:**

- **Built Environment** (CA.R6: Key Facilities and Infrastructure of region which is at risk by a natural resource threat to be managed to maintain current condition. Infrastructure development to take account of NRM priorities, threats and opportunities for management.)

- **Human Capacity/Governance**  CA.R1: NRM funding into the Region to be the equivalent of 1% of GDP; CA.R2: Clear governance and decision making framework and support for regional delivery of NRM is in place; CA.R3: Strong and positive partnerships in place and regional strategy aligns and enables local area plans; CA.R4: Integrated incentive schemes established and enabling positive resource management through flow of private investment).

For detail on targets relating to Community Assets see page 138.
6.0 OPPORTUNITIES

6.1 OVERVIEW

The pessimist sees difficulty in every opportunity. The optimist sees opportunity in every difficulty. ~ Winston Churchill

In using an “asset/threat” paradigm for the development of this strategy we have been conscious of the risk of developing a “problem-centred” focus. However, we are blessed with the fact that the NAR has a relatively pristine environment, a stable and prosperous economy based on a range of different industries, and a vibrant, committed and independent community. In addition there are many new economic opportunities opening up which we are keen to take advantage of. One of the strengths of this strategy will be if we can link the resource and management targets we have set for natural resources, to the development of these opportunities.

Some of the reasons that opportunities exist in the region are:

- Cheap land
- Good quality groundwater
- High value conservation assets
- Mineral, oil and gas deposits
- Near pristine oceans with abundant fish
- A long coast with unoccupied beaches

Currently the region still has relatively cheap land. In a recent analysis of agricultural land on offer in Western Australia, cropping/grazing land was available in the NAR from as little as $150-250 per ha between Mullewa and Perenjori, with variations up to $950 per ha at Badgingarra and Dandaragan. Horticultural land in the Chapman Valley and Gingin areas was available for approximately $2000 per ha. In contrast, land in the South West and South Coast of the state was on offer for $1000 (Wellstead), $2600 (Boyup Brook), $4900 (Balingup), and $8900 (Denmark) per ha (JM Wilson, pers comm).

The high value conservation areas, particularly National Parks like Nambung, Mt Leseur, Kalbarri and Moore River, and beautiful coastline, coupled with an interesting inland lake system and abundant wildflowers, make this region ideal for the expansion of environmental tourism. A strong Indigenous population and culture further strengthens this possibility.

In the following pages, some of the opportunities for the region are outlined, together with a brief discussion of their links with NRM issues. In some cases (eg mining and tourism), there may also be potential threats from the development of the opportunity.

The opportunities outlined are as follows:

- Agriculture
- Forestry
- Tourism
- Mining
- Fishing
- Aquaculture
- Lifestyle and Urban Expansion

6.1.1 GROUNDWATER AS AN OPPORTUNITY

As demonstrated in the assets section on groundwater (page 68), there is abundant high quality groundwater under parts of the region, particularly on the coastal plain. While there are some allocation issues associated with this water, and some areas are already fully allocated, there remain many opportunities for expansion in horticulture and other industries that depend on groundwater supplies. In particular, the abundant groundwater under the Eneabba area is yet to be exploited. While irrigated horticulture is developing rapidly in coastal parts of the NAR, there is still much expansion that could be achieved. Other opportunities presented by groundwater include other forms of intensive agriculture, aquaculture and secondary industries, as well as urban expansion, all of which depend on good water supplies.
Figure 14. Soil and rainfall characteristics which link with farming system zones.
6.2 AGRICULTURE

6.2.1 CHALLENGES, CONSTRAINTS AND OPPORTUNITIES

To overcome environmental issues and production constraints, remain profitable in the face of declining terms of trade, and meet emerging community values relating to sustainability, agriculture faces significant challenges to its traditional land and enterprise practices (Bennet et al, 2003). Innovative solutions need to be developed for these issues, which may require identifying opportunities located within the challenges. Listed below are a number of opportunities potentially available to agriculture.

For the purposes of this section, the Northern Agricultural Region has been divided into four Climatic/Soil Zones (Fig 14):

1. High rainfall zone (HRZ) – broad acre cropping and grazing dominate, with increasing numbers of beef due to low land prices and the introduction of perennial fodder. Horticulture is expanding rapidly, particularly within 50km of the coast.

2. Medium and low rainfall sandplain soils (SS) – predominantly broad acre farming with reliance on wheat/lupin rotation. Although there has been a shift to cropping and reduction in livestock over the past 2 decades, the problem of herbicide resistance is resulting in a gradual recovery in livestock numbers in this zone.

3. Medium and low rainfall medium heavy textured soils (MHS) – predominantly broad acre farming with reliance on continuous cereal (wheat, barley, oats) production, with some pulse, oilseed and pasture rotational phases. Sheep grazing is also significant.

4. Pastoral Zone (PZ) – Traditionally and currently focused on wool production, with some harvesting of feral goats.

Salinity and rising groundwater

Salinity and rising groundwater are significant in the NAR and the problems are increasing (see p19). In addition to various management actions to address these issues, such as banks, drains and planting perennials, some more strategic or future alternatives potentially exist.

Saltland farming systems (HRZ, SS, MHS):

A significant amount of research has been conducted over the past decade into annual and perennial crops and pastures, and halophytes. These plants provide an opportunity to help rehabilitate saline land and/or manage waterlogging/rising groundwater, while still allowing the generation of income from grazing or cropping. Alley farming and phase farming, using annual and perennials in conjunction with normal cropping systems, is becoming a popular management method. Recently, a network of groups have been formed which focus on Sustainable Grazing of Saline Land and this will facilitate further development, innovation and adoption of saline farming systems. Some problems associated with the adoption of these systems include establishment success and cost, lack of salt land agronomy and animal husbandry knowledge, along with opportunity costs (Barrett-Lennard, 2003; Department of Agriculture, 2003).

Harvesting of salt and minerals from salt water (MHS):

Salt is one of the world’s most widely used inorganic chemicals with more than 14,000 known uses. Minerals such as gypsum and magnesium have also been successfully harvested in conjunction with salt. Although several relatively small salt harvesting ventures exist (eg. Kalannie), most mineral extraction processes require large inputs of brine to be profitable. For smaller production systems, niche markets will need to be targeted. Considerable technical knowledge and venture capital is also required. Opportunities may exist however for cooperatives or joint ventures in regional areas that have large salt lakes and amounts of saline water (Department of Agriculture, 2003b; Kingwell, 2003).

Salinity trading and offset schemes (MHS):

In this initiative market-based instruments such as salinity trading are used to value the services provided by native vegetation in maintaining a functioning hydrological system. This value is then used to generate a land-use change. Under a
trade mechanism, a limit can be placed on the total salt load generated by various activities. Offsets are mechanisms where negative activities such as clearing can be balanced by separate actions with positive impacts. Currently this initiative is in its trial stage with some pilot tests being conducted in Victoria and NSW (EPA, 2004).

Salt tolerant cereal crops (MHS):
CSIRO, the WA Department of Agriculture and Murdoch University are currently collaborating on research into salt tolerant wheat varieties. This involves identifying ancient varieties of wheat, whose roots or leaves exclude or tolerate salt, and crossing them with modern varieties. It is not yet clear what levels of salt these plants are able to tolerate, but they may have application in areas mildly or moderately affected by salt which are unlikely to become further saline (CSIRO, 2002; Murdoch University, 2002).

Desalination (MHS):
Desalination technology is developing rapidly, with processes such as reverse osmosis showing potential for fodder production, aquaculture and horticulture. Currently, the cost of traditionally supplied water is cheaper than the full cost of desalinating water, but as the cost of finding, maintaining and delivering fresh water increases, and the cost of desalination decreases, there may be greater uptake of this technology (Kingwell, 2003; DAWA, 2003b).

Plantation timber and carbon trading (HRZ, SS, MHS):
Parts of the high rainfall zone are suitable for timber plantations, such as Maritime pines and Eucalyptus sawlogs. Across the region, other opportunities include Broombush, Oil Mallees and Sandalwood. As well as alternative income, trees also provide an opportunity to manage groundwater recharge and reduce erosion. They may also provide a source of revenue through carbon trading. Further discussion of forestry is given on page 104.

Soil condition
Soil condition issues such as pH, structure, erosion and fertility are major constraints to production and have significant environmental implications. There are a number of emerging technologies that can be used in conjunction with, or to complement, traditional soil management practices to increase their effectiveness.

Precision farming (HRZ, SS, MHS):
Precision farming refers to the use of GPS guidance technologies, yield mapping, variable rate technology, remote and electro-magnetic sensing, and tramline farming techniques. Precision farming results in more efficient use of inputs such as fertiliser and herbicide, greater management of soil variability, more targeted application of soil amelioration inputs such as gypsum and lime, and less soil compaction. Precision farming technologies have been demonstrated to significantly improve crop production gross margins and soil condition. However, the current costs of introducing precision farming equipment can be considerable and this may be prohibitive to widespread adoption until benefits are quantified further and/or the technologies become less expensive (Wylie, 2002; Department of Agriculture, 2004).

Environmental Management Systems (universally applicable):
An EMS is a systematic approach which can assist any enterprise to identify and manage its impacts on the environment effectively, while providing opportunities for improved business performance and marketing. The value of the EMS framework lies in improving the efficiency of on-farm resource use and the sustainability of agricultural production, while assisting landholders to meet evolving challenges of community and marketing demands. Barriers to EMS adoption include product segregation, cost and time requirements for implementing and maintaining the system, as well as the costs associated with third-party verification, particularly when no premiums currently exist for EMS certified produce. Until community/market signals become more pronounced it is unlikely that there will be widespread adoption of EMS (AFFA, 2003, Taylor and Dracup, 2000).

Farming systems
The viability of a number of traditional farming systems is being threatened by a range of economic, environmental and biological issues, such as declining terms of trade, soil degradation and herbicide resistance. For landholders to survive and prosper they need to evaluate their options, adopt new technologies and practices, and diversify where appropriate.
Decision support tools (HRZ, SS, MHS):

A number of computer models, such as Simulated Transitional Economic Planning, Ryegrass Integrated Management, MIDAS, and Agricultural Production Systems Simulator are available to assist landholders assess the feasibility of changes to their enterprise mix or practices. These models provide information on the economic and biological implications of various agronomic options and enable projections based on transitional costs and income. The value of these models lies in their ability to provide landholders with valuable insights into changes to the farming system, before committing financial resources. However, increased familiarity with these models among landholders and consultants, along with some improvements in their user-friendliness and application, may be needed before they are commonly used (P. Metcalfe, pers. comm.).

Climatic forecasting and decision support tools (SS, MHS, PZ):

Climate variability is a significant issue and good management of climate risks will become increasingly important in agriculture. Improvements in climate forecasting along with a number of climate related decision support tools, such as Australian Rainman and Potential Yield Calculator, provide information that enable landholders to adjust their farming practices and inputs according to seasonal predictions. Landholder familiarity with, and confidence in, these technologies and tools currently limits their utilisation (Department of Agriculture, 2004b).

New crop and pasture varieties (HRZ, SS, MHS):

Modern selection and breeding techniques are resulting in continual improvements in the genetic qualities of crop and pasture varieties. Greater yields and quality, disease and pest resistance, earlier maturing, reduced recharge and soil condition tolerance provide landholders with plants that have more flexibility and can contribute improved sustainability. Awareness, availability and price of new seed, along with concerns about the independence of claims about some commercial varieties, can be limiting factors in the uptake of new varieties (Department of Agriculture, unpublished).

Diversification

Horticulture (HRZ):

Over the past decade there have been significant increases in the horticultural industry in the NAR, mainly in the Gingin and Geraldton areas. The Dandaragan and Northampton shires are also regarded as areas with good development potential. Major crops include rock melons, citrus, zucchini, watermelons, olives, carrots and table grapes. However, other crops such as asparagus, custard apples and mangoes are also being developed. Some of the suitable crops (eg asparagus, some tomatoes) also have some salt tolerance. However, suitable climate and access to adequate water supplies and licences, as well as the limited availability of consultants and labour are challenges for horticultural expansion (Agriculture Western Australia, 2000; Dept of Local Government and Regional Development, 2003; Wilson and Bonnardeaux, Bonnardeaux (2000).)

Floriculture (HRZ, SS):

Wildflower harvesting and production has grown significantly in the NAR over the past five years. With a wide variety of plant species and large areas of unallocated crown land, the NAR is considered to have considerable floriculture potential. Furthermore, an improved range of commercial native flower varieties with better shelf life, ability to withstand environmental stresses and greater export potential, has widened the range of plants capable of being grown commercially. A related benefit could be the expansion of the apiculture industry. However, distance to market, regularity and volume of supply and limited technical knowledge may inhibit industry development (Agriculture WA, 2000; Department of Local Government and Regional Development, 2003).

Pastoral beef (HRZ, SS, MHS):

Cattle numbers in the NAR have moved from 159,000 in 1996/97 to 260,000 in 2003. This increase has been mainly due to beef producers recognising a number of desirable features that the NAR has to offer, such as comparatively affordable land prices, access to port, live trade facilities and fresh water supplies, as well as opportunities to value add to pastoral cattle and manage risks. These factors have resulted in 70 pastoral stations purchasing properties in the NAR, more integration of beef with cropping systems, feedlot and biodynamic/organic...
beef developments, as well as new export markets. Adoption of perennial pastures, which provide the benefit of less groundwater recharge, is increasing rapidly. Further expansion opportunities exist although constraints include rising land prices in the NAR, lack of agricultural knowledge by pastoralists, and biosecurity concerns (Agriculture WA, 2000b).

Alternative sheep breeds (SS, MHS, PZ):

Fat tailed sheep, such as the Damara and Afrikaner, provide landholders with an alternative to traditional Merino flocks. These sheep are able to survive, grow and breed extremely well in harsh conditions, achieving optimum production at low cost. They are non-selective graziers and are capable of walking long distances, thereby making use of feed away from watering points. Pure breeds are not susceptible to flystrike and do not require shearing. These qualities make fat tail sheep potentially suitable for a broad range of conditions, including low rainfall areas, salt-affected land and pastoral country. However, further research is needed to determine their strengths and limitations in a WA context. Constraints include access to genetic material and live animals, and concerns of cross-contamination of hair sheep with wool sheep.

Other

Due to the availability of natural gas, transport infrastructure, raw agricultural materials and industrial land, the NAR is regarded as having strong potential for both biofuels and other value-adding. Pigs are also an expanding industry, particularly in the Moore sub-region.

Biofuels (HRZ, SS, MHS):

The use of fossil fuels as an energy source is a significant contributor to greenhouse gases. Biofuels offer an opportunity for the State to reduce its greenhouse emissions. It is estimated that biodiesel produces 75% less accountable greenhouse emissions than diesel. Biofuels are generated from plant matter, such as residues from wood processing, canola oil and crop stubble. The main constraint for development relates to Excise Legislation and Regulation reform, along with industry investment (Dept. of Agriculture, 2003d).

Value adding (HRZ, SS):

The NAR is the worlds largest exporter of lupins and opportunities are being investigated to value-add to the industry with products such as flour and pasta, as well as for feed for livestock and aquaculture industries. Also, the Mingenew-Irwin Group is conducting a feasibility study into the potential for a paper pulp mill using wheat straw. Preliminary research indicates that the mill has good potential due the availability of large volumes of stubble and new pulping technology which produces a number of valuable by-products. However, value-adding industries have been of interest for many years in the NAR and, securing adequate venture capital, remains the greatest challenge.
6.3 FORESTRY & TREE CROPS

6.3.1 OVERVIEW

Farm Forestry in the Northern Agricultural Region has great potential. There is a diverse range of tree species that can provide economic, environmental and social benefits to the growers and the wider community (Table 31). Currently farmers throughout the region and investment companies in the private sector are growing some of the following tree crops: Pines and Eucalypts, Oil Mallees, Sandalwood, and Melaleuca (broombush) for brushwood fencing. A variety of native trees and shrubs are also being grown for bush tucker.

Farm Forestry can assist in addressing land and water degradation issues that impact upon the regions agricultural productivity, natural systems and biodiversity. The commercial returns, as well as the social and environmental benefits associated with farm forestry make it an excellent NRM tool that encourages private investment (Agriculture, Fisheries and Forestry 2003).

There has been significant investment into pine plantations in the southern parts of the region by the Forest Products Commission in share farming partnership with landholders. To date there has been approximately 7,000 hectares of pines planted in the lower parts of the region in the medium – high rainfall zones (above 450 mm per year). The Forest Products Commission also invested in smaller scale plantings of Sandalwood and Eucalypts with landholders throughout the region. In addition, there has been investment in the Piawanning and New Norcia areas by Forest Rewards, an investment company that has planted approximately 1500 hectares of sandalwood.

Members of the Oil Mallee Association have also planted thousands of hectares of Mallees throughout the region. The most noted achievement was the brokering of a multi-million dollar carbon credit arrangement with the Kansai power company in Japan, that resulted in 1000 hectares of Oil Mallee trees planted on farms.

There are also a number of farmers throughout the region who are investing in commercial tree crops, from Northampton to Gingin, and as far east as Kalannie.

Farm Forestry will play a pivotal role in natural resource management in the Northern Agricultural Region in future years. Replanting perennial vegetation into the landscape to address environmental issues is a vast and challenging task. It will require a revegetation system that can provide incentives and resources to further investment into sound land management activities (John Bartle, pers comm.).

As well as providing potential for alternative income on unproductive land, and a potential source of revenue through carbon trading, forestry provides an opportunity to manage groundwater recharge and/or waterlogging, and in turn salinity (although lack of salt-tolerance can limit effectiveness). However, both commercial and carbon sink plantings would need to reach critical masses before being able to support new industry development, and this may be more readily achieved by cooperative or joint venture arrangements (Department of Agriculture, 2003b; Kingwell, 2003; Department of Agriculture, 2003c).

The ‘Search’ Project

There have been numerous tree crop trials established throughout the Northern Agricultural Region (NAR). Most of these trials have been dedicated to finding out what trees will grow where. Perhaps the most ambitious tree trials were a part of the ‘Search’ project run by the Department of Conservation and Land Management.

This project focused on those areas of Western Australia that received less than 600mm of rain per year and replanted 6.3 million trees back into the landscape. This project established 107 demonstration sites, many of which are within the NAR. The project evaluated a wide range of native species and selected 12 species that demonstrated potential to be grown on a large scale for commercial purposes, such as pulp for paper and cardboard products. Some of the species grown for this purpose included: Taxandria juniperina, Grevillea leucopteris, Alogyne huegelii and Grevillea candelabroides.

Trees were also selected for products like medium density fibre-board (MDF). Some of the species that demonstrated potential for MDF products included Taxandria juniperina, Eucalyptus rudis, Viminaria juncea, Anthoceros littorea, Gyrostromon ramulosus, and Condocarpus contoinifolius. Many of the species selected also have the potential for high quality oils and hardwood timber products. Further work needs to be completed on provenance selection to improve the commercial viability of many of
the species tested. (Final Report for NHT Project 973849, 2004).

6.3.2 CHALLENGES AND CONSTRAINTS

Some of the challenges and constraints to farm forestry development include:

- A shift in the culture of the agricultural sector is needed. Tree crops do not provide returns annually, are often long term investments, and require good farm planning in terms of setting aside land from other enterprises;
- The constraints of some grant funding can restrict farm forestry options;
- The failures of some taxation driven tree-planting schemes has a negative impact on adoption;
- Coordinating the efforts of stakeholders and investors is a continuing challenge;
- Distance to processing plants is an issue. Often the economics of projects are undermined by the transportation costs of sending the products to Perth.
- A skilled workforce. As this is a relatively new industry to the region there is a shortage of contractors with skills in managing plantations and processing timber products.
- The willingness of industry to embrace the private growers sector. This is currently causing difficulties in regard to harvesting and marketing.
- The ‘Rights to Harvest’ issue and legislation. Legislation, and the lack of understanding about it in the community, has caused confusion with some landowners, and has some negative impacts on adoption.
- Research and development into the growth rates and yields of tree crops throughout the region is at its infancy, and requires further funds and resources to encourage future private investment.

6.3.3 FUTURE OPPORTUNITIES FOR EXPANSION

This region has a great potential to capitalise on future investments into plantations and the development of processing facilities. Existing industries in urban areas are currently under pressure to relocate factories and processing plants. Much of the infrastructure required to develop forestry in the region is already in place. Roads are being built to handle heavy haulage trucks and there is excess power and water available in some areas.

Sites that will be seriously considered for future industry development must have power and water as well as be positioned close to a highway, major road or have direct access to rail. This will allow efficiency in transportation of raw materials and value added products. Future development will also require a workforce and room to expand, so there will be no short-term pressures to relocate. One such place, that fulfils all of the above requirements in the region is Moora.
Table 31. Opportunities for tree production in the NAR.

<table>
<thead>
<tr>
<th>Tree Crop</th>
<th>Current Area (2004)</th>
<th>Rainfall H/M/L</th>
<th>Expansion Potential H/M/L</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pinus pinaster (Maritime Pine)</td>
<td>7,000 Ha</td>
<td>400 mm plus (requires at least a 3m depth of well drained soil)</td>
<td>High</td>
<td>Forest Products Commission has provided majority of investments into the region so far, although the number of private plantations is growing. Private Industry is currently looking to the NAR for expansion and relocation opportunities.</td>
</tr>
<tr>
<td>Oil Mallee</td>
<td>Approx. 3,000 Ha</td>
<td>300 mm plus</td>
<td>High</td>
<td>This tree crop has already attracted significant external investment into the region by selling carbon credits to a Japanese power company.</td>
</tr>
<tr>
<td>Paulownia</td>
<td>Approx. 1,000 Ha</td>
<td>On irrigation</td>
<td>Low</td>
<td>Driven by a tax incentive scheme. Provided external investment into rural communities.</td>
</tr>
<tr>
<td>Sandalwood (hemiparasitic)</td>
<td>Approx. 1,600 Ha</td>
<td>200 mm plus commercial – 350mm plus (NB requires host trees)</td>
<td>High</td>
<td>Forest rewards have provided external investments into the region through a prospectus document planting 1500 ha. Forest Products Commission also have sandalwood share farm agreements within the NAR.</td>
</tr>
<tr>
<td>Melaleuca spp.</td>
<td>Less than 1,000 Ha</td>
<td>300 mm plus</td>
<td>High</td>
<td>A brushwood-processing factory for the region will be built when 1,000 Ha is established. The Company Brushwood Australia is also looking to relocate possibly to the NAR or the Avon.</td>
</tr>
<tr>
<td>Eucalypts</td>
<td>Less than 1,000 Ha</td>
<td>350mm plus</td>
<td>High</td>
<td>Forest Products Commission have Eucalypt share farm agreements within the NAR. There are private growers currently managing plantations up to 20 Ha. On farm processing using portable equipment will be encouraged.</td>
</tr>
</tbody>
</table>
6.4 FISHING & AQUACULTURE

6.4.1 OVERVIEW
As discussed previously, commercial fisheries are a key component of the economy of many of the small towns in the NAR. The western rock lobster (Panulirus Cygnus) is the dominant fishery species and provides most of the dollar value of the commercial fisheries. There are a number of other fisheries, for bottom living finfish such as dhufish, baldchin groper, snapper and coral trout. There are also local areas where scallops and abalone are caught. Recreational fishers are equally important to the local economy, and their numbers are growing.

6.4.2 CHALLENGES AND CONSTRAINTS
Most of the major fisheries in Western Australia are now fully exploited (Penn et al. 2003), allowing little opportunity for expansion of the catch. As the number of recreational fishers increases, there will be increasing competition between the commercial and recreational sectors. A major challenge will be to develop integrated fisheries management to manage the fisheries as a whole and to accommodate the requirements of the two segments of the fishery.

There are several major constraints to the development of marine aquaculture in the NAR:

- The coastline is open and exposed, and sea-based ventures risk losses of equipment and stock during storms. Most of the sheltered water in the NAR is in the Houtman Abrolhos Islands, where a number of pearl farms have already been established and a tuna farm proposed. There is little space available in the islands for further farms. There will be competition for space with other users inshore but intensive onshore aquaculture may overcome some of the space constraints.

- As the industry is new in Western Australia, there is little available information on techniques for raising local species, including endemic Western Australian species in the local environment.

- A third constraint is the remoteness of much of the NAR from the major markets in Perth or overseas. This increases the costs of inputs and product transport.

6.4.3 FUTURE OPPORTUNITIES

Processing and marketing
As there is little opportunity to expand the wild caught component of fisheries in the NAR area, opportunities must be sought to enhance the value of the existing catch. Since the western rock lobster is the economically dominant species, it is the logical place to start. Rock lobsters were originally sold canned or boiled and frozen. In recent years there has been a move towards exporting more of the catch live, as the live animals command a higher price. When the lobsters are caught and handled, a proportion of them react by autotomizing (throwing off) their legs. This makes the lobster less attractive, and thus worth less. Research is underway to chill the lobsters after they are caught to reduce the loss of legs, and improve the price. Improved marketing, and certification as sustainable fisheries will also open opportunities for enhancing the value of the catch. Similarly, better handling techniques could enhance the value of the finfish catch, and other species in the industry.

The sardine industry in Fremantle provides an excellent example of how clever marketing can enhance the value of an existing catch. Sardines were originally a low-value fishery, but clever marketing enhanced the public appeal of the fish through an annual “Sardine Festival” in Fremantle. Now the fish are widely sold and are included on the menus of leading fish restaurants.

There are a number of species which could be used for aquaculture in the NAR, including pearl oysters, scallops, abalone, oysters, rock lobsters, and a variety of finfish (Fisheries WA 2000). Water quality in the region is generally good, and Western Australian seafoods have a “clean and green” image. As aquaculture techniques improve, it may be possible to develop profitable aquaculture ventures in the NAR producing high quality seafoods for the WA and overseas markets.

Resource sharing
Described as a challenge, this is also an opportunity to ensure that the arrangements developed obtain the maximum economic advantage from the limited fisheries resources.

Marine aquaculture
Other than pearling, which has a long history in the state, most aquaculture industries in Western Australia are in their infancy.
• Companies have been trialing production of blacklip pearls, Pinctada Margaritifera, which are grown widely in the Pacific. Several companies now have leases in the Abrolhos, including all three island groups. In some cases, lines have been in the water for several years and pearls have been produced. Commercial production levels may be reached in the very near future.

• Tuna Trials: Environmental assessment is underway for a trial to catch yellowfin tuna (Thunnus albacores) in open waters then to grow them out in cages in the channel north of Southern Group at the Abrolhos.

• Snapper: Several years ago there was an attempt to grow snapper commercially in Jurien Bay, but the project failed.

• Scallops: The Abrolhos scallop fishery for Amusium balloti has been targeting wild caught scallops. An experiment is currently being conducted by Shark Bay Tuna Pty Ltd into spawning scallops in a shore based laboratory in Geraldton. The idea is to grow millions of young in the laboratory through the veliger larval stage which lives in the plankton and into the spat settlement stage. The young spat will then be released into the wild to enhance catches of commercial scallops when they have grown. Unfortunately, the Geraldton laboratory was dependent on water from Geraldton Harbour. The experiment was suspended in anticipation of high silt concentrations from the harbour dredging problem.

**Land-based aquaculture**

Finfish, algae and brine shrimp have all been successfully produced commercially using saline ground water. Freshwater species such as yabbies, marron and silver perch have also been successfully produced commercially in areas where there is an abundance of freshwater. Both types of aquaculture exist in the NAR but it is a very minor industry. However, algae are being successfully grown at Port Gregory for the production of beta carotene in a land-based venture. The labour intensive nature of aquaculture, preference for clay soils for dams, requirement for specialised technical knowledge, high capital outlays, distance to market and issues associated with water disposal are likely to prove prohibitive to most individuals. Opportunities may exist however for cooperatives or joint ventures (Kingwell, 2003; Agriculture WA, 2000).
6.5 TOURISM

6.5.1 OVERVIEW

Several tourism plans and reports for this area, characterise tourism product as largely underdeveloped, with mixed quality standards, limited accommodation, fragmented promotion and low visitor awareness and visitation. Coastal regions are more advanced, particularly Geraldton, Cervantes and Kalbarri.

Nevertheless, significant and growing numbers of visitors are travelling within the Mid West and Wheatbelt. For example, in calendar year 2003, the Bureau of Tourism’s National Visitor Survey records 524,000 and 697,000 visitors respectively with particularly strong growth from interstate visitors (over 10%).

6.5.2 CHALLENGES FOR TOURISM

There are challenges to create tourism experiences that are in tune with and enhance the environment, and which leave a “small footprint”. The location of much nature-based tourism also means that it is likely to be impacted by management decisions for national parks and reserves.

6.5.3 OPPORTUNITIES

Tourism opportunities are plentiful with particular potential for places and experiences that are linked with the natural beauty of the region. There are also untapped possibilities associated with Indigenous culture.

Marketing by the WA Tourism Commission will concentrate on iconic experiences. The Abrolhos Islands, Nambung National Park and wildflowers are the only icons that exist at present in the NAR. Some other places, or experiences, may soon be adopted as icons worthy of marketing campaigns. New Norcia, the Monsignor Hawes Heritage Trail, wind, beaches and Kalbarri are some of the more likely candidates. Icon status is determined by the ability to attract visitors from interstate, overseas and from within WA.

Some of the opportunities include:

Provision of additional visitor accommodation and services, eg,

- Additional caravan parks in coastal locations; construction of 4 star resort style accommodation at Geraldton and Kalbarri;
- Construction of up-market restaurants in Geraldton and Kalbarri
- Conversion of the Iluka work camp into visitor accommodation at Lake Indoon, Eneabba
- Construction of more holiday and retirement housing, particularly in the coastal areas of Dongara, Kalbarri, Geraldton and Jurien Bay
- Development of additional farm and station stay accommodation, B & B’s and a range of additional accommodation added to existing caravan parks, hotels and motels

Provision of additional planned visitor environmental interpretation sites, eg:

- The planned Separation Point (Geraldton) Marine Interpretation Centre
- Dalwallinu Environmental Interpretative Centre
- The planned Nambung National Park (Pinnacles) Interpretative Centre
- The Greenough Hamlet Interpretative Centre
- The planned Kalbarri Interpretative Centre
- Greater use of the excellent new Gravity Discovery Centre at Gingin

Provision of additional visitor trails and drives, eg:

- Planned development of the 22 sites along a self-drive Monsignor Hawes Heritage Trail;
- The recently completed stage one of the three self-drive Outback Pathways;
- The Painted Roads project;
- The planned Old North Stock Road trail for walkers and bike riders in Gingin;
- CALM’s programme of short interpretative drives and walks in Kalbarri and Mt Lesueur National Parks.

Expansion of regional events and conferences, eg:

Rural expo’s and shows (e.g. Mingenew), conferences (with Geraldton and New Norcia particularly suitable), festivals (e.g. Dongara’s Larry Lobster Festival), and events like the Moora Country Campout are growing contributors to the region’s economy.

There are untapped possibilities associated with Indigenous culture.
Growth of industrial tourism

Tours of crayfish factories, Geraldton port, mines, farms, aquaculture ventures, technological sites (like the new Walkaway and Emu Downs wind farms) and other worksites are growing in popularity and will continue to attract more visitors.

Flow on effects of Tourism based on natural resources

Tourism that is strongly reliant on the good condition of the natural resources is likely to be a major contributor to local economic development of the region. A recent study conducted in the other parts of Western Australia (Gascoyne Coast and South West forests) showed that around 90% of all visitor expenditure that contributed to local economies was due to the presence of the National Parks (David Wood, pers comm). These figures, and the fact that the total number of visitors to CALM-managed areas had doubled over the past 10 years, are critical for supporting greater investment in conservation and management of priority areas. Recreational users of natural resources, such as fishers, are also significant when considering the economic implications of tourism. Recreational angling is one of the most popular activities in the coastal and marine areas and the fishers are likely to use local accommodation and services when visiting the NAR.

Indigenous Tourism

Near Geraldton, Aboriginal tourism encompasses the Yamaji Cultural Trail operated by Wila Gutharra and the three day Cultural Awareness Tours operated by the Yamaji Language Centre. There are also a number of Indigenous art outlets. One objective of the Yamaji Cultural Trail was the production of a blue print for other Indigenous operators to follow in creating their tourism product. Protocols for Indigenous tourism are very different from those of non-Indigenous product. What stories are allowed to be told, by whom, and which sites may be visited and by whom, are very significant protocols for Aboriginal societies.

In the south of the region, Mogumber Mission is a vibrant location, steeped in the history of Aboriginal and European interactions. It has recently become well known through films like the “Rabbit Proof Fence”.

Another asset for Aboriginal tourism in the Mid West is the existence of the Indigenous Tourism Reference Group. This committee has representatives from ATSIS, the Office of Aboriginal Economic Development, WATC, Yamaji Land and Sea Council and the Department of Indigenous Affairs. Thus it is a “one-stop shop” for any tourism operator wanting information on the cultural proprieties for any site and a place to ask questions related to Indigenous tourism. No other area has such a multifaceted body to give appropriate direction to Indigenous tourism.

With only 20% of international visitors experiencing Aboriginal culture during their visit to Australia, and over 80% wishing to do so, quite clearly there is a gap between supply and demand. Better educated Australians are also wanting to become more knowledgeable about traditional cultures. Thus there are many opportunities for future growth in this area of tourism.

The Western Australian Tourism Commission will have available by August 2004 Destinational Development Plans (DDP’s) for each of its five regions of WA. These plans will identify all icons, major tourism towns and list tourism developments that are planned, recently completed and being constructed. While the NAR overlaps two of the WATC’s tourism regions, the DDP’s for these regions will be a useful tool to identify where the opportunities exist to take advantage of the growing profile of tourism as an industry in the NAR.

Thus the NAR is poised to take advantage of nature based, cultural, experiential, heritage and soft-adventure tourism, utilising the trend to short stay visits.
6.6 MINING & ENERGY

6.6.1 OVERVIEW
Mining occurs across the region, with the main product being mineral sands which is valued at over $350 million. A large proportion of the coastal plain, and the ocean, is currently subject to exploration licenses for a range of products. Also of note is the increasing demand for lime sand by the agricultural sector. This will continue to be mined and transported from the coast inland. Natural gas is also produced in the region at sites around Dongara, with production valued at $40 million. The petroleum industry, particularly offshore from Dongara, is also developing rapidly. There are opportunities for iron ore at Tallering Peak near Mullewa and at Mt Gibson.

6.6.2 OPPORTUNITIES
Mineral Sands
The Northern Agricultural Region is a significant producer of mineral sands, with zircon, ilmenite, rutile, titanium dioxide and garnet being the major commodities.

Eneabba: Iluka Resources mine site is located 150 km south of Geraldton, with production for ilmenite, rutile, synthetic rutile and zircon being $12 million, $80 million, $109 million and $100 million respectively in 2001/02.

- Synthetic rutile (of which we produce 29% of the state’s production), has a high titanium dioxide content, is produced from the upgrading of ilmenite. It is used as feedstock for the production of titanium dioxide pigment which is used in paints, plastics, paper, rubber, printing inks, cosmetics, soap and pharmaceuticals.
- Rutile is the preferred feedstock for the titanium metal used in aircraft frames and engines, aerospace industries, transport equipment and artificial joints for replacement surgery in humans.
- Zircon production in the NAR represents 46% of the state’s total. It is used in ceramic and porcelain glazes, wall tiles, dinnerware, glazed bricks and industrial tiles. Approximately half the world’s production of zircon is produced in WA.

Iluka is currently developing a new mine just west of the Gingin townsite.

Cooljarloo: The Tiwest Joint Venture, located 180km north of Perth, is Australia’s largest titanium dioxide pigment producer. Titanium dioxide pigment is produced by processing a range of titanium bearing ores, including ilmenite, upgraded ilmenite (synthetic rutile), rutile and leucoxene. It is used in the manufacture of paints, plastics, paper, rubber, printing inks, cosmetics, soap and pharmaceuticals.

Zircon is recovered as a co-product from mining titaniferous ores. It is used in ceramic glazes, porcelain glazes, wall tiles, dinnerware, glazed bricks and industrial tiles. Zirconia compounds are produced at Kwinana. Approximately half of the world production of zircon comes from WA. In 2001/02 staurolite was also mined as a co-product; it has a number of uses including as an industrial abrasive.

The Tiwest mine at Cooljarloo has a capacity to mine 20 million tonnes of ore per annum, which is processed through a dry separation plant and synthetic rutile (upgraded ilmenite) plant at Chandala, south of Gingin.

Over the last few years there has been some variability in the production of ilmenite, zircon, rutile and leucoxene by TiWest but the respective values are about $130m, $60m, $25m and $8m.

Port Gregory: The total Western Australian output of garnet is mined at Port Gregory, 100km north of Geraldton. The mine produces about 100,000 tonnes of garnet with a value of about $12 million. Garnet is naturally a hard material and is predominantly used as an abrasive in industrial cleaning and maintenance.

Talc
The Three Springs talc mine, operated by Rio Tinto, is the largest talc mine in Australia. Situated 330km north of Perth, the operation is capable of producing 150,000 tonnes of talc ore annually. The value of talc produced at the mine is about $12m. Output from the mine is sold to customers in Australia, Japan, Korea, Europe, America and New Zealand.

Natural Gas
Natural gas production is a significant industry with regional production valued at about $22 million (3% of the state’s total). However, natural gas production is expected to grow in the future with an increase in gas demand expected for the purpose of power generation by mineral-based companies, as well as
for domestic consumption. Gas processing plants are currently in operation at Dongara, Mondarra, Beharra Springs and Woodada, to treat gas produced from surrounding gas fields. The Parmelia natural gas pipeline transports gas from these processing plants, as well as gas from the north-west shelf area, to Perth and Pinjarra. There is a natural gas storage and compression facility at Mondarra, which is undergoing a second upgrade in order to meet growing market requirements and new opportunities. Recently discovered fields such as Hovea, have yet to be tied in to existing processing facilities or new facilities.

**Crude Oil and Condensate**

The onshore oil fields at Dongara are located about 65 kilometres south of Geraldton in the Perth Basin. The fields produce both crude oil and condensate with a value of $1.5 million and $0.2 million respectively.

### 6.6.3 CHALLENGES AND CONSTRAINTS

There is enormous potential for expansion of mining in the NAR, and considerable pressure on landowners not to challenge the granting of new exploration licenses on their properties. While mining can have large economic benefits there are also some concerns that the operations are conducted with sensitivity to the environment.

**Renewable Energy Generation**

A feature of the NAR, particularly near the coast, is strong and frequent wind. This makes windsurfing a popular pastime and tourist drawcard, but also provides other possibilities. There is increasing interest in wind turbines for electricity generation. There are already several wind farms planned for the region, with projects being developed by both government and private investment. For example, Alinta and Renewable Power Venture are planning a $200m, 90MW wind farm near Geraldton. The Queensland company Stanthorpe is planning one near Cervantes and another private development is under consideration for Oakajee north of Geraldton. In addition, companies such as Pacific Hydro are currently negotiating with landowners near Lancelin for rights to conduct wind resource assessments and planning.

With abundant sunshine, there is obviously also the possibility of increased solar power, but there is little current development in the region beyond domestic water heating.

**Coal mining**

The states first coal was mined in the Irwin/Mingenew area, but coal has ceased to be an important industry. However, there is renewed interest in coal mining, particularly in the Eneabba area. Any such developments need to proceed with caution and be mindful of the high value native vegetation communities in this area.
6.7 LIFESTYLE & URBAN EXPANSION

6.7.1 OVERVIEW

As for the rest of Western Australia, and indeed Australia, the majority of the population of the NAR resides in coastal settlements. From Guilderton in the south to Kalbarri in the north, there is an increasing trend towards the growth of these settlements.

The population of the NAR grew by about 6.3% for the census period 1996 to 2001. Western Australia Tomorrow (WAPC, 2000) predicts continued population growth into the future. Continued population growth will provide economic opportunities in the NAR and will support continued improvements to services.

However, population growth is not consistent across the NAR. Shires that contain either parts of, or entire coastal settlements, are experiencing high growth rates, while other Shires of the NAR with mainly inland communities, are experiencing population decline. This means that while there are significant opportunities for the NAR as a result of population growth, these opportunities are largely limited to coastal settlements. The concentration of growth within and around coastal settlements will continue to place pressure on the conservation and landscape values of coastal and near coastal areas.

Notwithstanding the economic and social opportunities available in coastal settlements, due to the multipliers associated with strong population growth, there are lifestyle opportunities in other parts of the NAR. Many people seek to escape the pressures of urban development and find a quiet country lifestyle. Improvements in transport and communication allow people to live further away from employment centres and social infrastructure. People may be attracted to non-coastal settlements of the NAR because of the relaxed atmosphere, the established character, safe environment, the scenic setting or the country lifestyle combined with access to services.

The Aboriginal population of the NAR is steadily increasing (Australian Bureau of Statistics Census 1991, 1996, 2001) with over 60% of the population under 25 years old. Factors contributing to this are high fertility rates, reduction in infant mortality and increased life expectancy. Aboriginal communities have close associations with particular parts of the NAR. In some cases, communities establish settlements or living quarters on traditional lands.

6.7.2 CHALLENGES AND CONSTRAINTS

A challenge for settlements of the NAR in achieving urban growth, is the concentration of services and infrastructure, both at a State and regional scale. A study should be undertaken to identify services and infrastructure that are required at both a regional and settlement level but are either currently not available or inadequate, and actions should be taken to promote such services and infrastructure being provided or improved.

The biggest challenge in accommodating urban expansion in the NAR is protecting significant conservation and landscape values in the path of development. To meet this challenge it is necessary for studies to be undertaken to identify areas around coastal settlements with significant conservation or landscape values so that these values can be retained through future planning, and to recommend appropriate management arrangements so these values are not degraded.

The land clearing restrictions under amendments to State environmental legislation may pose a constraint to urban expansion in some coastal settlements of the NAR, particularly where there is low representation of vegetation communities. To overcome this constraint it will be necessary to prioritise cleared areas or, if this is not possible, areas of relatively low conservation value around coastal settlements for future development.

Another constraint to urban expansion in settlements of the NAR is access to adequate potable water supplies. The capacity of surface water catchments to supply public drinking water in the NAR is relatively low and groundwater resources are heavily relied upon. In some cases current groundwater reserves limit growth potential. In others there are competing demands on groundwater resources. A study should be undertaken to determine the potential for urban
expansion in NAR settlements based on secured sustainable public drinking water allocations.

A significant challenge in attracting people to non-coastal settlements to take advantage of lifestyle opportunities, is the retention and maintenance of community services and infrastructure. The trend of declining populations in agricultural areas is a cause of service and infrastructure providers discontinuing and rationalising services, and service and infrastructure maintenance. As services and infrastructure are withdrawn and deteriorate it becomes more difficult to reverse the trend of population decline. A services and infrastructure strategy is needed for the NAR to determine how services and infrastructure can be most efficiently provided without compromising community access.

6.7.3 FUTURE OPPORTUNITIES FOR EXPANSION

The growth of coastal settlements in the NAR will continue where there are sufficient water resources, services and infrastructure to sustain such growth. The growth will be accommodated without adversely impacting on significant conservation and landscape values.

Other settlements in the NAR will remain important centres for surrounding communities. People will move to these areas to take advantage of the country lifestyle and because these areas are appropriately serviced by physical and social infrastructure.
7.0 GOALS & TARGETS

7.1 OVERVIEW

7.1.1 GOALS AND OUTCOMES

One of the main aims of this strategy is to set goals and targets for the region in relation to our natural assets. As indicated in the introduction, and repeated in the next section, we have set an overall long-term goal (sometimes referred to as an “aspirational target”) for each of the six assets we have identified. While these are broad in nature, they are intended to give an overall perspective on the direction we are taking, and the outcome we aspire to. The “National Framework for Natural Resource Management Standards and Targets” sets national outcomes that government investment in natural resource management expects to achieve. In line with these guidelines we have addressed the following outcome statements:

- **Salinity:** The impact of salinity on land and water resources is minimised or avoided.
- **Ecosystems:** Biodiversity and the extent, diversity and condition of native ecosystems are maintained or rehabilitated.
- **Species & Communities:** Populations of significant species and ecological communities are maintained or rehabilitated.
- **Ecosystem services and functions are maintained or rehabilitated.**
- **Water Quality:** Surface and groundwater quality is maintained or enhanced.
- **Threats minimised:** The impact of threatening processes on locations and systems which are critical for conservation of biodiversity, agricultural production, towns, infrastructure and cultural and social values, is avoided or minimised.
- **Water allocation:** Surface water and groundwater is securely allocated for sustainable production purposes and to support human uses and the environment, within the sustainable capacity of the water resource.
- **Sustainable production systems are developed and management practices are in place, which maintain or rehabilitate biodiversity and ecosystem services, maintain or enhance resource quality, maintain productive capacity and prevent and manage degradation.**

7.1.2 ACTIONS AND TARGETS

Also in line with the “National Framework” we have researched the condition of the resource, and for each asset (and “sub-asset”) we have set “Resource Condition Targets” (RCTs). These are medium-term goals that we believe could be achieved within 10-20 years. We are conscious that these targets need to be specific, measurable, scientifically-based, and achievable. This is a challenge, but we believe we have developed a plan that will deliver significant benefits to the region. We recognise that while we are fortunate to live in a region with significant natural attributes still intact, and with high conservation values, there is much that could be done to preserve and/or improve the condition of our resources.

We have also devised shorter-term management or capacity-building actions which will contribute to achievement of the RCTs, and have set corresponding “Management Action Targets” (MATs). As natural processes are frequently slow, it has been a challenge to set targets that are measurable and realistic and can be achieved in a short timeframe (1-5 years).

The diagram overleaf shows the main steps we have taken. A key element of our process has been the grass roots approach and the substantial input of the community, particularly in relation to the setting of the Management Action Targets. The diagram also shows that MATs are linked in a further step to projects via a trade-off process. All actions developed into projects will also have monitoring and evaluation components; this is dealt with in a later section (see p 143).

7.1.3 FORMULATING ACTIONS

In order to achieve changes in the resource condition, and lead to improved natural resource management in the region, it is imperative that we identify actions that not only have scientific validity, but are also practical. From the community’s point of view, it was also important that the majority of these actions deliver changes that are clearly observable “on-the-ground.”

“Desirable futures” were discussed at a large number of community forums where community members compared their “dreams and nightmares” about...
the future state of local natural resources. A large number of actions were devised which were later tabulated, cross-referenced, and refined at a series of regional workshops. In assessing the worth of each proposed action, we analysed the following, in accordance with the government strategy guidelines:

- the mechanism by which the action will achieve its target;
- relevant indicators that can be used to assess progress;
- background assumptions inherent in the action or the related mechanisms;
- possible risks that might impact on achievement of the target;
- any data gaps, including baseline data, a lack of indicators, or monitoring deficiencies.

While it is desirable to concentrate on actions with an “on-ground” component, we also believe that activities relating to investigative studies, planning and community capacity building are also very important. Thus our MATs cover a range of issues and activities, including:

- Resource assessment—resource investigations, baseline monitoring, decision support tools;
- Institutional change—policy or legislative adjustments or interpretations that would assist NRM implementation;
- Planning—plans relating to a particular resource, and integrated management plans, particularly those that cross boundaries or themes;
- Community capacity—particularly skills and training;
- On-ground works—a wide range of practical activities which involve action within and directly in contact with the landscape, waterscape or seascape.

**Timeframes and measurable outcomes**

Management Action Targets are designed to be achieved within 1-5 years. They are also formulated such that progress can be measured quantitatively and compared with the target. An example is “X ha of woody perennials to be planted within 5 years”. This is designed to contribute in the long term to a lowering of the watertable, and an amelioration of salinity. A difficulty is that measuring the rate of development of salinity is imprecise and we have an inadequate bore-monitoring program with which to measure water tables. Nevertheless it is widely acknowledged that this MAT is appropriate and important. Where such difficulties exist we have noted them in the tables.
7.2 LINKAGES

7.2.1 HIERARCHICAL FLOWS BETWEEN TARGETS

There is a link between all levels of the process in a type of “hierarchical flow”. At each step in the chain multiple branches arise leading onto more and more specific activities. Eventually several actions may be re-grouped as projects with multiple outputs. Table 32 gives an example of a single flow-through link for the asset Biodiversity, using the threat of vegetation removal and showing how Aspirational Targets are linked to the various targets.

Table 32. Links between different levels of targets.

| VISION for the Region (Aspirational target) | We aspire to be part of a vibrant communityin a diversified economy with a healthy environment |
| ASSET | BIODIVERSITY |
| GOAL FOR BIODIVERSITY (Aspirational target) | Species and community diversity, and ecological processes, maintained, protected and enhanced for all terrestrial habitats |
| THREAT/ISSUE | Vegetation Removal / Degradation |
| Current Resource Condition | Quality vegetation is decreasing due to human activities such as clearing and grazing. The extent remaining in the Greenough, Yarra Yarra, West Midlands and Moore sub-regions is 15%, 12%, 52% and 24% respectively |
| Resource Condition Target (BD.R1) | Maintained and increased native vegetation extent (other than approved clearing applications) by a yet to be determined % for each IBRA* sub-bioregion by 2025. Interim Bio-Regionalisation of Australia |
| Management Actions | Analyse vegetation not within the formal reserve system and identify priority remnants; Fence, and develop voluntary management agreements, for off-reserve areas greater than 10ha |
| Management Action Target – Resource Assessment (BD.R1.M3) | Priority Remnants identified for inclusion in Comprehensive, Adequate and Representative (CAR) reserve system annually with a yet to be determined number of ha purchased in 5 years. |
| Management Action Target – Institutional Change (BD.R1.M5) | Develop incentives for biodiversity protection and management over the next 1-3 years |
| Management Action Target – On Ground Works (BD.R1.M1) | A yet to be determined percentage of off-reserve remnant vegetation over 10Ha protected by fencing year 2008A yet to be determined percentage of off-reserve vegetation over 10Ha under a management agreement by 2008 yet to be determined percentage of off-reserve remnant vegetation protected under a legal mechanism (e.g. conservation covenant) by 2008 |
| Indicators | Indicator: Change of vegetation extent /condition analysisNOI process vs. revegetation for biodiversity cons. |
| Investment Plan | All these management actions will be part of a significant regional biodiversity project that will focus on reducing fragmentation, by identifying and preserving high priority off-reserve remnants |
7.2.2 LINKS TO OTHER STRATEGIES OR PLANS

We recognise that greater progress will be obtained by linking our actions to existing strategies or plans, rather than by acting independently. These links may be strategies of national, state or regional derivation, or may be an action already identified by another (possibly non-government) organisation. This is discussed in more detail in the section on Legislation, Policy and Plans on page 141.

7.2.3 CROSS-REGION OR CROSS-THEME SYNERGIES

None of the elements in this strategy can be considered in isolation – there are numerous issues that cross boundaries, or cross themes. For instance, salinity is a threat to most of the assets we have identified and needs to be addressed in a holistic way. In addition, many assets, threats or opportunities occur in, or trend across, more than one region and there will be considerable synergism by acting in tandem. Links between targets are noted as “synergies” in the target tables.

In the target tables a column on “synergies” is presented. This directs the reader to other Management Action Targets that are linked to the one in question. Links may be “positive” or “negative”. Negative synergies may occur when two actions together result in a “more undesirable” outcome than before. However, in general most synergies are positive.

7.2.4 MATTERS FOR TARGETS

As the goals and outcomes are very broad, the “National Framework” also identified ten ‘matters for targets’ designed to help focus the natural resource planning and investment needed to deliver the outcomes. We have considered all of these matters, and have set corresponding targets. In addition to the matters specified by the guidelines, we have included a number of others, most importantly those related to infrastructure and community, but also to issues such as air quality and climate change.

Overleaf is a table which links the “matters for target” with the corresponding RCT and MAT that we have identified. Where a particular matter is only of minor importance in this region at the moment, this is also noted.
### 7.3 MATTERS FOR TARGET

**Table 33. Summary of links between the mandatory “matters for target” identified in the “National Framework” and the NAR strategy. For target tables see pages 123-140.**

<table>
<thead>
<tr>
<th>MANDATORY MATTERS FOR TARGET</th>
<th>CORRESPONDING RCTS (OR MATS WITHIN THEM)</th>
<th>REFER TO PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>RC1 Land salinity</td>
<td>LN.R1, LN.R2</td>
<td>123</td>
</tr>
<tr>
<td>RC2 Soil condition</td>
<td>LN.R4, LN.R5, LN.R6, LN.R7, LN.R11, LN.R12</td>
<td>124, 125</td>
</tr>
<tr>
<td>RC3 Native vegetation integrity</td>
<td>BD.R1, BD.R2, BD.R5, BD.R6</td>
<td>127, 128</td>
</tr>
<tr>
<td>RC4 Inland aquatic ecosystems integrity (rivers and other)</td>
<td>WA.R3, WA.R4, WA.R5</td>
<td>130, 131</td>
</tr>
<tr>
<td>RC5 Estuarine, coastal and marine habitats integrity</td>
<td>WA.R7, WA.R10, CM.R2, CM.R4-R8, CM.R12, CM.R16</td>
<td>132, 135-137</td>
</tr>
<tr>
<td>RC6 Nutrients in aquatic environments</td>
<td>WA.R5</td>
<td>131</td>
</tr>
<tr>
<td>RC7 Turbidity/suspended particulate matter in aquatic ecosystems</td>
<td>WA.R1</td>
<td>130</td>
</tr>
<tr>
<td>RC8 Surface water salinity in freshwater aquatic ecosystems</td>
<td>WA.R4</td>
<td>131</td>
</tr>
<tr>
<td>RC9 Significant native species and ecological communities</td>
<td>BD.R5, WA.R7, CM.R9-11</td>
<td>128, 136, 137</td>
</tr>
<tr>
<td>RC10 Ecologically significant invasive species</td>
<td>BD.R8, BD.R9, WA.R3, CM.R9, CM.R11</td>
<td>129, 132, 136, 137</td>
</tr>
<tr>
<td>MA1 Critical assets identified and protected</td>
<td>BD.R1, WA.R3, CM.R16</td>
<td>127, 130, 137</td>
</tr>
<tr>
<td>MA2 Water allocation plans developed and implemented</td>
<td>WA.R11</td>
<td>132</td>
</tr>
<tr>
<td>MA3 Improved land and water management practices</td>
<td>All LN RCTs, WA.R1, ULN.R2</td>
<td>123-125, 126, 130</td>
</tr>
</tbody>
</table>

**ADDITIONAL NAR MATTERS FOR TARGET**

| NAR1 Biosecurity | LN.R3 | 124 |
| NAR2 Groundwater quality | WA.R14 | 133 |
| NAR3 Management and planning for urban and crown land | ULN.1, ULN.2, WA.R8, WA.R9, WA.R10 | 126, 132 |
| NAR4 Aboriginal land | CM.R13, CA.R6 | 137, 139 |
| NAR5 Recognising and preserving culture and heritage | CM.R13, CA.R3 | 137, 138 |
| NAR6 Developing human capacity/governance | BD.R10, CM.R1, CA.R1-4 | 129, 135, 138, 139 |
| NAR7 Built Environment | CA.R6 | 140 |
| NAR8 Regional Economy | CA.R7 | 140 |
| NAR9 Climate change and seasonal variability | AR.R1 | 134 |
| NAR10 Air quality | AR.R2 | 134 |
| NAR11 Visual aesthetics | WA.R8, CM.R7 | 132, 136 |
### 7.4 COMMENTS ON ISSUES ADDRESSED IN TARGETS

#### 7.4.1 CONTENTIOUS OR COMPLEX ISSUES

In the course of analysing the targets we had set at the community workshops, several issues arose which we decided were worth commenting on separately. This may be because they are issues of contention between various parties, because they are complex, or because we felt they needed to be emphasised separately. The issues are each outlined briefly below. In general however, there was surprisingly little argument during our community workshops and few seriously contentious issues arose.

**Clearing**

While clearing has had an obvious detrimental effect on the environment, both in terms of salinity and loss of biodiversity, and regulations are now in place to prevent inappropriate removal of perennial vegetation, this remains a problematic issue. We have addressed loss of vegetation in many MATs. Nevertheless one issue that may not be clear is that there is a perception amongst the community that regulations need to be equitable, and that the same rules should apply to government agencies (eg infrastructure utilities) as to individual landowners. While compensation for the inability to clear has been discussed amongst landowners on many occasions, it did not arise as a MAT in this process.

**Surface Water Management and Drainage**

Surface water management and drainage are complex issues. Inappropriate design and construction, and the use of high value environmental land or infrastructure assets as sinks for excess water are increasing dilemmas (see Drainage Reform Group, 2004).

Surface water management and drainage are covered in several MATs, but did not emerge as an issue that warranted a separate sub-heading. Nevertheless, there was concern that drainage regulations need to be amended to ensure greater accountability. Capacity building in relation to drainage was identified as an issue and there was clear support, in more than one section, for accreditation of drainage and earthwork contractors.

**Water allocation**

This is currently an extremely important issue in this region. On the coastal plain we have excellent groundwater reserves but enormous competition for allocation; and some concern that allocation should be more strategic and more equitable. There is also a need for a better understanding of the sustainability of supply and of environmental water requirements. While water allocation features in the MATs, from a community perspective it is an issue that has a localised focus and did not feature in the community’s priorities at all meetings.

**On-ground works**

In the Target Tables we have noted the type of activity each MAT represents. Many of the activities are on-ground-works. It should be noted that the community consider on-ground works to be a very high priority; this will be addressed in the investment plan.

**Structural adjustment**

Salinity is a major and emerging issue in this region. While land retirement and structural adjustment are valid, and possibly effective mechanisms for addressing salinity, these are not popular concepts with farmers and did not feature significantly in the targets. Nor are they politically attractive options. However, this may be an issue to consider in the future.

**Cross-boundary issues**

Several issues raised in the target process cross regional boundaries and could be addressed by joint projects. There are generic issues such as those related to research, monitoring, institutional change and industry accreditation. In addition, some biophysical issues cross boundaries. Some of the obvious synergies are:

- Salinity, surface water management and drainage – with the Avon
- Coastal issues – confluent with the Swan and the Gascoyne/pastoral region
- Capacity building on a range of issues
- Forestry/perennials – with the South Coast and South West
- Farming systems – with the Avon
- Water allocation – with the South West
- Wetlands – with the Swan
Integration and Coordination

At many community meetings concerns were raised about the need for more coordination between different parties (particularly government agencies) and more integration of effort. Coordinated strategic approaches feature highly in our targets.

Capacity Building

Human capacity, governance, incentive schemes and training also feature prominently in our targets. At all meetings a strong belief was voiced that arming the community with better knowledge and implementation mechanisms would be an effective way of gaining better natural resource management.

Imprecise nature of targets

It was challenging to be precise about the extent and timeframe of some of the achievements in the targets. In view of the poor baseline data we have in this region, and the lack of accurate scientific knowledge on many methodologies, this is understandable. All Management Action Targets have been quantified but the precision of some Resource Condition Targets is dependent on other actions. It is intended that these targets will be refined and clarified over the next year.

NACC’s contribution to actions

Some of the issues and targets dealt with in this document are outside the scope of work that is likely to be undertaken in the region, and/or managed by NACC. We have included some issues of state, national or global importance because we believe that our endorsement can be a catalyst in assisting that work to be done elsewhere.

7.4.2 INDICATORS

In order to measure progress towards achievement of targets it is essential to have reliable indicators. Further discussion on indicators, together with a framework for Monitoring and Evaluation, is given on page 143.

For each mandatory “Matter for Target”, recommended indicators are being developed by State and Commonwealth government staff (Dept of Environment and Heritage, 2004). For example, for Land Salinity, “area threatened by shallow or rising water tables” is the indicator heading and three indicators have been developed:

- depth to groundwater
- groundwater salinity
- location and size of salt affected areas

The website identified in the above reference is an excellent source of information on indicators including background information and protocols.

The recommended indicators are in the process of being approved by the Monitoring and Evaluation Working Group (MEWG) which was established by the Natural Resource Management Ministerial Council in 2001 and contains both State and Commonwealth representatives. We will be guided by the MEWG deliberations and any subsequent approval by the Commonwealth and State governments. However, the indicators are still being developed, and are at various stages of approval. We are also conscious that there are difficulties with many indicators because the scientific instruments are still being developed and because rates of change in resource condition are affected by both spatial and temporal variations.

We have developed potential indicators for all our RCTs and MATs. However, as more work needs to be done to clarify and refine them, they are not all shown in the tables but will be available on the NACC website. Only potential indicators for RCTs are presented here.
### 7.5 THE THREAT RISK/ESSENTIAL - DESIRABLE MATRIX

On the following pages are presented the results of our community workshops into target setting. For each asset and sub-asset we have presented information on:

- Resource Condition Targets (RCT);
- The level of community preference (Essential, Important or Desirable) and the level of threat risk (High, Medium, Low) are indicated in the cell left of the RCT;
- A proposed indicator for each RCT; indicators have also been prepared for all MATs but have not been presented as they are still being refined;

- The different types of activities that the MATs represent:
  - Resource Assessment (including monitoring and evaluation),
  - Planning,
  - Institutional Change,
  - Capacity Building; and
  - On-ground works.

- Synergies between different MATs – these are MATs that are linked in some way, either positive or negative.

**Figure 15. Explanation of the target table layout (Tables start on the next page).**

<table>
<thead>
<tr>
<th>ASSET:</th>
<th>WATER</th>
<th>Sub Asset:</th>
<th>STREAM CONDITION</th>
<th>Activity</th>
<th>Ref. code</th>
<th>Targets</th>
<th>Synergies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Essential</td>
<td>WA.R3</td>
<td>Increase the current extent</td>
<td>Indicator: Change in % coverage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Resource Assessment</td>
<td>Planning</td>
<td>Institutional change</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Capacity Building</td>
<td>Onground works</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**RCTs – Resource condition targets; and MATs - Management action targets**

*Specific, timebound, measurable, pragmatic and achievable*
### 8.1 LAND

Target tables are presented for all the assets described in section 4 (see page ). Each RCT and MAT is given a reference number with the following prefixes: Land: LN; Urban and Crown Land ULN; Terrestrial Biodiversity, BD; Water WA; Coastal and Marine CM; Atmosphere, AR; and Community / Infrastructure, CA. Some sub-assets are dealt with in other sections – see notes at the bottom of relevant sections relating to Aboriginal Land, Aquatic Biodiversity and Marine Biodiversity.

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>REF CODE</th>
<th>RESOURCE CONDITION / MANAGEMENT ACTION TARGETS</th>
<th>SYNERGIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASSET: AGRICULTURAL LAND - SALINITY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ESSENTIAL</strong></td>
<td>LN.R1</td>
<td>Maintain or reduce the rate of groundwater rise and ensure that all salt affected areas are rehabilitated by 2025</td>
<td>WA.R4.M1; WA.R14.M1 LN.R3.M5; LN.R3.M1; WA.R14.M3</td>
</tr>
<tr>
<td>Indicator: Groundwater levels, quality and rate of change, extent of salt affected land</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LN.R1.M3</td>
<td>Additional economically viable plants for saline land identified and extended to community by 2009</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LN.R1.M6</td>
<td>Prepare and implement a salinity drainage plan for the region which endeavours to improve surface and sub-surface drainage over 20% of the poorly drained areas by 2007</td>
<td>WA.R4.M3</td>
<td></td>
</tr>
<tr>
<td>Institutional Change</td>
<td>LN.R1.M8</td>
<td>Audit conducted on all regulations relevant to drainage, to ensure greater accountability by 2009</td>
<td>WA.R4.M3</td>
</tr>
<tr>
<td>Capacity Building</td>
<td>LN.R1.M10</td>
<td>Technical on ground support available for landholders to develop plans and investment proposals in regards to rising groundwater and salinity by 2006</td>
<td>CA.R1.M4; CA.R2.M6 WA.R1.M8; WA.R1.M6 WA.R1.M4</td>
</tr>
<tr>
<td>LN.R1.M11</td>
<td>Appointment of accredited drainage coordinators and contractors for each sub-region in the NAR by 2006</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ESSENTIAL</strong></td>
<td>LN.R2</td>
<td>A yet to be determined reduction in the economic and environmental impacts of all priority animal and plant pests and diseases across the region by 2020</td>
<td>BD.R9.M4; BD.R9.M3</td>
</tr>
<tr>
<td>Indicator: Baseline; identification of biosecurity “hot spots”*Indicator; Number of farmers adopting appropriate management practices, reduction in the number of pests and weeds</td>
<td></td>
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</tr>
<tr>
<td>LN.R2.M1</td>
<td>Coordinate an integrated weed and pest animal control and awareness program across the region by 2009</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institutional Change</td>
<td>LN.R2.M3</td>
<td>Audit of all regulations which impact on biosecurity measures to ensure greater compliance by 2009</td>
<td></td>
</tr>
<tr>
<td>On ground works</td>
<td>LN.R2.M6</td>
<td>Biosecurity services are publicity funded by 2009</td>
<td>LN.R2.M5; WA.R3.M8</td>
</tr>
<tr>
<td>SUB-ASSET: AGRICULTURAL LAND - FARMING SYSTEMS &amp; SOIL CONDITION</td>
<td></td>
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<tr>
<td>---------------------------------------------------------------</td>
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<td></td>
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</tr>
<tr>
<td><strong>ESSENTIAL</strong> High Threat risk</td>
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<tr>
<td>LN.R3 All farmers adopting profitable farming system practices that reduce the threat to agricultural land by 2025</td>
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<tr>
<td>Indicator: Farm profitability according to ABARE statistics; number of farmers implementing appropriate farming systems</td>
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<tr>
<td>LN.R3.M6 A management package developed for herbicide resistance developed by 2009</td>
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<tr>
<td>LN.R3.M7 A decision support model for new farming systems developed and available by 2006</td>
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<tr>
<td>LN.R3.M8 Investigate that use of GMOs to create salt tolerant productive spp. by 2009</td>
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<tr>
<td>LN.R3.M5 Develop robust sustainability and production indicators specific to the region that can be used in models and EMS. Draft list by 2009</td>
<td></td>
<td></td>
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<tr>
<td>LN.R3.M2 10% of farmers adopting EMS in NAR by 2009</td>
<td></td>
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<tr>
<td>LN.R2.M1 Identify suitable indicators and methodologies for monitoring and evaluating farming systems by 2009</td>
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<tr>
<td>On ground works LN.R2.M4 By 2009, 100,000 ha of farmland in perennial, high water using systems</td>
<td></td>
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</tr>
<tr>
<td><strong>IMPORTANT</strong> Medium Threat risk</td>
<td></td>
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<tr>
<td>LN.R4 A yet to be determined increased protection of soils at risk from erosion by 2020</td>
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<tr>
<td>Indicator: A reduction in the number of recorded wind erosion events, satellite imagery analysis of ground cover at end of summer, cesium measurements, amount of earthworks implemented, area of minimum tillage, stubble retention practices, sediment levels in streams</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>LN.R4.M1 Identify and develop benchmarks of the existing areas affected by erosion by 2009. Identify suitable indicators and methodologies for monitoring and evaluating erosion by 2009</td>
<td></td>
<td></td>
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<tr>
<td>LN.R4.M3 Extension program operating to promote best practice for management of erosion by 2007</td>
<td></td>
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<tr>
<td>On Ground Works LN.R4.M2 Four priority catchments to collaboratively source funding for the rehabilitation of riparian zones by 2008</td>
<td></td>
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<tr>
<td><strong>DESIRABLE</strong> Medium Threat risk</td>
<td></td>
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<tr>
<td>LN.R5 Soils (surface and sub-surface) affected by soil acidity to have a pHCaCl2 of 5.5 or above by 2020. Soil types of high priority include all sandplain soils</td>
<td></td>
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<tr>
<td>Indicator: Lime sales, pH of representative monitoring points, numbers of farmers adopting lime strategies for farm</td>
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<tr>
<td>LN.R3.M5; LN.R3.M1</td>
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<tr>
<td>LN.R5.M1 Identify and develop benchmarks of the existing areas affected by soil acidity by 2009. Identify suitable indicators and methodologies for monitoring and evaluating erosion by 2009</td>
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<tr>
<td>LN.R3.M5; LN.R3.M1</td>
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<tr>
<td>Capacity Building LN.R5.M2 Extension program operating to promote best practice for management of soil acidity by 2007 – continuation of “Time To Lime Program”</td>
<td></td>
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</tr>
<tr>
<td>CA.R2.M6</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>DESIRABLE</strong> Low Threat risk</td>
<td></td>
<td></td>
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<tr>
<td>LN.R6 A yet to be determined increase in soil fertility in soils with identified problems and improvement of soils affected by low fertility by 2025</td>
<td></td>
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<tr>
<td>Indicator: Baseline soil fertility levels are known and documented indicator, the amount of nutrient applied reduced and a marked increase in the number of the soil microfauna per square meter</td>
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<td></td>
</tr>
<tr>
<td>LN.R3.M5; LN.R3.M1</td>
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</tr>
<tr>
<td>Resource assessment LN.R6.M1 Identify and develop benchmarks of the existing areas affected by soil fertility decline by 2009. Identify suitable indicators and methodologies for monitoring and evaluating soil fertility decline by 2009</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LN.R3.M5; LN.R3.M1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacity Building LN.R6.M2 An education and awareness program established for soil fertility and appropriate nutrient requirements for horticulture and broad acre agriculture by 2008</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CA.R2.M6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DESIRABLE</strong> Medium Threat risk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LN.R7 A yet to be determined increase in treatment of soils at risk from non-wetting (water repellence) by 2020</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indicator: Number of farmers adopting appropriate management practices such as claying or furrow sowing, MED testing at representative sites</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LN.R3.M5; LN.R3.M1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resource assessment LN.R7.M1 Identify and develop benchmarks of the existing areas affected by non-wetting water repellent soil by 2009. Identify suitable indicators and methodologies for monitoring and evaluating non-wetting water repellent soils</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LN.R3.M5; LN.R3.M1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacity Building LN.R7.M2 Extension program operating to promote best practice for management of water repellency by 2007 (On farm demonstrations of options to deal with non-wetting soils)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LN.R1.M10; CA.R2.M6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
LAND continued

**DESIRABLE Low Threat risk**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Baseline; popultations and occurrence of soil microflora key indicator; number of land managers address soil biology as part of farm management</th>
</tr>
</thead>
<tbody>
<tr>
<td>LN.R8.M1</td>
<td>Identify and develop benchmarks for the existing biological activity of soils by 2009. Identify suitable indicators and methodologies for monitoring and evaluating soil biology by 2009</td>
</tr>
<tr>
<td>LN.R8.M2</td>
<td>Within 3 years, facilitate research into the impact of agricultural practices on soil microflora which is supported by extension</td>
</tr>
</tbody>
</table>

**DESIRABLE Low Threat risk**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Baseline; high risk areas affected by nutrient loss and eutrophication identified; Indicator; decrease in nutrient and chemical load</th>
</tr>
</thead>
<tbody>
<tr>
<td>LN.R9.M1</td>
<td>Identify and develop benchmarks of the existing areas affected by nutrient loss and eutrophication by 2009. Identify suitable indicators and methodologies for monitoring and evaluating nutrient loss and eutrophication by 2009</td>
</tr>
<tr>
<td>LN.R9.M2</td>
<td>Develop and implement a monitoring program to assess load and movement of nutrients and chemicals in catchments by 2006</td>
</tr>
<tr>
<td>LN.R9.M3</td>
<td>An integrated research and extension program into management options for nutrient loss and eutrophication implemented by 2009</td>
</tr>
</tbody>
</table>

**DESIRABLE Low Threat risk**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Land managers adopt best management practices to reduce impact of waterlogging by 2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>LN.R10.M1</td>
<td>Identify and develop benchmarks of the existing areas affected by waterlogging by 2025. Identify suitable indicators and methodologies for monitoring and evaluating waterlogging by 2009</td>
</tr>
<tr>
<td>LN.R10.M2</td>
<td>By 2009, conduct research into alternative solutions for managing waterlogged areas specific to the region</td>
</tr>
</tbody>
</table>

**Planning**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Develop an integrated catchment management plan to reduce the impact of waterlogging by 2009 over 30 % of heavily waterlogged areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>LN.R10.M3</td>
<td>Develop an integrated catchment management plan to reduce the impact of waterlogging by 2009 over 30 % of heavily waterlogged areas</td>
</tr>
</tbody>
</table>

**IMPORTANT Medium Threat risk**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>A yet to be determined decrease in area of soils affected by soil structure decline by 2020. Priority soil types include coarse textured soils and medium to heavy textured soils</th>
</tr>
</thead>
<tbody>
<tr>
<td>LN.R11.M1</td>
<td>Identify and develop benchmarks of the existing areas affected by soil structure decline by 2009. Identify suitable indicators and methodologies for monitoring and evaluating soil structure decline by 2009</td>
</tr>
</tbody>
</table>

**Resource assessment**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Number of farmers adopting appropriate management practices, satellite imagery to determine yield losses, extent of earthworks implemented</th>
</tr>
</thead>
<tbody>
<tr>
<td>LN.R11.M2</td>
<td>A 10 % increase in farm businesses implementing appropriate management practices to stabilise and improve soil structure by 2010.</td>
</tr>
<tr>
<td>LN.R12.M1</td>
<td>Identify and develop benchmarks of the existing areas affected by sub surface compaction by 2009. Identify suitable indicators and methodologies for monitoring sub-surface compaction by 2025</td>
</tr>
<tr>
<td>LN.R12.M2</td>
<td>Research and extension program operating to promote best practice for management of sub surface compaction (tram lining) by 2007</td>
</tr>
</tbody>
</table>

**Resource assessment**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Priority risk areas identified and preparation of management plans for flood control commenced by 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>LN.R13.M1</td>
<td>Priority risk areas identified and preparation of management plans for flood control commenced by 2009</td>
</tr>
</tbody>
</table>

**Resource assessment**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Baseline; popultations and occurrence of soil microflora key indicator; number of land managers address soil biology as part of farm management</th>
</tr>
</thead>
<tbody>
<tr>
<td>LN.R13.M2</td>
<td>Identify and develop benchmarks of the existing areas prone to flooding by 2009. Identify suitable indicators and methodologies for monitoring and evaluating flooding by 2009</td>
</tr>
<tr>
<td>LN.R14.M1</td>
<td>Identify and develop benchmarks for the existing areas affected by soil contaminants by 2009. Identify suitable indicators for monitoring and evaluating soil contamination by 2009</td>
</tr>
</tbody>
</table>

**On – ground Works**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>By 2007 on ground monitoring programs established in 2 priority catchments which assess chemical load and movement through the soil profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>LN.R14.M2</td>
<td>By 2007 on ground monitoring programs established in 2 priority catchments which assess chemical load and movement through the soil profile</td>
</tr>
</tbody>
</table>
### URBAN & CROWN LAND

<table>
<thead>
<tr>
<th>SUB-ASSET</th>
<th>Indicator</th>
<th>Resource assessment</th>
<th>Institutional change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ESSENTIAL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Threat risk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ULN.R1</td>
<td></td>
<td>Development and and urban expansion to be balanced with environmental values by 2020</td>
<td></td>
</tr>
<tr>
<td>Indicator: TBA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ULN.R1.M1</td>
<td></td>
<td>By 2007 identify areas where growth and development expected and define suitable sites to accommodate growth</td>
<td>All MATs under CA.R6</td>
</tr>
<tr>
<td>Indicator: TBA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ULN.R2</td>
<td></td>
<td>Crown land to be appropriately managed</td>
<td></td>
</tr>
<tr>
<td>Indicator: TBA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ULN.R2.M2</td>
<td></td>
<td>By 2006 identify responsibilities and resource crown land management</td>
<td>All MATs under BD.R7, BD.R8 and BD.R9, BD.R2</td>
</tr>
</tbody>
</table>

### COASTAL LAND

Coastal land is dealt with in other sections: see Coastal and Marine CM.R1, CM.R2, CM.R5, CM.R6, CM.R7, Water WA.R8 and WA.R9

### ABORIGINAL LAND

Aboriginal land is dealt with in other sections: see Coastal and Marine CM.R5, Community CA.R5
### Activity 8.2 Biodiversity

<table>
<thead>
<tr>
<th>ASSET:</th>
<th>Biodiversity</th>
<th>Table 35</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUB-ASSET:</td>
<td>Terrestrial Biodiversity – Native Vegetation</td>
<td></td>
</tr>
</tbody>
</table>

#### Essential

**High Threat Risk**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Ref Code</th>
<th>Resource Condition / Management Action</th>
<th>Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD.R1</td>
<td></td>
<td>Maintained and increased native vegetation extent (other than approved clearing applications) by a yet to be determined % for each IBRA* sub-bioregion by 2025 “Interim Bio-Regionalisation of Australia”</td>
<td></td>
</tr>
<tr>
<td>BD.R1.M1</td>
<td></td>
<td>1. Establish baseline for native vegetation extent by 2005</td>
<td></td>
</tr>
<tr>
<td>BD.R1.M3</td>
<td></td>
<td>Priority Remnants identified for inclusion in Comprehensive, Adequate and Representative (CAR) reserve system annually with 10,000 hectares purchased by 2010</td>
<td></td>
</tr>
<tr>
<td>BD.R1.M1</td>
<td></td>
<td>Options for Carbon Credit trading investigated and promoted over the next 2-5 years</td>
<td>CA.R4.M4</td>
</tr>
<tr>
<td>BD.R1.M4</td>
<td></td>
<td>Extension and financial incentives for on farm biodiversity management developed and promoted by 2006</td>
<td>WA.R1.M6; BD.R5.M3</td>
</tr>
<tr>
<td>BD.R1.M6</td>
<td></td>
<td>Improved accessibility, availability and awareness of funding for biodiversity protection leading to at least 10 biodiversity focused projects within two years of strategy accreditation</td>
<td>WA.R1.M7; RN.R1.M4; CM.R3.M3; BD.R1.M5</td>
</tr>
<tr>
<td>BD.R1.M8</td>
<td></td>
<td>Clearing of native vegetation only occurs through legislative processes over the next 5 Years</td>
<td>WA.R8.M2</td>
</tr>
<tr>
<td>BD.R1.M9</td>
<td></td>
<td>Options for best practice for road and rail vegetation reserves with vegetation management activity promoted to reserve managers by 2005</td>
<td>BD.R1.M5</td>
</tr>
<tr>
<td>BD.R1.M4</td>
<td></td>
<td>Locations of priority areas for biodiversity conservation identified via GIS by 2005 with ground truthing ongoing</td>
<td>BD.R1.M1; BD.R1.M9; BD.R5.M3</td>
</tr>
<tr>
<td>BD.R1.M5</td>
<td></td>
<td>Poorly represented and restricted vegetation associations are targeted in greater than 70% of biodiversity conservation projects for protection/rehabilitation by 2005 and on-going</td>
<td>BD.R1.M1; BD.R1.M9; BD.R10.M2; WA.R1.M5; WA.R3.M5</td>
</tr>
<tr>
<td>BD.R2</td>
<td></td>
<td>A yet to be determined increase in protection and condition by 2020 of</td>
<td>LN.R1.M7 (possible impact)</td>
</tr>
<tr>
<td>BD.R2.M1</td>
<td></td>
<td>- Poorly represented vegetation associations (less than 10% and 30% remaining of original statewide extent)</td>
<td></td>
</tr>
<tr>
<td>BD.R2.M2</td>
<td></td>
<td>- Restricted vegetation associations (less than 2,000 and 10,000 ha remaining of original statewide extent)</td>
<td></td>
</tr>
<tr>
<td>BD.R2.M3</td>
<td></td>
<td>- Biodiversity hotspots (i.e. areas of high species diversity and/or endemism)</td>
<td></td>
</tr>
<tr>
<td>BD.R2.M4</td>
<td></td>
<td>- Other ecosystems at risk</td>
<td></td>
</tr>
<tr>
<td>BD.R2.M5</td>
<td></td>
<td>Mapping of disease risk to native flora/vegetation to be completed by 2007</td>
<td>BD.R1.M2</td>
</tr>
<tr>
<td>BD.R2.M6</td>
<td></td>
<td>1. Establish baseline for condition of above mentioned ecosystems by 2008</td>
<td></td>
</tr>
<tr>
<td>BD.R2.M7</td>
<td></td>
<td>2. Identify indicators and methodologies for measuring change in ecosystem condition by 2008</td>
<td></td>
</tr>
<tr>
<td>BD.R2.M8</td>
<td></td>
<td>Locations of priority areas for biodiversity conservation identified via GIS by 2005 with ground truthing ongoing</td>
<td></td>
</tr>
</tbody>
</table>

#### Desirable

**High Threat Risk**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Ref Code</th>
<th>Resource Condition / Management Action</th>
<th>Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD.R2</td>
<td></td>
<td>A yet to be determined increase in protection and condition by 2020 of</td>
<td>LN.R1.M7 (possible impact)</td>
</tr>
<tr>
<td>BD.R2.M1</td>
<td></td>
<td>- Poorly represented vegetation associations (less than 10% and 30% remaining of original statewide extent)</td>
<td></td>
</tr>
<tr>
<td>BD.R2.M2</td>
<td></td>
<td>- Restricted vegetation associations (less than 2,000 and 10,000 ha remaining of original statewide extent)</td>
<td></td>
</tr>
<tr>
<td>BD.R2.M3</td>
<td></td>
<td>- Biodiversity hotspots (i.e. areas of high species diversity and/or endemism)</td>
<td></td>
</tr>
<tr>
<td>BD.R2.M4</td>
<td></td>
<td>- Other ecosystems at risk</td>
<td></td>
</tr>
<tr>
<td>BD.R2.M5</td>
<td></td>
<td>Mapping of disease risk to native flora/vegetation to be completed by 2007</td>
<td>BD.R1.M2</td>
</tr>
</tbody>
</table>

#### Resource Assessment

<table>
<thead>
<tr>
<th>Activity</th>
<th>Ref Code</th>
<th>Resource Condition / Management Action</th>
<th>Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD.R1.M1</td>
<td></td>
<td>1. Establish baseline for native vegetation extent by 2005</td>
<td></td>
</tr>
<tr>
<td>BD.R1.M3</td>
<td></td>
<td>Priority Remnants identified for inclusion in Comprehensive, Adequate and Representative (CAR) reserve system annually with 10,000 hectares purchased by 2010</td>
<td></td>
</tr>
<tr>
<td>BD.R1.M4</td>
<td></td>
<td>Extension and financial incentives for on farm biodiversity management developed and promoted by 2006</td>
<td>WA.R1.M6; BD.R5.M3</td>
</tr>
<tr>
<td>BD.R1.M6</td>
<td></td>
<td>Options for Carbon Credit trading investigated and promoted over the next 2-5 years</td>
<td>CA.R4.M4</td>
</tr>
<tr>
<td>BD.R1.M7</td>
<td></td>
<td>Improved accessibility, availability and awareness of funding for biodiversity protection leading to at least 10 biodiversity focused projects within two years of strategy accreditation</td>
<td>WA.R1.M7; RN.R1.M4; CM.R3.M3; BD.R1.M5</td>
</tr>
<tr>
<td>BD.R1.M8</td>
<td></td>
<td>Clearing of native vegetation only occurs through legislative processes over the next 5 Years</td>
<td>WA.R8.M2</td>
</tr>
<tr>
<td>BD.R1.M9</td>
<td></td>
<td>Options for best practice for road and rail vegetation reserves with vegetation management activity promoted to reserve managers by 2005</td>
<td>BD.R1.M5</td>
</tr>
<tr>
<td>BD.R2.M5</td>
<td></td>
<td>Mapping of disease risk to native flora/vegetation to be completed by 2007</td>
<td>BD.R1.M2</td>
</tr>
</tbody>
</table>

#### Planning

<table>
<thead>
<tr>
<th>Activity</th>
<th>Ref Code</th>
<th>Resource Condition / Management Action</th>
<th>Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD.R2.M6</td>
<td></td>
<td>1. Establish baseline for condition of above mentioned ecosystems by 2008</td>
<td></td>
</tr>
<tr>
<td>BD.R2.M7</td>
<td></td>
<td>2. Identify indicators and methodologies for measuring change in ecosystem condition by 2008</td>
<td></td>
</tr>
<tr>
<td>BD.R2.M8</td>
<td></td>
<td>Locations of priority areas for biodiversity conservation identified via GIS by 2005 with ground truthing ongoing</td>
<td></td>
</tr>
<tr>
<td>BD.R2.M9</td>
<td></td>
<td>A system for benchmarking and measuring condition of identified vegetation associations/ecosystems developed by 2007</td>
<td></td>
</tr>
<tr>
<td>BD.R2.M10</td>
<td></td>
<td>Options for Carbon Credit trading investigated and promoted over the next 2-5 years</td>
<td>CA.R4.M4</td>
</tr>
<tr>
<td>BD.R2.M11</td>
<td></td>
<td>Extension and financial incentives for on farm biodiversity management developed and promoted by 2006</td>
<td>WA.R1.M6; BD.R5.M3</td>
</tr>
<tr>
<td>BD.R2.M12</td>
<td></td>
<td>Locations of priority areas for biodiversity conservation identified via GIS by 2005 with ground truthing ongoing</td>
<td></td>
</tr>
</tbody>
</table>

#### On-Ground Works

<table>
<thead>
<tr>
<th>Activity</th>
<th>Ref Code</th>
<th>Resource Condition / Management Action</th>
<th>Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD.R2.M3</td>
<td></td>
<td>500 hectares of special ecosystems/ecosystems at risk off reserve protected by legally binding conservation mechanisms by 2009</td>
<td></td>
</tr>
</tbody>
</table>
## SUB-ASSET: TERRESTRIAL BIODIVERSITY – THREATENED SPECIES & COMMUNITIES

### IMPORTANT

**High Threat risk**

<table>
<thead>
<tr>
<th>BD.R4</th>
<th>No major losses to meta populations of threatened species and communities from 2003 and to increase and improve populations by 2020</th>
</tr>
</thead>
</table>

**Indicator:** Baseline: Information collected through WATSCU and Threatened Species Network i.e. threatened species database

**Change in the numbers of species and/or populations**

| BD.R4.M1 | Critical threatened species with Recovery Plans (RP’s) or Interim Recovery Plans within 3 years of strategy accreditation with priority actions implemented within 12 months of RP’s and RP’s being completed |
| BD.R4.M2 | All threatened species to have appropriate management actions implemented by 2015 |
| BD.R4.M3 | No further conservation dependent species to become listed as threatened within 5 years |

### DESIRABLE

**High Threat risk**

<table>
<thead>
<tr>
<th>BD.R5</th>
<th>A yet to be determined increase in the protection and enhancement of key habitats by 2020 including</th>
</tr>
</thead>
</table>

- Key habitat for populations of threatened species and communities
- Granite outcrops
- Natural saline ecosystems
- Cave systems
- Key vegetation habitats e.g. woodlands, heath etc.

**Baseline:**

- Locations identified as habitat for threatened species and communities (note: critical/key habitat is not clearly identified)
- Biodiversity Audit
- Baseline for other habitats is poor

**Indicator:** Area/number of habitat for threatened species protected by reservation, fencing, covenant etc

### Resource assessment

<table>
<thead>
<tr>
<th>BD.R5.M4</th>
<th>1. Establish baseline for key habitats by 2005/6</th>
</tr>
</thead>
</table>

2. Identify indicators and methodologies for measuring level of protection for key habitats by 2005/6

### Planning & On-Ground Works

<table>
<thead>
<tr>
<th>BD.R1.M9</th>
<th>Protect &amp; re-vegetate in locations that protect habitat and provide linkages via corridors a &amp; neighbour hood  communities (excluding threatened spp and threatened communities) within 5 years</th>
</tr>
</thead>
</table>

| BD.R5.M2 | R&D completed for regeneration and revegetation techniques in low rainfall areas by 2008 |
| BD.R5.M3 | At least 20 areas of key habitat identified for strategic habitat management by 2006/7 |

### SUB-ASSET: TERRESTRIAL BIODIVERSITY – SALINITY RISK

### DESIRABLE

**High Threat risk**

<table>
<thead>
<tr>
<th>BD.R6</th>
<th>A yet to be determined reduction of biodiversity assets at risk from secondary salinity by 2015</th>
</tr>
</thead>
</table>

**Baseline:** Land/monitor mapping of potentially saline areas, site assessment of salinity risk

<table>
<thead>
<tr>
<th>BD.R6.M1</th>
<th>Identify high value biodiversity assets at risk from secondary salinity with a high feasibility of management success by 2007 with planning for mitigation running concurrently and completed by 2009</th>
</tr>
</thead>
</table>

### Resource assessment & planning

| BD.R6.M2 | Research of the impact of salinity on NAR ecosystems completed by 2007/8 |
| BD.R7.M1 | Ecologically appropriate fire management plans implemented for 10 reserves at highest risk of biodiversity loss from fire by 2020 |
| BD.R7.M2 | Extension material developed for the promotion of best practice fire management of off-reserve native vegetation by 2006 |

### SUB-ASSET: TERRESTRIAL BIODIVERSITY – FIRE RISK

### DESIRABLE

**Medium Threat risk**

<table>
<thead>
<tr>
<th>BD.R7</th>
<th>Assets of high biodiversity value (yet to be determined) are not at risk from inappropriate fire regimes by 2020</th>
</tr>
</thead>
</table>

**Baseline:** CALM fire scar/fuel age mapping, fire regimes based on information available N.B. information on burning practices on freehold and some reserves (incl. Shire, transport etc) land are not well known or documented

**Indicator:** Fire frequency, fire intensity, management plans for fire (incl. freehold land etc)

### Resource assessment

| BD.R7.M2 | Research of the impact of fire on NAR ecosystems completed by 2007/8 |
| BD.R7.M3 | Extension material developed for the promotion of best practice fire management of off-reserve native vegetation by 2006 |

### Planning

| BD.R7.M1 | Ecologically appropriate fire management plans implemented for 10 reserves at highest risk of biodiversity loss from fire by 2020 |
| BD.R7.M2 | Extension material developed for the promotion of best practice fire management of off-reserve native vegetation by 2006 |

### Capacity Building

| BD.R7.M3 | Extension material developed for the promotion of best practice fire management of off-reserve native vegetation by 2006 |
### SUB-ASSET: TERRESTRIAL BIODIVERSITY – ENVIRONMENTAL WEEDS & PESTS

#### IMPORTANT
- **High Threat risk**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Indicator</th>
<th>Baseline</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD.R8</td>
<td>A yet to be determined reduction in the density and distribution of significant environmental weed species affecting high value biodiversity assets by 2020</td>
<td>Largely unknown other than point sources lodged in state herbarium or in reserve management plans.</td>
<td>BD.R11.M2</td>
<td></td>
</tr>
<tr>
<td>BD.R8.M2</td>
<td>1. Establish baseline for density and distribution of environmental weeds effecting high value biodiversity assets in NAR by 2005/6. 2. Identify indicators and methodologies for measuring density and distribution of environmental weeds effecting high value biodiversity assets in NAR by 2005/6</td>
<td>BD.R11.M2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Planning
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Indicators</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD.R8.M4</td>
<td>All projects with a biodiversity focus to incorporate effective weed control as part of on-ground works by 2006</td>
<td>BD.R1.M4; BD.R1.M5; WA.R3.M6</td>
<td></td>
</tr>
</tbody>
</table>

#### Institutional change
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Indicators</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD.R8.M1</td>
<td>A structure established with representation of relevant stakeholders that effectively coordinates control of weeds over entire NAR by 2006/7</td>
<td>WA.R3.M6; CM.R3.M2</td>
<td></td>
</tr>
</tbody>
</table>

#### Capacity Building
- **High Threat risk**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Indicator</th>
<th>Baseline</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD.R9</td>
<td>A yet to be determined reduction in biodiversity impacts of significant invasive animals (native and exotic) by 2020</td>
<td>Exotic animals recorded in Formal Reserve System; APB Data (further information required)</td>
<td>BD.R11.M2</td>
<td></td>
</tr>
<tr>
<td>BD.R9.M6</td>
<td>1. Establish baseline on the impact of significant invasive animals effecting high value biodiversity assets in NAR by 2007/8 2. Identify indicators and methodologies for measuring the impact of significant invasive animals affecting high value biodiversity assets in NAR by 2007/8</td>
<td>BD.R1.M4</td>
<td></td>
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</tr>
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</table>

#### Planning
<table>
<thead>
<tr>
<th>Code</th>
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<th>Indicators</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD.R9.M3</td>
<td>Effective control of pest native animals through programs by 2006</td>
<td>LN.R2.M2</td>
<td></td>
</tr>
</tbody>
</table>

#### On-Ground Works
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Indicators</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD.R9.M2</td>
<td>15 % of private land managers controlling feral animals effecting biodiversity within region by 2010</td>
<td>WA.R3.M8</td>
<td></td>
</tr>
</tbody>
</table>

#### SUB-ASSET: TERRESTRIAL BIODIVERSITY – CAPACITY
- **ESSENTIAL**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Indicator</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD.R10</td>
<td>Informed and experienced groups across the NAR with the capacity to understand issues and drive landscape change to a benchmark yet to be determined</td>
<td>TBA</td>
<td>LN.R1.M15; BD.R1.M4</td>
</tr>
<tr>
<td>BD.R10.M1</td>
<td>Develop a &quot;Toolbox&quot; for stakeholders to better manage biodiversity by 2006</td>
<td>BD.R1.M2</td>
<td></td>
</tr>
<tr>
<td>BD.R10.M5</td>
<td>Develop an education program on the impacts of cats (Feral and domestic) on native animals by 2006</td>
<td>BD.R10.M2</td>
<td></td>
</tr>
</tbody>
</table>

#### Institutional change
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Indicators</th>
<th>Actions</th>
</tr>
</thead>
</table>

#### DESIRABLE
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Indicator</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD.R11</td>
<td>Scientific knowledge of biodiversity increased by identifying and implementing the top 5 research priorities by 2020</td>
<td>Completion of research projects, and findings developed into actions</td>
<td>LN.R9.M3; CA.R4.M1; CM.R9.M1; BD.R6.M2; BD.R7.M2; BD.R9.M4</td>
</tr>
</tbody>
</table>

**BIODIVERSITY continued**
### 8.3 WATER

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>REF CODE</th>
<th>RESOURCE CONDITION / MANAGEMENT ACTION</th>
<th>TARGETS</th>
<th>SYNERGIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASSET: WATER</td>
<td>TABLE 36</td>
<td>SURFACE WATER CONTROL</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SUB-ASSET:</strong> SURFACE WATER CONTROL</td>
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<tr>
<td><strong>ESSENTIAL</strong></td>
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</tr>
<tr>
<td>High Threat risk</td>
<td>WA.R1</td>
<td>A reduction in the peaks of surface water runoff from catchments by 2020</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>2. Change in % areas affected by erosion and sedimentation</td>
<td>LN.R1.M1; LN.R4.M1; LN.R1.M1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Levels of total suspended solids (TSS) for sedimentation</td>
<td>LN.R3.M3; WA.R4.M3; LN.R10.M2</td>
<td></td>
</tr>
<tr>
<td>Resource assessment</td>
<td>WA.R1.M1</td>
<td>Develop baselines for extent and severity of erosion and sedimentation and establish clear targets for a reduction in peaks of surface water runoff by 2008. Identify suitable indicators and methodologies for monitoring and evaluating surface water runoff by 2008</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>WA.R1.M3</td>
<td>Identify the primary sources of sediment input along priority waterscapes by 2007</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>WA.R1.M4</td>
<td>Facilitate a research project to support the growth of alternative options to utilise surface water runoff and reduce sediment laden runoff by 2009</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planning</td>
<td>WA.R1.M2</td>
<td>Develop and consolidate flood management strategies for 25 % of major flood risk towns by 2007</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>LN.R13.M1</td>
<td></td>
</tr>
<tr>
<td>Resources</td>
<td>WA.R1.M6</td>
<td>Two LGAs implementing Water Sensitive Design Principles in at least one of their towns by July 2009</td>
<td></td>
<td></td>
</tr>
<tr>
<td>On ground works</td>
<td>WA.R1.M5</td>
<td>15 % of landholders in the region to be implementing options for surface water control by 2009</td>
<td></td>
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</tr>
<tr>
<td><strong>SUB-ASSET:</strong> SURFACE WATER ALLOCATION</td>
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</tr>
<tr>
<td><strong>DESIRABLE</strong></td>
<td></td>
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</tr>
<tr>
<td>High Threat risk</td>
<td>WA.R2</td>
<td>Equitable allocation of surface water between social, environmental and economic requirements by 2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indicator:</td>
<td></td>
<td>Number of licenses that comply with sustainable limits of surface water resources</td>
<td>CA.R3.M3</td>
<td></td>
</tr>
<tr>
<td>Institutional change</td>
<td>WA.R2.M2</td>
<td>Issue licenses according to sustainable limits for surface water allocation in Gingin Brook and enforce compliance by 2009</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SUB-ASSET:</strong> WATERSCAPE CONDITION</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>ESSENTIAL</strong></td>
<td></td>
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</tr>
<tr>
<td>High Threat risk</td>
<td>WA.R3</td>
<td>Increase the current extent and improve the condition of riparian vegetation along targeted sections of priority waterscapes by 2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Condition: change in foreshore condition class</td>
<td>LN.R2.M1; BD.R8.M1; BD.R8.M4</td>
<td></td>
</tr>
<tr>
<td>Resource assessment</td>
<td>WA.R3.M1</td>
<td>Develop baselines for extent and condition of riparian vegetation and establish clear targets for an increase in extent and condition of riparian vegetation by 2008. Identify suitable indicators and methodologies for monitoring and evaluating riparian vegetation by 2008</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planning</td>
<td>WA.R3.M6</td>
<td>Coordinate an integrated aquatic/ riparian weed management and awareness program by 2009, including financial incentives where public benefits will result</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>WA.R3.M8</td>
<td>Coordinate an integrated feral animal management and awareness program (for pigs and goats) by 2009, including financial incentives where public benefits will result</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institutional change</td>
<td>WA.R3.M9</td>
<td>A policy for sustainable management of livestock in waterways and wetlands developed by 2009</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacity building</td>
<td>WA.R3.M7</td>
<td>2 community based river restoration and wetland restoration workshops to be held in each subregion by 2008</td>
<td></td>
<td></td>
</tr>
<tr>
<td>On ground works</td>
<td>WA.R3.M2</td>
<td>Conduct Foreshore Assessments along 3 priority rivers to improve knowledge of vegetation condition, bank stability, stream cover and habitat diversity by 2008</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>WA.R3.M10</td>
<td>Fence at least 20 % of priority sections along waterways to improve and increase riparian vegetation through erosion control and stock management by 2009</td>
<td>LN.R1.M12; LN.R4.M2</td>
<td></td>
</tr>
<tr>
<td>SUB-ASSET: SURFACE WATER QUALITY</td>
<td>ESSENTIAL High Threat risk</td>
<td>Indicator: Salinity levels, measured as mean annual flow weighted salinity TDS mg/L</td>
<td></td>
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</tr>
<tr>
<td><strong>Resource assessment</strong></td>
<td>WA.R4</td>
<td>Maintain current salinity levels in historically fresh and brackish priority waterscapes by 2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>WA.R4.M1</td>
<td>Develop baselines for salinity levels in waterscapes by 2006 and identify suitable indicators and methodologies for monitoring and evaluating salinity levels by 2008</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>WA.R4.M3</td>
<td>Facilitate a research project to support the growth of alternative options for drainage of excess water that will not increase salinity levels in waterscapes, and agronomic practices to reduce salinity risk by 2009</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>WA.R4.M2</td>
<td>Set up 5 monitoring sites along priority waterways and wetlands to identify high risk areas for salinity by 2009</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Planning | WA.R4.M8 | 5% of farms in priority waterway catchments develop and implement integrated catchment plans by 2008 to progressively improve the water quality in priority waterscapes such as the Gingin Brook and Hill River |
| Capacity building | WA.R4.M5 | Facilitate a research project to support the growth of alternative options for drainage of excess water that will not increase salinity levels in waterscapes, and agronomic practices to reduce salinity risk by 2009 |

**DESIRABLE Low Threat risk**

<table>
<thead>
<tr>
<th>Indicator:</th>
<th>Total nitrogen and phosphorus levels measured as TN mg/L and TP mg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>WA.R4.M4</td>
<td>15% of landholders in the region to be implementing options for salinity control by 2009 that aim to reduce salinity risk in priority waterscapes</td>
</tr>
<tr>
<td>WA.R4.M7</td>
<td>Fence at least 10% of salt affected waterscapes and revegetate with salt tolerant perennials by 2009</td>
</tr>
</tbody>
</table>

| **Resource assessment** | WA.R5 | Level of contamination in priority waterscapes maintained within National Water Quality Management Strategy (NWQMS) guidelines by 2025 |
| | WA.R5.M1 | Develop baselines for levels of total nitrogen (TN), total phosphorus (TP), chemical and heavy metal contaminants in waterscapes and establish clear targets for levels of contaminants according to NWQMS guidelines by 2008. Identify suitable indicators and methodologies for monitoring and evaluating levels of nutrients, chemicals and heavy metals by 2008 |
| | WA.R5.M3 | Continued development of best management practices for nutrient and chemical control in high risk agriculture / horticulture land uses by 2006 |
| | WA.R5.M2 | Facilitate 3 research projects that measure and monitor nutrient and chemical load and movement within catchments by 2006 |

| Planning | WA.R5.M8 | Develop management plans for existing sites of contamination by 2007 |
| Capacity building | WA.R5.M7 | Extend knowledge of management solutions for control of nutrient and chemical contamination and support local and catchment scale activities across the region by 2009 |

<table>
<thead>
<tr>
<th>On ground works</th>
<th>WA.R5.M6</th>
<th>An awareness program established to educate community on the causes and implications of nutrient, chemical and heavy metal contamination by 2007</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DESIRABLE Low Threat risk</strong></td>
<td>WA.R5</td>
<td>No waterscapes or groundwater resources contaminated by Acid Sulphate Soils (ASS) or acid groundwater by 2010</td>
</tr>
<tr>
<td></td>
<td>WA.R5.M1</td>
<td>Facilitate a research project to determine extent and magnitude of risk for contamination from Acid Sulphate Soils and acid groundwater across the NAR by 2009</td>
</tr>
</tbody>
</table>

1. See Appendix X for further information on priority waterscapes
### ECOLOGICAL INTEGRITY

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Indicator/Resource</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DESIRABLE</strong></td>
<td>Maintain or improve the ecological function of priority waterscapes by 2020</td>
<td>Condition of key habitats, according to riparian vegetation (% coverage and foreshore condition class), bank stability and water quality (nutrients – TP mg/L and TN mg/L, sedimentation – TSS, salinity – TDS mg/L, pollutants – triazines, Pb, Zn, As)</td>
<td>WA.R7</td>
</tr>
<tr>
<td></td>
<td><strong>High Threat risk</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Indicator:</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>On ground works</strong></td>
<td>5 river and wetland restoration demonstration sites to be developed across the region by 2009, to build technical capacity and awareness of the community</td>
<td>WA.R7.M2</td>
<td>BD.R1.M9; CM.R4.M5</td>
</tr>
</tbody>
</table>

1. See Appendix X for further information on priority waterscapes.

### URBAN AND COASTAL LAND

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Indicator/Resource</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DESIRABLE</strong></td>
<td>Vegetation buffers to protect waterscapes from future urban and industrial developments enforced by 2015</td>
<td>Adequate vegetation buffers surrounding all urban and industrial developments</td>
<td>WA.R8</td>
</tr>
<tr>
<td></td>
<td><strong>Low Threat risk</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Indicator:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All development to follow the guidelines for foreshore and water course buffer zone establishment with monitoring for compliance by 2005, to protect from urban encroachment</td>
<td>WA.R6.M1</td>
<td>BD.R1.M8; CM.R2.M1; CA.R3.M11</td>
</tr>
<tr>
<td><strong>DESIRABLE</strong></td>
<td>No solid waste contamination of high recreation waterscapes and waterscapes adjacent to urban land by 2015</td>
<td>Presence of solid waste contamination such as household litter, industrial waste</td>
<td>WA.R9</td>
</tr>
<tr>
<td><strong>On ground works</strong></td>
<td>Litter plans for high recreation waterscapes and waterscapes adjacent to urban land to be developed and implemented by 2007</td>
<td>WA.R9.M1</td>
<td>CA.R3.M8</td>
</tr>
<tr>
<td><strong>DESIRABLE</strong></td>
<td>All recreation in priority waterscapes managed by 2020</td>
<td>Impact of recreation activities, according to damage of riparian vegetation, litter, contamination</td>
<td>WA.R10</td>
</tr>
<tr>
<td><strong>Medium Threat risk</strong></td>
<td>Recreation management plans for priority recreation areas to be developed and implemented by 2007</td>
<td>CA.R3.M8</td>
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</tbody>
</table>

### GROUNDWATER ALLOCATION

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Indicator/Resource</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ESSENTIAL</strong></td>
<td>Sustainable use of groundwater resources and equitable allocation of resources between economic, environmental and social requirements by 2020</td>
<td>Amount of groundwater allocated to different sectors (environmental, social and economic)</td>
<td>WA.R11</td>
</tr>
<tr>
<td></td>
<td>Improve regional aquifer monitoring programs to achieve greater knowledge of water availability and salinity trends by 2005</td>
<td>WA.R11.M3</td>
<td>LN.R1.M4</td>
</tr>
<tr>
<td><strong>Planning</strong></td>
<td>Prepare regional and local Groundwater Management Plans for the Northern Agricultural Region by 2007</td>
<td>CA.R0.M2</td>
<td>CA.R0.M2</td>
</tr>
<tr>
<td><strong>Institutional change</strong></td>
<td>Develop environmental water requirements (EWR’s) for 3 priority groundwater dependent waterscapes by 2009</td>
<td>LN.R1.M4</td>
<td>LN.R1.M4</td>
</tr>
<tr>
<td></td>
<td>Groundwater licences to have conditions, with monitoring for compliance, to ensure the sustainable use of resources by 2008</td>
<td>WA.R11.M5</td>
<td>LN.R1.M4</td>
</tr>
<tr>
<td><strong>Capacity building</strong></td>
<td>Increase the technical capacity of community to understand groundwater systems and sustainable management through education and awareness programs by 2007</td>
<td>WA.R11.M4</td>
<td>LN.R1.M4</td>
</tr>
<tr>
<td></td>
<td>Establish local water resource management committees for all regional groundwater areas by 2007</td>
<td>WA.R11.M6</td>
<td>LN.R1.M4</td>
</tr>
</tbody>
</table>
### WATER continued

<table>
<thead>
<tr>
<th>SUB-ASSET: WATER SUPPLY</th>
<th>DESIRABLE&lt;br&gt;High Threat risk</th>
<th>WA.R12</th>
<th>Progressive increase in water use efficiency practices by users of allocated water by 2020&lt;br&gt;Indicator: Efficiency of water use per gigalitre of allocated water</th>
<th>LN.R1.M4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource assessment</td>
<td>WA.R12.M2</td>
<td>Develop and implement a regional monitoring program for water use by 2006</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacity building</td>
<td>WA.R12.M1</td>
<td>Increase community awareness of best practice water use efficiency through education and awareness programs by 2007</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SUB-ASSET: GROUNDWATER QUALITY</th>
<th>IMPORTANT&lt;br&gt;Low/High Threat risk</th>
<th>WA.R14</th>
<th>Maintain current water quality in groundwater supply areas within National Water Quality Management Strategy guidelines by 2015&lt;br&gt;Indicator: Quality of groundwater supply, according to salinity (TDS mg/L), nutrients (TN mg/L, TP mg/L), contamination (triazines, Pb, Zn, As)</th>
<th>CA.R6.M2; WA.R11.M1; LN.R1.M1</th>
</tr>
</thead>
<tbody>
<tr>
<td>On ground works</td>
<td>WA.R14.M2</td>
<td>Develop and implement a monitoring program to investigate future risks to groundwater aquifers by 2009</td>
<td>WA.R11.M1; CA.R6.M2</td>
<td></td>
</tr>
<tr>
<td>On ground works</td>
<td>WA.R14.M3</td>
<td>Implement Water Source Protection Plans for public drinking water supply areas (PDWSA) by 2007</td>
<td>LN.R1.M1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SUB-ASSET: WATER SUPPLY</th>
<th>DESIRABLE&lt;br&gt;Medium Threat risk</th>
<th>WA.R13</th>
<th>All rural and farming communities to have reliable water supplies by 2015&lt;br&gt;Indicator: Number of communities with reliable water supplies</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>On ground works</td>
<td>WA.R13.M1</td>
<td>Seventy percent farmers to have self sufficient stock water supplies available through farm water grants by 2009</td>
<td>CA.R6.M2</td>
<td></td>
</tr>
</tbody>
</table>
### 8.4 ATMOSPHERE

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>REF CODE</th>
<th>RESOURCE CONDITION / MANAGEMENT ACTION TARGETS</th>
<th>SYNERGIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASSET: ATMOSPHERE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUB-ASSET: CLIMATE CHANGE AND SEASONAL VARIABILITY</td>
<td></td>
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</tr>
<tr>
<td><strong>ESSENTIAL</strong></td>
<td>AR.R1</td>
<td>By 2008 information and tools will be available such that stakeholders in the NAR can manage the impacts of climate change and seasonal variability, and reduce the associated environmental, economic and social risks.</td>
<td>WA.R11.M5; WA.R11.M2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Indicator: TBA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AR.R1.M2</td>
<td>By 2007, a broad assessment of the likely impacts of climate change on natural resource management in the NAR will be completed.</td>
<td>WA.R11.M5; WA.R11.M2</td>
</tr>
<tr>
<td></td>
<td>AR.R1.M3</td>
<td>Processes for completing a risk assessment of the effects of climate variability on agricultural production will be developed by 2007.</td>
<td>LN.R2.M3</td>
</tr>
<tr>
<td></td>
<td>AR.R1.M4</td>
<td>A program for extending climate risk management tools to agricultural producers will be implemented by 2008.</td>
<td>LN.R2.M3</td>
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<td></td>
<td>AR.R1.M1</td>
<td>By 2006, NACC will develop partnerships with greenhouse/climate change researchers and organisations to develop a better understanding of the long-term impacts of climate change on natural resources in the NAR.</td>
<td>CA.R3.M1; CM.R12.M3CM.R1.M1</td>
</tr>
<tr>
<td>SUB-ASSET: AIR QUALITY</td>
<td>AR.R2</td>
<td>Maintain the quality of air within the region.</td>
<td></td>
</tr>
<tr>
<td><strong>IMPORTANT</strong></td>
<td>AR.R2</td>
<td></td>
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<td></td>
<td></td>
<td>Indicator: TBA</td>
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</tbody>
</table>
2. Develop benchmarks for acceptable levels of emissions by 2008.  
Identify suitable indicators and methodologies for monitoring and evaluating air quality by 2008.                                                                                               | CA.R7.M13                                                                                                                                                                                               |
|                                 | AR.R2.M3 | R & D and extension into the pros and cons of burning stubble.                                                                                                                                                                               | AR.R2.M1                                                                                                                                                                                                 |
|                                 | AR.R2.M6 | Develop and implement a program to routinely monitor emissions from industry by 2008.                                                                                                                                                           | AR.R7.M13                                                                                                                                                                                               |
|                                 | AR.R2.M5 | Education and awareness about wood heaters in areas of high population eg; Geraldton.                                                                                                                                                         |                                                                                                                                                                                                          |
|                                 | AR.R2.M2 | 80% of farmers with 50% soil cover to reduce the risk of dust storms during the summer/autumn months by 2007.                                                                                                                               | LN.R4.M1                                                                                                                                                                                               |
|                                 | AR.R2.M4 | 70% of farmers not burning or burning windrows by 2007.                                                                                                                                                                                    | LN.R4.M1                                                                                                                                                                                               |
### 8.5 COASTAL AND MARINE

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>REF CODE</th>
<th>RESOURCE CONDITION / MANAGEMENT ACTION TARGETS</th>
<th>SYNERGIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASSET: COASTAL AND MARINE GOVERNANCE</td>
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<tr>
<td></td>
<td>CM.R1.M5</td>
<td>Obtain 25% more funding for management and research that directly contributes to biodiversity conservation and sustainable use of coastal and marine resources in the NAR by 2010</td>
<td>CA.R1.M4, CA.R1.M5, CM.R1.M1</td>
</tr>
<tr>
<td>SUB-ASSET: COASTAL LAND</td>
<td></td>
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</tr>
<tr>
<td>ESSENTIAL Low/High*Threat risk</td>
<td>CM.R2</td>
<td>The condition and function of our coastal geomorphic systems will be maintained and improved by 2015</td>
<td>There are many threats with various levels of risk</td>
</tr>
<tr>
<td>Indicator: TBA</td>
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<tr>
<td>SUB-ASSET: COASTAL BIODIVERSITY</td>
<td></td>
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<tr>
<td>DESIRABLE Threat risk</td>
<td>CM.R3</td>
<td>By 2015, the area of good condition coastal vegetation / habitat will be increased by 5% to ensure no loss of taxa</td>
<td></td>
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<tr>
<td>Indicator: TBA</td>
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</tr>
<tr>
<td>Planning</td>
<td>CM.R3.M1</td>
<td>By 2008 identify priority coastal areas for addition to the conservation reserve system to meet comprehensive, adequate and representative (CARR) criteria</td>
<td>BO.R2.M2, CM.R9.M5, BD.R1.M3</td>
</tr>
</tbody>
</table>
### SUB-ASSET: ESTUARIES AND COASTAL WETLANDS

<table>
<thead>
<tr>
<th>IMPORTANT Med/High*Threat risk</th>
<th>Resource Assessment</th>
<th>On-Ground Works</th>
<th>Institutional change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CM.R4</strong></td>
<td>By 2007, map the extent and condition of all the estuarine and coastal wetland habitats in the NAR</td>
<td>By 2008 ensure no permanent loss of invertebrate and fish meta-populations in coastal wetlands and estuaries</td>
<td>By 209, establish agreements for cooperative management of three priority estuaries or wetlands</td>
</tr>
<tr>
<td><strong>CM.R4.M4</strong></td>
<td></td>
<td>By 2008 reduce by 10 % the area of estuarine and coastal wetland degraded by recreational and development impacts</td>
<td></td>
</tr>
<tr>
<td><strong>CM.R4.M2</strong></td>
<td>By 2008, implement monitoring and management actions to ensure water quality in priority estuaries meets relevant standards</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CM.R4.M1</strong></td>
<td>By 2029, establish agreements for cooperative management of three priority estuaries or wetlands</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CM.R4.M3</strong></td>
<td>By 2009, identify and reduce by 10 % the area of estuarine and coastal wetland degraded by recreational and development impacts</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CM.R4.M5</strong></td>
<td>By 2008 ensure no permanent loss of invertebrate and fish meta-populations in coastal wetlands and estuaries</td>
<td></td>
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<tr>
<td><strong>CM.R4.M6</strong></td>
<td>Reduce by 10 % the volume of unfiltered stormwater discharge into estuarine systems by 2008</td>
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</tbody>
</table>

### SUB-ASSET: COASTAL HERITAGE AND AMENITY

<table>
<thead>
<tr>
<th>Resource Assessment</th>
<th>On-Ground Works</th>
<th>Planning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CM.R5</strong></td>
<td>By 2006 identify and document Indigenous cultural / spiritual values, and reduce the barriers to groups’ involvement in planning</td>
<td>By 2006 develop and implement design principles for coastal recreation nodes that incorporate historical, cultural and natural heritage values</td>
</tr>
<tr>
<td><strong>CM.R5.M1</strong></td>
<td></td>
<td>By 2006 develop and implement design principles for coastal recreation nodes that incorporate historical, cultural and natural heritage values</td>
</tr>
<tr>
<td><strong>CM.R6</strong></td>
<td>By 2009, cultural heritage values will be explicitly considered in coastal management and site plans</td>
<td>By 2009, the visual amenity of our coastal environments will be valued and maintained</td>
</tr>
<tr>
<td><strong>CM.R6.M1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CM.R7</strong></td>
<td>By 2009, the visual amenity of our coastal environments will be valued and maintained</td>
<td>By 2008 the impact on visual amenity of all coastal development proposals will be assessed within a regionally-consistent framework</td>
</tr>
<tr>
<td><strong>CM.R7.M1</strong></td>
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</tbody>
</table>

### SUB-ASSET: MARINE SEA-BOTTOM

<table>
<thead>
<tr>
<th>Resource Assessment</th>
<th>On-Ground Works</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CM.R8</strong></td>
<td>By 2008, run one education program to prevent introduction and promote management of introduced marine pest species</td>
</tr>
<tr>
<td><strong>CM.R8.M1</strong></td>
<td></td>
</tr>
<tr>
<td><strong>CM.R8.M2</strong></td>
<td></td>
</tr>
</tbody>
</table>

### SUB-ASSET: MARINE BIODIVERSITY

<table>
<thead>
<tr>
<th>Resource Assessment</th>
<th>On-Ground Works</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CM.R9</strong></td>
<td>By 2009, undertake projects to ensure the effects of TBT are identified and monitored by 2009</td>
</tr>
<tr>
<td><strong>CM.R9.M1</strong></td>
<td></td>
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<tr>
<td><strong>CM.R9.M2</strong></td>
<td></td>
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<tr>
<td><strong>CM.R9.M3</strong></td>
<td></td>
</tr>
<tr>
<td>Med/High*Threat риск</td>
<td>CM.R10</td>
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<tr>
<td>----------------------</td>
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</tr>
<tr>
<td>Indicator: TBA</td>
<td></td>
</tr>
<tr>
<td>On-Ground Works</td>
<td>CM.R10.M1</td>
</tr>
<tr>
<td><strong>SUPPORTING</strong> Med/High*Threat риск</td>
<td>CM.R11</td>
</tr>
<tr>
<td>Indicator: No net loss of fish and invertebrate communities due to human actions</td>
<td></td>
</tr>
<tr>
<td>Planning</td>
<td>CM.R11.M7</td>
</tr>
<tr>
<td>Institutional change</td>
<td>CM.R11.M1</td>
</tr>
<tr>
<td>CM.R11.M2</td>
<td>Assess and monitor (in detail) the impacts of recreational fishing in three priority locations over the next 3 years</td>
</tr>
<tr>
<td>CM.R11.M3</td>
<td>Implement 2 projects in the next 5 years to ensure recreational fishing is ecologically sustainable</td>
</tr>
<tr>
<td>Capacity Building</td>
<td>CM.R11.M5</td>
</tr>
<tr>
<td>On-Ground Works</td>
<td>CM.R11.M4</td>
</tr>
<tr>
<td><strong>SUB-ASSET:</strong> MARINE WATER</td>
<td></td>
</tr>
<tr>
<td>Medium Threat риск</td>
<td>CM.R12</td>
</tr>
<tr>
<td>Indicator: TBA</td>
<td></td>
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<tr>
<td>Institutional Change</td>
<td>CM.R12.M1</td>
</tr>
<tr>
<td>Capacity Building</td>
<td>CM.R12.M3</td>
</tr>
<tr>
<td>On-ground works</td>
<td>CM.R12.M2</td>
</tr>
<tr>
<td><strong>SUB-ASSET:</strong> MARINE HERITAGE AND AMENITY</td>
<td></td>
</tr>
<tr>
<td>Capacitiy Building</td>
<td>CM.R13.M1</td>
</tr>
<tr>
<td>CM.R14</td>
<td>By 2010, there will be a measurable increase in the awareness of visitors and residents of the marine cultural heritage</td>
</tr>
<tr>
<td>Indicator: TBA</td>
<td></td>
</tr>
<tr>
<td>Capacity Building</td>
<td>CM.R14.M1</td>
</tr>
<tr>
<td>CM.R15</td>
<td>By 2010, the visual amenity of our marine environments will be recognised and protected</td>
</tr>
<tr>
<td>Indicator: TBA</td>
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<tr>
<td><strong>SUB-ASSET:</strong> HOUTMAN ABROLHOS ISLANDS</td>
<td></td>
</tr>
<tr>
<td><strong>IMPORTANT</strong> Med/High*Threat риск</td>
<td>CM.R16</td>
</tr>
<tr>
<td>Indicator: TBA</td>
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<tr>
<td>Resource Assessment</td>
<td>CM.R16.M3</td>
</tr>
<tr>
<td>Capacity Building</td>
<td>CM.R16.M6</td>
</tr>
<tr>
<td>CM.R16.M4</td>
<td>By 2008, implement actions to protect and restore priority terrestrial ecosystems of the Abrolhos</td>
</tr>
<tr>
<td>CM.R16.M5</td>
<td>By 2007, cooperatively implement actions to reduce the anthropogenic impacts on the Abrolhos' natural systems</td>
</tr>
</tbody>
</table>
### 8.6 COMMUNITY

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>REF CODE</th>
<th>RESOURCE CONDITION / MANAGEMENT ACTION</th>
<th>TARGETS</th>
<th>SYNERGIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASSET:</td>
<td>HUMAN CAPACITY / GOVERNANCE</td>
<td></td>
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</tr>
<tr>
<td>IMPORTANT</td>
<td>CA.R1</td>
<td>NRM funding into the Region to be the equivalent of 1% of GDP</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Indicator: Baseline: Determine current investment in NRM funding as % of GDP; Indicator: % of GDP of region spent on NRM activities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resource assessment</td>
<td>CA.R1.M1</td>
<td>Determine the yearly investment in known NRM processes by auditing NHT projects in region. Establish GDP of region in each sector</td>
<td>BD.R1.M4; BD.R1.M2</td>
<td></td>
</tr>
<tr>
<td>Planning</td>
<td>CA.R1.M2</td>
<td>Develop Business Prospectus to secure non-govt funding for implementation NACC Strategy</td>
<td>CM.R2.M1</td>
<td></td>
</tr>
<tr>
<td>Institutional Change</td>
<td>CA.R1.M3</td>
<td>Application processes for investors accessible, simple, transparent and provides feedback so applicants learn how to use the system</td>
<td>LN.R4.M2</td>
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<tr>
<td></td>
<td>CA.R1.M4</td>
<td>Technical support staff on-ground and available to support land-owners to develop plans and investment proposals</td>
<td>LN.R1.M10; BD.R10.M3; LN.R11.M2; LN.R13.M2; CM.R1.M4</td>
<td></td>
</tr>
<tr>
<td>Capacity Building</td>
<td>CA.R1.M5</td>
<td>Develop the capacity of NACC (through staff and contractors) to strategically approach and partner with government and non-government investors</td>
<td>CM.R1.M4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CA.R1.M6</td>
<td>NACC has developed a website based system for recording all investment in NRM projects and programs (electronic database management system)</td>
<td>BD.R1.M10; CM.R1.M4</td>
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<tr>
<td></td>
<td>CA.R1.M7</td>
<td>Targeted communications campaign by NACC to promote positive NRM practices, including to urban communities (Geraldton and Perth)</td>
<td>WA.R1.M8; WA.R1.M6</td>
<td></td>
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<tr>
<td></td>
<td>CA.R1.M8</td>
<td>Build the technical capacity of the region in salinity and surface water management by 2009</td>
<td>WA.R13.M2; CA.R2.M4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CA.R1.M9</td>
<td>State govt to expand &amp; support the APB program i.e. increased control of declared pests by 2006</td>
<td>LN.R2.M9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CA.R1.M10</td>
<td>Extension and financial incentives developed to enable the support of local and catchment scale salinity management techniques by 2007</td>
<td>CA.R1.M8; WA.R1.M6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CA.R1.M11</td>
<td>Extension and financial incentives developed to support on farm management and protection of high conservation value wetlands by 2009</td>
<td>CM.R4.M1; CM.R4.M3</td>
<td></td>
</tr>
<tr>
<td>On-Ground Works</td>
<td>CA.R1.M12</td>
<td>Use investment planning process to ensure 50% of all investment received by NACC goes into on-ground works</td>
<td>LN.R1.M12; BD.R1.M2</td>
<td></td>
</tr>
<tr>
<td>IMPORTANT</td>
<td>CA.R2</td>
<td>Clear governance and decision making framework and support for regional delivery of NRM is in place</td>
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<td>Indicator: Baseline: existing framework and governance structure recorded</td>
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<tr>
<td>Planning</td>
<td>CA.R2.M1</td>
<td>Quality engagement of community continued through investment planning and implementation stages through “bottom up” and targeted approaches</td>
<td>BD.R1.M7; CM.R2.M2; CM.R4.M1</td>
<td></td>
</tr>
<tr>
<td>Institutional Change</td>
<td>CA.R2.M2</td>
<td>Establish NACC and sub-regional local bodies as the NRM coordinating framework for NAR with Statutory authority. Ongoing resourcing of NACC core function including Committee support</td>
<td>CM.R1.M3</td>
<td></td>
</tr>
<tr>
<td>Capacity Building</td>
<td>CA.R2.M3</td>
<td>Multi-skilling of NACC employees, locally based technical coordination and advisory personnel on long term contracts. This includes support for local NRMO officers to support community involvement in investment plan implementation, and technical support to local NRMO network to develop and implement effective NRM</td>
<td>BD.R10.M3</td>
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<tr>
<td></td>
<td>CA.R2.M4</td>
<td>Build capacity of NACC Committee to respond to local issues in acceptable, relevant and exploratory ways</td>
<td>CA.R1.M8</td>
<td></td>
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<tr>
<td></td>
<td>CA.R2.M5</td>
<td>Corporate knowledge of NACC is retained and enhanced through continuity of delivery and continual relationship building with region and investors</td>
<td>CM.R2.M2</td>
<td></td>
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<tr>
<td></td>
<td>CA.R2.M7</td>
<td>Develop clear and accessible system for local projects and ideas to be funded through regional system. Enable long term projects to be funded</td>
<td>BD.R10.M2; BD.R1.M8; WA.R1.M8</td>
<td></td>
</tr>
<tr>
<td>IMPORTANT</td>
<td>CA.R3</td>
<td>Strong and positive partnerships in place and regional strategy aligns and enables local area plans</td>
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<td>Indicator: TBA</td>
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</tr>
<tr>
<td>Resource assessment</td>
<td>CA.R3.M1</td>
<td>Develop a map of all key players and through forums/meetings define roles and responsibilities and investment partners for strategy implementation (include special interest groups). Also include partnerships with players outside the region</td>
<td>AR.R1.M1; CM.R1.M3</td>
<td></td>
</tr>
<tr>
<td>Planning</td>
<td>CA.R3.M2</td>
<td>By Dec 2004, NACC to develop a clear role definition for each area of strategy implementation eg. Partner, initiating on-ground works, facilitator, catalyst, broker etc.</td>
<td>CA.R1.M8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CA.R3.M4</td>
<td>Audit and map geographic coverage of community groups to provide a planning resource for project planners to quickly identify local partners and groups that should be involved</td>
<td>BD.R10.M2; CM.R2.M2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CA.R3.M5</td>
<td>NRMO’s have developed local area plans which align regional strategy with local area plans, bringing into partnership community groups and local government (in both rural and urban communities in NAR)</td>
<td>LN.R10.M3; BD.R3.M1; BD.R1.M2; CM.R2.M5</td>
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</tr>
</tbody>
</table>


### Regional NRM Strategy - Northern Agricultural Region of WA

**Northern Agricultural Catchments Council 2005**

**CA.R3.M6** NRM plans align with local area land use plans (link with NRM infrastructure map)  
**BD.R1.M2; CM.R2.M5**

**CA.R3.M7** Ensure there is a regionally-consistent approach to zoning land use for recreation, development, agriculture and conservation  
**BD.R2.M2; CM.R2.M3**

**CA.R3.M8** Facilitate recreational, townscapes, waste management and landscape plans in place for each community in NAR  

**Institutional change**

**CA.R3.M9** Ongoing collaboration between NACC and partners in an open and transparent manner  
**CM.R1.M2**

**CA.R3.M10** NACC to form relationships with key lobby organisations which influence policy development  
**WA.R3.M9; BD.R1.M8; WA.R8.M2; CM.R1.M3**

**CA.R3.M11** Audit of all legislation which impacts on strategy implementation to identify any changes required eg Kyoto protocol, firebreaks  
**WA.R3.M8; BD.R1.M6; WA.R8.M2; CM.R1.M3**

**Capacity Building**

**CA.R3.M12** Developed better awareness of needs and issues of partners by mapping key relationships, and identifying where improvement is needed  
**BD.R1.M2; WA.R10.M1**

**CA.R3.M13** NRM's to rejuvenate local groups or support new groups to form where there is a defined role for group  
**BD.R1.M2; WA.R10.M1; CM.R2.M1**

**CA.R3.M14** NACC to increase investment in communication and awareness raising of their role, and potential opportunities to work with them  
**BD.R10.M2**

**On-ground works**

**CA.R3.M15** Developed working relationship with Aboriginal reference groups and local Aboriginal organisations  
**BD.R1.M2**

### IMPORTANT

**CA.R4** Integrated incentive schemes established and enabling positive resource management through flow of private investment  

**Indicator:** Baseline: establish degree of incentive systems in use already in NAR  
**Indicator:** 500% increase in uptake of possible mechanisms for on-ground work by year 3

**Resource assessment**

**CA.R4.M1** Investigated and developed range of potential incentive schemes for funding positive change in NRM  
**BD.R1.M5**

**CA.R4.M2** Have established system which enables regional trading of “costs and benefits” in NRM, enabling cost in one area to be offset by investment in another area  
**BD.R11.M1**

**CA.R4.M7** Annual review of outcomes against indicators set, leading to growth in knowledge and understanding and redirection of efforts to areas of strategic intent  
**BD.R1.M5; BD.R9.M5**

**Planning**

**CA.R4.M3** Established how incentive schemes can work within the local government planning systems and have encouraged 50% of all shires to adopt measures  
**BD.R1.M5; BD.R9.M5**

**Institutional change**

**CA.R4.M4** Incentive schemes which require change to national legislation to enable have been investigated and case presented to Australian Government (with other regions) to implement incentive systems (eg. Kyoto protocol)  
**BD.R1.M6**

**Capacity Building**

**CA.R4.M5** Developed NRM entrepreneurship program which focuses on innovation thinking “out of the box”. Includes extension of thinking into communities through a learning network structure like community builders  
**BD.R1.M1**

**CA.R4.M8** Viability rural population maintained or increased by facilitating incentives / subsidies to encourage local business / industry development  
**WA.R3.M7; CM.R1.M2**

### SUB-ASSET: CULTURE AND HERITAGE

**DESIRABLE**

**CA.R5** Ensure priority places of cultural and heritage significance are managed for the benefit of future generations  
**CA.R6.M4; CM.R5.M1**

**Indicator:** TBA

**Resource assessment**

**CA.R5.M1** Identify places of high significance to Aboriginals and prioritise for management actions  
**CA.R6.M4; CM.R5.M1**

**CA.R5.M10** Review the level of knowledge amongst land managers with respect to managing areas of high Aboriginal significance  
**CA.R5.M10**

**Planning**

**CA.R5.M2** Develop management plans for high priority Aboriginal places  
**BD.R1.M2; WA.R10.M1**

**CA.R5.M3** Facilitate the preparation of management plans (including human impact) for recreational and tourism areas that have high ecological value  
**BD.R1.M2; WA.R10.M1**

**CA.R5.M4** Identify places of cultural and historical significance in each local area and support the prioritised development of management plans  
**BD.R1.M1; BD.R1.M2; CM.R5.M1**

**Institutional change**

**CA.R5.M5** Work with local government and heritage organisations to encourage proactive management of high priority sites of significance  
**BD.R1.M10; CM.R2.M2**

**Capacity Building**

**CA.R5.M6** Introduce training to ensure NRM staff and organisations are able to manage issues and places relating to Aboriginal heritage  
**CA.R1.M8; BD.R10.M3; CM.R13.M1**

**CA.R5.M7** Spiritual values of natural resources understood, and knowledge in this area has grown  
**CA.R1.M8; BD.R10.M3; CM.R13.M1**

**On-ground works**

**CA.R5.M8** Implement management plans for high priority places of Aboriginal significance  
**BD.R1.M1**

**CA.R5.M9** Implement management plans for recreational areas with high ecological value  
**BD.R1.M2; BD.R1.M1; WA.R10.M1; CM.R6.M1**

**Northern Agricultural Catchments Council 2005**

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## Sub-asset: Built Environment

### Important

**CA.R6** Key Facilities and Infrastructure of region which is at risk by a natural resource threat to be managed to maintain current condition. Infrastructure development to take account of NRM priorities, threats and opportunities for management.

**Indicator:** Baseline: existing state either known or first stage is to assess condition resource. Indicators: TBA

#### Resource Assessment

**CA.R6.M1** Conduct mapping activity which overlaps resource condition risks, with infrastructure (existing and planned) and highlights areas for management and areas where industry opportunities will drive infrastructure into zones.

**CA.R6.M2** Audit state of household water supplied in region to determine areas which need targeted management.

**CA.R6.M3** Identify road drainage “hot-spots” and prioritise areas for management action.

**CA.R6.M12** Evaluation of achievement of MAT’s carried out as part of programs or projects.

#### Planning

**CA.R6.M4** Conduct planning activities as result of mapping process (R5.M1) in partnership with key agencies and local government.

**CA.R6.M5** Design protection of built infrastructure to town sites from altered hydrological regimes (32 designated priority communities in NAR).

**CA.R6.M6** Develop integrated road and NR management plans for each locality (eg. Road reserves linked to biodiversity conservation areas).

#### Institutional Change

**CA.R6.M7** DOSHWA to oversee accreditation/licensing of earthwork contractors.

#### Capacity Building

**CA.R6.M8** Develop network of interpretative centres (along concept Dalwallinu) to grow knowledge about how to work with our natural resources better.

**CA.R6.M9** NACC has developed excellent partnerships with local government and Main Roads to implement prioritised actions in facility and infrastructure maintenance.

#### On-ground Works

**CA.R6.M10** Implement townsite salinity management plans for 2-3 priority areas.


### Resource Assessment

**CA.R6.M1** Determine research priorities for land asset planning and management by 2006.

#### Institutional Change

**CA.R6.M2** Develop and recommend changes to Environmental Protection Policies (EPPs), Planning Policies and the Regional Planning Scheme (RPS) by 2009.

#### Planning

**CA.R6.M3** Develop and promote NRM clauses for inclusion in Environmental Protection Policies, Planning Policies and the Regional Planning Scheme that address NAR regional priorities.

### Sub-asset: Regional Economy

#### Essential

**CA.R7** All industry to be economically, socially and environmentally sustainable through facilitation of industry change.

**Indicator:** Baseline: Ecological footprint of regional industry to be calculated as baseline Indicators: Participation and outcome indicators proposed for each MAT.

#### Resource Assessment

**CA.R7.M1** Facilitate research to support the growth of knowledge on alternative land, water and power uses (including tree crops). Market and promote resource management opportunities.

**CA.R7.M2** Have in place mechanisms which enable landholders to derive income by protecting remnant vegetation.

**CA.R7.M3** Research the development of an indicator which reports on sustainability of all industry practice in NAR (eg. % raw materials exported as % regional GDP with goal being to reduce it over time).

**CA.R7.M13** Evaluate sustainability of each industry based upon indicators developed through self managed system.

#### Planning

**CA.R7.M4** System developed to enable offset practices to be traded.

**CA.R7.M5** Facilitate industry and private incentive schemes to reward positive behaviour change in NRM (taxation system, rates system, trading systems).

**CA.R7.M6** Incentive schemes to be developed to enable retention of skilled professional labour market in region (for all industries).

#### Institutional Change

**CA.R7.M7** Extend knowledge developed on alternative land, water and power uses.

**CA.R7.M8** Provide facilitation and support for industry to adopt good practice changes.

**CA.R7.M9** Facilitate support for development of new industry opportunities which generate greater regional sustainability (as defined by INCA.R6.M3).

**CA.R7.M10** Facilitate industries to adopt offset practices (through trading system established through INCA.R3.M2).

**CA.R7.M11** Protection of remnant vegetation on farms through incentive or trading schemes.

**CA.R7.M12** Develop sustainable farm forestry initiatives with NAR.
9.0 LEGISLATION, POLICY AND PLANS

9.1 LINKS, COORDINATION & INSTITUTIONAL CHANGE

9.1.1 THE CONTEXT

There is a range of legislation, policy and plans which interact with NRM, and they impact at many levels: Commonwealth or State legislation and policies, Local Government plans and policies, sub-regional, regional and local strategies and action plans. Here they are all loosely referred to as “policies”. There are also many stakeholders; from local groups to cabinet ministers, all with a part to play.

This NRM strategy provides a strategic framework for future investment in NRM. The actions and targets developed here interact with a wide variety of current policies. In general we see existing policies as platforms with which to strengthen and link our approaches. There is no intention to “reinvent the wheel”. However, we have identified some issues relating to “institutional change” which we believe are areas where change management could be implemented.

9.1.2 COORDINATION OF POLICY AND ACTION

Because policies have evolved separately and at different times, they can appear to be poorly coordinated. There is also often confusion at the grassroots level regarding who has particular responsibility for an issue or what the “rules” are. For example, there are many agencies involved in the coastal land/marine interface and there is confusion in the community as to where help can be obtained. There is increasing pressure on our coast from development and human impact and there is an urgent need for a coordinated approach. It is hoped that an NRM strategy such as this can ultimately lead to better coordination by linking diverse stakeholders under a common strategic purpose but with a local focus.

9.1.3 LEGISLATION

A summary of some of the Commonwealth and State legislation relevant to NRM is given in Appendix VIII, together with guidelines on actions that need to be taken to comply with particular policy. This is provided for reference, and to describe the legislative framework in which NRM can be implemented.

9.1.4 LOCAL GOVERNMENT

There are 17 local government authorities (LGA) within the NAR, each with various policies and plans that overlap with NRM. Most shires are hampered by a very low rate base and lack the financial resources to implement significant NRM policy. Few have an environmental vision for their area that is translated into policy (Wilson, 2003). Nevertheless, there are many ways in which local government could become more involved. For example, local government policy impacts on the management of significant amounts of native vegetation on road and conservation reserves both via direct management and via policies relating to weed management, fire control and land use planning. There are many relatively simple actions that can be put in place to make sure that such management is effective (Binning et al 1999).

Local government policy also interacts with NRM in a wide variety of other ways. Issues such as water quality, drainage, site conservation, land use systems, environmental degradation and roadside management are all issues which LGAs can legally influence (Eaton and Fraser, 2003). There are also many opportunities for partnerships to be developed by local government in the event they wish to increase their commitment to NRM.

Local government has been involved in the development of this strategy, and NACC has also worked directly with the NRM Coordinator of WALGA. There is much further work that could be done to build and support capacity in local government, to develop partnerships, and to move towards aligning local government policies and plans with NRM outcomes.
9.1.5 INSTITUTIONAL CHANGE

New legislation is continually being devised. For example the new state Biodiversity Conservation Act is currently in development, and acts relating to soil and land conservation and agricultural resources have been under review for some time, with a view to amalgamation and adjustment.

In identifying actions and targets for this strategy, a number of activity areas were identified (see p118) including institutional change. Sometimes this may mean new legislation, but more usually it means adjustments or interpretation of policy, or a new focus on an issue. For example MATs were developed to:

- provide incentives for biodiversity protection and management (BD.R1.M5);
- amend surface water management and drainage regulations to ensure greater accountability (LN.R1.M7);
- develop policy for sustainable management of livestock in waterways and wetlands (WA.R3.M9); and
- review the integration and effectiveness of coastal and marine NRM organisations (government, private and non-government) (CM.R1.M3).

There are other examples in the target tables (page 123).

9.1.6 LINKS TO POLICY, STRATEGIES AND PLANS

In addition to policy issues, there are many strategies and plans that are linked with our goals. As mentioned previously we are keen to link our actions to existing strategies or plans, rather than act independently. These links may be strategies of national, state or regional derivation, or may be an action already identified by another (possibly non-government) organisation.

For example, a MAT related to rising groundwater and salinity, aims to increase plant water usage by increasing the proportion of perennials in the landscape (LN.R2.M5). This has direct links to government activities in the Forest Products Commission; the Departments of Environment, Conservation and Land Management, and Agriculture; and to the following government strategies:

- State Salinity Strategy (2000)

In addition, this action has links to the following:

- Soil and Land Conservation Act (1945)
- Forest Products Act
- Western Australian Greenhouse Strategy (in development)
- Carbon Rights Bill (2002)

The action is also directly compatible with the activities of certain non-government groups in the region such as the Evergreen Group and the West Midlands Forestry Alliance. Related strategies and plans are also listed in the Appendix VIII, and in the Bibliography.

We have yet to fully develop our investment plan, but in doing so we will be working on aligning all our actions and projects in this way with current policies and plans. For instance, there are a considerable number of conservation reserve management plans, threat abatement plans and recovery plans for threatened species and ecological communities that are available and being implemented in the region.

9.1.7 SUB-REGIONAL PLANS

The NAR has 4 sub-regions: Greenough, Yarra Yarra, Moore and West Midlands, and sub-regional strategies and action plans have been developed for all of them (NAIMS, 1999). In addition, the Yarra Yarra and Moore sub-regions have since developed more detailed dedicated strategies (Yarra Yarra Catchment Group, 1999; Moore Catchment Council, 2000). Now that this regional NRM strategy is complete, a challenge for sub-regions is to align their strategies with the regional one, and develop investment and action plans accordingly.
10.0 MONITORING, EVALUATION & REPORTING

10.1 NACC’S VISION FOR MER

In the NAR we see MER (Monitoring, Evaluation and Reporting) as an opportunity to assist us in identifying change, and to support an adaptive approach that is flexible enough to cope with the reality of change, enabling learning at an individual, community and organisational level (Outhwaite, 2004). We are developing internal processes for MER that foster a learning environment, integrate with external reporting requirements, and provide information that can clearly communicate our progress to community and investors.

10.1.1 GOVERNMENT REQUIREMENTS

The Commonwealth and State Governments are investing hundreds of millions of dollars in the National Action Plan for Salinity and Water Quality (NAP) and the Natural Heritage Trust (NHT2).

The goals of NAP are to

- Prevent, stabilise and reverse trends in salinity, particularly dryland salinity
- Improve water quality and secure reliable allocations for human uses, industry and the environment

The goals of NHT2, under section 19 of the Natural Heritage Trust of Australia Act 1997, relate to

- Biodiversity conservation
- Sustainable use of natural resources
- Community capacity building and institutional change

Both these agreements have as a central requirement a monitoring, evaluation and reporting framework which is to be implemented as part of each regional strategy. The investment plan will include an allocation of funds for monitoring and evaluation of actions (with 10-15% the usual figure quoted). The framework is shown in Figure 16.

10.1.2 OUTCOMES AND OUTPUTS

MER is required at a range of different levels and timeframes. Outcomes are long-term achievements, in this context usually related to progress towards RCTs. Intermediate outcomes may relate to achievements towards MATs. Outputs are smaller steps along the way, in particular achievements of specific activities or management actions including monitoring of program performance and accountability. The main aspects of performance and implementation are as follows:

The underlying logic of MER is that

Resource Condition is changed by
Management Actions which are achieved by
Outputs and Activities, which require
Investment

The primary purpose of NAP/NHT2 monitoring, evaluation and reporting is to demonstrate that investments contribute to meeting resource condition targets. Supplementary purposes are to provide feedback and support adaptive management for NAP/NHT2 projects, and to contribute to a regional and national view of status and trends in resource condition. The four areas of reporting are:

Figure 16. National framework for Monitoring Evaluation and Reporting

<table>
<thead>
<tr>
<th>NATURAL RESOURCE CONDITION</th>
<th>PROGRAM, STRATEGY AND POLICY PERFORMANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MONITORING</strong></td>
<td><strong>EVALUATING MODELS &amp; ASSUMPTIONS</strong></td>
</tr>
<tr>
<td>• NATURAL RESOURCE CONDITION MONITORING AT LOCAL, REGIONAL, STATE/TERRITORY AND NATIONAL LEVELS</td>
<td>• MONITORING OF RESOURCE CONDITION AGAINST STANDARDS AND TARGETS FRAMEWORK</td>
</tr>
<tr>
<td>• EVALUATING PROGRESS TOWARDS IMPROVED NATURAL RESOURCE CONDITION AT THE NATIONAL LEVEL</td>
<td>• MANAGEMENT ACTION MONITORING</td>
</tr>
<tr>
<td><strong>EVALUATION</strong></td>
<td><strong>PERFORMANCE EVALUATION OF PROGRAMS AND STRATEGIES</strong></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
• Resource condition, and progress in achieving resource condition targets (annual reporting)
• Management actions completed, compared with targets (annual reporting)
• Short term outputs and activities accomplished, compared with targets (half yearly reporting)
• Financial activity, compared with budget (quarterly reporting)

MER occurs at all levels of governance and in relation to all project and program activities. The diagram below shows the linkages. MER is often made out to be more complex than it actually is. In simple terms:

• Monitoring is recording information on the condition of something natural, or the measurable outputs of the work you are doing.
• Evaluation is deciding whether you are doing the right thing, and how effectively you are working towards your project/program objectives.
• Reporting is telling others about what you are doing and how you are going.

10.1.3 RCT AND MAT INDICATORS, PROTOCOLS AND LINKS

There is a discussion on page 117 and a list on 119 of the key “matters for target” identified for this region. The tables commencing on page 123 show an indicator for each RCT. In general, we will use any resource condition indicators that have been agreed nationally and that relate to specific investments in the region. One difficulty in this region is the lack of baseline data.

The state agencies monitor resource condition and trend in many different areas and, as much as possible, we will be linking with their existing programs. However, in this region baseline data is missing for most indicators and it will be necessary to establish a program and protocol in relation to monitoring for the region. Where possible we will use data from the existing resource condition monitoring programs and we are keen to work closely with State agencies. However because of both the paucity of data and the significance of the issue, it is anticipated that a specific project will be developed on MER for the region.

We recognise the significance of the National Land & Water Resources Audit (NLWRA) which is responsible for coordinating the collation of resource condition data at a national level and are keen to cooperate with this.
10.1.4 PROGRAM OUTPUTS

Program output reporting relates to outputs and activities that contribute to the achievement of Management Action Targets. We have sorted our MAT outputs into 5 categories: Resource Assessment, Planning, Capacity Building, On Ground Works and Institutional Change and will report in relation to these. All except the last are recommended in the guidelines. During our community consultation period, Institutional Change arose frequently and, as it is considered to be a key driver in effective NRM, we are keen to retain it.

Financial reporting will also be undertaken as required under the guidelines - at project, program and regional organisational level, and in relation to administrative and management outputs as well as for biophysical or community indicators. We are happy to contribute to an aggregated reporting mechanism.

10.1.5 EVALUATION

Evaluation is related to:

Effectiveness of program in delivering on its goals and meeting RCTs and MATs; improving program management, transparency and accountability; reducing risk and uncertainty; and fostering learning;

Efficiency and cost-effectiveness of the regional program; wise and effective use of funding, with an eye to enhance synergies and reduce duplication; and;

Appropriateness - whether the strategy and mechanisms are the most appropriate means of achieving high level objectives, and whether there are any unintended outcomes - positive or negative.

To deal with these issues, there is a need for systems of MER to:

- be clear and not overly complex;
- seen as worthwhile and personally satisfying for individuals involved;
- built into every part of managing and delivering programs, projects and people,
- able to incorporate qualitative and quantitative assessments,
- build on the good work already done,
- help users of the systems learn faster!

“The underlying logic of MER is that Resource Condition is changed by Management Actions which are achieved by Outputs and Activities which require Investment”
### 10.1.6 DEVELOPMENT AND INTEGRATION OF MER AT THE REGIONAL LEVEL

MER will be incorporated into the budget of each project. The majority will be spent on monitoring programs. Evaluation and reporting are likely to be less costly exercises (in both technical requirements and time) than monitoring.

Monitoring programs will be integrated at the regional level by a senior organisational manager (e.g., the Program Manager – who works closely with the CEO). In addition, there will be a specific regional level project to conduct a monitoring needs analysis, prioritise investigations, and work on synergies with current agency monitoring programs.

Within the NAR there is already an enormous amount of knowledge and wisdom about NRM. As well as the formal MER systems, there is the opportunity to create synergisms by developing a strong regional MER network. With a system that goes beyond regular reports, there is an opportunity to foster a culture of ongoing learning in which adaptive management can be facilitated. There is an opportunity for the community and NACC staff to be continually conducting self-assessment of their activities, reflecting on the success of their work in achieving progress towards MATs, making evaluations, and adapting future work to incorporate more effective processes.

The diagram below attempts to draw together a few elements of adaptive management approaches, the INRM program logic, and the NHT objectives to show how MER can play a fundamental role in ensuring we are on track towards what we want to achieve in the region. The loop on the right illustrates a systems-based framework for the evaluation of NRM initiatives. The spiral on the left incorporates the evaluation loop, and shows how MER contributes to achieving RCTs and delivering outcomes and outputs. It is likely that outcomes and outputs will contribute to different outcomes and outputs simultaneously and cyclically, but there is some level of logical progression e.g., you have to know the condition of your resource and have a plan before you start doing anything.

**Figure 18. Integration of MER, adaptive management, INRM program logic and NHT objectives**
11.0 PRIORITISATION OF ACTIONS AND TARGETS

11.1 COMMUNITY & AGENCY PRIORITIES

11.1.1 DEVELOPMENT OF A SUITE OF ACTIONS

In the course of community consultation and development of actions to address threats and opportunities, we developed a very large number of Resource Condition Targets, Management Action Targets and Management Actions (MA). Not only the general community, but also state and local government personnel, and Commonwealth representatives, were involved in this process. Overall there were more than 1000 actions identified. The table below indicates the raw number of RCTs, MATs and MAs we gathered.

“First Focus” was developed as a label for this community activity as it connotes that the first actions identified are only part of a subsequent suite of activities.

An interesting set of statistics is to identify those issues that attracted the most actions. These were as follows:

- Agricultural land: Farming systems research and development (12 MAs), (LN.R2.M4);
- Terrestrial biodiversity: Environmental Weeds (25 MAs), (BD.R8.M1);
- Water: Sustainable surface water allocation from perennial waterways (11 MAs), (WA.R2.M1);
- Coastal and Marine: Develop and deliver community education programs on coastal and marine issues (11 MAs), (CM.R1.M4);
- Community and Infrastructure / Economy: Develop profitable and sustainable farm forestry initiatives (27 MAs), (IN.R5.M27).

Because of the large number of actions generated, it was necessary to group, amalgamate and consolidate them so that they were more manageable, and so that we were able to prioritise them. Using the threat ranking and asset values developed previously, the Regional NRMOs selected the top 6 RCTs and within them the top 5 MATs in each asset class (a total of 151 MATs). These were presented to the community at “You Decide” workshops.

11.1.2 OUR VALUES PREFERENCES

At “You Decide” workshops we:

- confirmed the Resource Condition Targets and Management Action Targets;
- recommended a strategic mix of investment across actions for each asset class;
- identified relationships critical to delivering resources and action.

In order to develop the strategic mix of investment, selections were made that would:

- target the significant opportunities and threats as previously identified;
- protect high value assets;
- deliver a significant improvement in wide area;
- build up capacity long-term.

Preferences were identified by allocating points to priority MATs within each asset class.

Table 40. Numbers of RCTs, MATs and MAs developed in community consultation

<table>
<thead>
<tr>
<th></th>
<th>RCT</th>
<th>MAT</th>
<th>MA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Land</td>
<td>17</td>
<td>52</td>
<td>183</td>
</tr>
<tr>
<td>Terrestrial Biodiversity</td>
<td>12</td>
<td>44</td>
<td>115</td>
</tr>
<tr>
<td>Water</td>
<td>18</td>
<td>68</td>
<td>178</td>
</tr>
<tr>
<td>Coastal and Marine</td>
<td>16</td>
<td>76</td>
<td>178</td>
</tr>
<tr>
<td>Air</td>
<td>2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Community and Infrastructure</td>
<td>19</td>
<td>69</td>
<td>391</td>
</tr>
</tbody>
</table>
11.1.3 MAKING SELECTIONS

“You Decide” workshops were held in several locations across the region, and the results were surprisingly consistent. The outstanding issues identified in each asset class were as follows. Indicated below are areas of “high threat risk” (see Appendix V) and/or “Essential” in relation to importance (see also Appendix V).

- Agricultural land:
  - Rehabilitation of saline areas;
  - Profitable farming systems that reduce threats, in particular perennial high water-use systems;
  - Implementation of biosecurity measures;
- Terrestrial biodiversity:
  - Increase extent of native vegetation;
  - Building skills and knowledge in Biodiversity management;
  - Increase protection and condition of poorly represented species or communities including threatened species and habitats;
  - Protection from salinity, weeds and invasive animals;
- Water:
  - Improve the condition of riparian vegetation on priority waterscapes;
  - Reduce surface water runoff;
  - Protect waterways from salinity;
  - Protect aquatic fauna;
  - Equitable allocation of groundwater;
  - Prevent water scapes and groundwater from contamination;
- Coastal and Marine:
  - Coordinated strategic approach to governance systems for coastal and marine issues;
  - Improve condition of coastal geomorphic systems in particular by coastal planning and management to ensure that development and human pressure is balanced with environmental values;
  - Protect estuarine systems from human impact;
- Community and Infrastructure:
  - NRM funding the equivalent of 1% of GDP;
  - Clear governance and decision making;
  - Integrated incentive schemes established and attraction of alternative sources of funding for NRM, in particular non-government investors;
  - Support for sustainable industries involving alternative land (including tree crops), water and power uses;
  - Support community capacity, partnerships and planning;

These are slightly different from those identified from the first weighting of actions developed by the community (see the previous page). Prioritisation is a complex issue, and while objectivity and a set of criteria are important, it is not possible to be strictly quantitative. It is an iterative process, with each stage providing a more accurate estimation.

“Actions were grouped, consolidated and prioritised using the threat ranking and asset values developed previously”
11.2 INCORPORATING THE THREAT RISK/ESSENTIAL INTO PRIORITISATION

A method for ranking of biophysical threatening processes at a regional level against three criteria (Scale, Severity, Timeframe) was developed to determine the level of threat risk to natural resource assets (see appendix IV). The results of this method have been applied in a matrix against the outcomes of the “You Decide” workshop.

The matrix (see Figure 19) provides a basis for comparing the level of community support against the level of threat risk at RCT level.

Within the Target Tables, (Tables 34-39) the level of community preference (Essential, Important or Desirable) and the level of threat risk (High, Medium, Low) are indicated in the cell left of the RCT. This assessment of threat risk doesn’t take into account social or economic risk and hence some RCT’s in the target tables do not show a threat risk; Table 41 (overleaf) shows the results of the prioritisation process.

Figure 19. Matrix of Threat Risk against Community Preference/Value.

<table>
<thead>
<tr>
<th>COMMUNITY PREFERENCE/VALUE</th>
<th>HIGH THREAT RISK</th>
<th>MEDIUM THREAT RISK</th>
<th>LOW THREAT RISK</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESSENTIAL</td>
<td>ESSENTIAL HIGH</td>
<td>ESSENTIAL MEDIUM</td>
<td>ESSENTIAL LOW</td>
</tr>
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<td></td>
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<tr>
<td>IMPORTANT</td>
<td>IMPORTANT HIGH</td>
<td>IMPORTANT MEDIUM</td>
<td>IMPORTANT LOW</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>DESIRABLE</td>
<td>DESIRABLE HIGH</td>
<td>DESIRABLE MEDIUM</td>
<td>DESIRABLE LOW</td>
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<td></td>
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<td></td>
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</tbody>
</table>
Table 41. Prioritisation of targets: matrix of threat risk against community preference value

This table shows the threat risk matrix for the Resource Condition Targets (RCTs). The issues in the boxes shaded red or orange are of highest priority, but projects may be developed on any of the issues listed. The threat risk of some of the resources was not ranked (right hand box), but community preference indicates their perceived priority. The threat risk of any marked * was assessed as variable, and depends on the specific associated issues.

<table>
<thead>
<tr>
<th>Essential</th>
<th>Important</th>
<th>Desirable</th>
<th>Non Threat Ranked</th>
</tr>
</thead>
<tbody>
<tr>
<td>LN.R1</td>
<td>LN.R2</td>
<td>LN.R3</td>
<td>BD.R10 Capacity to drive landscape change</td>
</tr>
<tr>
<td>LN.R4</td>
<td>LN.R5</td>
<td>LN.R7</td>
<td>AR.R1 Climate change/seasonal variability</td>
</tr>
<tr>
<td>BD.R1</td>
<td>BD.R5</td>
<td>BD.R6</td>
<td>CA.R7 Sustainable industry</td>
</tr>
<tr>
<td>WA.R1</td>
<td>WA.R5</td>
<td>WA.R6</td>
<td>CM.R1 Coastal and Marine governance</td>
</tr>
<tr>
<td>WA.R3</td>
<td>WA.R7</td>
<td>WA.R8</td>
<td>CA.R1 NRM regional funding</td>
</tr>
<tr>
<td>WA.R11</td>
<td>WA.R12</td>
<td>WA.R13</td>
<td>CA.R2 Regional NRM delivery system</td>
</tr>
<tr>
<td>CM.R14</td>
<td>CM.R18</td>
<td>CM.R19</td>
<td>CA.R3 Regional NRM partnerships</td>
</tr>
<tr>
<td>CM.R15</td>
<td>CM.R20</td>
<td>CM.R21</td>
<td>CA.R4 Incentive schemes</td>
</tr>
<tr>
<td>CM.R16</td>
<td>CM.R22</td>
<td>CM.R23</td>
<td>CA.R6 Infrastructure protection</td>
</tr>
<tr>
<td>LN.R11</td>
<td>LN.R24</td>
<td>LN.R25</td>
<td>AR.R2 Air</td>
</tr>
<tr>
<td>BD.R2</td>
<td>LN.R4</td>
<td>LN.R5</td>
<td>CA.R5 Culture and heritage sites</td>
</tr>
<tr>
<td>BD.R4</td>
<td>LN.R6</td>
<td>LN.R7</td>
<td>LN.R8 Soil Biology</td>
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<tr>
<td>WA.R10</td>
<td>LN.R8</td>
<td>LN.R9</td>
<td>LN.R14 Soil contamination</td>
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<td>LN.R10</td>
<td>LN.R11</td>
<td>ULN.R1 Development and Urban Expansion</td>
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<td>WA.R12</td>
<td>WA.R13</td>
<td>WA.R14</td>
<td>ULN.R2 Management of Crown Land</td>
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<td>CM.R8</td>
<td>WA.R15</td>
<td>WA.R16</td>
<td>CM.R5, R13 Coastal &amp; Marine Aboriginal Heritage</td>
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<td>CM.R9</td>
<td>WA.R16</td>
<td>WA.R17</td>
<td>CM.R6, R14 Coastal and Marine Heritage</td>
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<tr>
<td>CM.R10</td>
<td>WA.R17</td>
<td>WA.R18</td>
<td>CM.R7, CM.R15 Visual Coastal &amp; Marine Amenity</td>
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<tr>
<td>CM.R22</td>
<td>WA.R18</td>
<td>WA.R19</td>
<td>BD.R11 Science of biodiversity</td>
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<table>
<thead>
<tr>
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<th>Low</th>
<th>High</th>
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<tr>
<td>LN.R1 Rising Groundwater and salinity</td>
<td>CM.R2 Condition of coastal geomorphic systems*</td>
<td>LN.R1 Rising Groundwater and salinity</td>
</tr>
<tr>
<td>LN.R2 Farming Systems</td>
<td>LN.R11 Fish resources*</td>
<td>BD.R4 Threatened species and communities</td>
</tr>
<tr>
<td>LN.R3 Biosecurity</td>
<td>LN.R4 Erosion control</td>
<td>LN.R8 Environmental weeds</td>
</tr>
<tr>
<td>BD.R1 Extent of native vegetation</td>
<td>LN.R12 Sub-surface compaction</td>
<td>BD.R5 Protecting key habitats</td>
</tr>
<tr>
<td>WA.R1 Surface water control</td>
<td>WA.R14 Groundwater quality*</td>
<td>WA.R6 Salinity levels of wetlands*</td>
</tr>
<tr>
<td>WA.R3 Riparian vegetation</td>
<td>WA.R15 Managing recreation on waterscapes</td>
<td>WA.R7 Frewater aquatic fauna</td>
</tr>
<tr>
<td>WA.R11 Groundwater allocation</td>
<td>WA.R10 Waterlogging</td>
<td>WA.R12 Water use efficiency</td>
</tr>
<tr>
<td>CM.R16 Houtman Abrolhos Islands</td>
<td>WA.R13 Flood control</td>
<td>CM.R8 Marine sea-bottom*</td>
</tr>
</tbody>
</table>

Legend:
- Red: High priority
- Orange: Medium priority
- Yellow: Low priority
- Green: Non-threat ranked
- *: Variable threat risk
12.0 THE STRATEGY PROCESS AT A GLANCE

In the process of developing this strategy we have used a number of different processes, all of which have been discussed elsewhere in this document. Because many of the stages involve complex decisions, and a range of scientific and community values, the process can be confusing. Below is a diagrammatic representation of the process we have followed.

**STRATEGY PROCESS**

**EXPLANATORY NOTES**

The process that we used blended scientific knowledge about what natural resources are most at risk, with what the community most values. The process for consultation with Indigenous groups was guided by two, agency based, Indigenous reference groups.

By using the threat/risk maps in the MAT workshops, and then asking the “target question”, we got an intuitive answer to the asset based NRM question “what is the most threatened and most valued asset?” It then goes the next step and asks the question – what would you do to manage that? – which actually asks “what you do to solve a set of inter-related systemic issues that create the problem?”

The MAT’s that were developed therefore reflected the answer to this question we were seeking. The MAT’s are deceptively simple, but go to the heart of what needs to be done.

This is why so many MAT’s were on non-biophysical topics. The regional community told us what they needed to manage, how to manage natural resources better, and 40% of the ideas related to how to manage people, institutions and put the right financial environment in place for investment to flow to managing natural resources.

The NRMO team and committee members sorted and grouped community ideas for two days. The ideas were discussed and debated regarding what each person’s idea meant. The ideas were copied to put them in multiple places if it was considered they belonged in other asset classes. MAT’s were written for each group of like ideas and reworked. Where RCT’s were developed by the technical team, the MAT’s were placed under the relevant RCT’s. Where RCT’s weren’t developed, the Regional NRMOs and Strategy Team developed them.

The draft document was provided to a range of people with specific areas of technical expertise for feedback. The draft was also provided to the community to invite them to the YOU Decide workshops.
NRMO’s and committee members sat together in asset class areas and worked to integrate the feedback, and apply three tests as outlined:

- Sound science test - are the targets based on the best scientific and technical knowledge?
- TBL test – are they achievable in terms of the social, economic and cultural drivers of the region?
- Impact test – which of the targets will make the most difference?

The MAT’s and RCT’s were ranked based upon our tests.

At this stage of organising the RCT’s and MAT’s, a framework was developed for organising the MAT’s under each RCT.

It was considered that all changes to natural resources would flow through an active adaptive management cycle:

- Resource assessment
- Planning
- Institutional change
- Capacity building
- On-ground works
- Monitoring and evaluation
- And back to resource assessment or planning.

The MAT’s were presented in this order under each RCT. Monitoring and evaluation MAT’s were subsequently blended with resource assessment MAT’s.

Each asset class had developed a target investment mix sheet, which allowed participants to allocate investment resources across the ideas in each asset class.

The results across the four locations were surprising. The degree of consistency across the four sub-regions was astounding. There was some local areas of significance in each sub-region but the results were dramatically similar across the four workshops. A clear outcome was achieved.

Once targets had been identified and grouped, two complementary processes were used to arrive at priorities:

1. Issues were ranked using a Threat/Risk process developed for the purpose. This is described in Appendix IV. This process was informed by state agency priorities which also used a threat/risk mechanism for assessment. State agency priorities are summarised in Appendix X.

2. Community and agency personnel jointly developed what we have referred to as “Community Preferences”. These preferences were made on the basis of:

   - significant opportunities and threats;
   - protection of high value assets;
   - delivery of significant improvement in a wide area;
   - building capacity for the long term.

The threat/risk assessments and Community preferences were then cross-linked to arrive at a prioritisation matrix, which is now presented as Table 41. This table has been used in helping prioritise projects to incorporate into the Investment Plan. The table is also appended to this document.

It is important to note however that the degree of importance does not take into account the amount of resources it will take to achieve a target. Some targets may be easy to achieve and resource cheap and others may be at a larger scale and take 30 years to achieve. The YOU Decide workshops are only a first stage in the investment decision making process with the regional community.
13.0 GOING FORWARD: IMPLEMENTATION OF THE STRATEGY

13.1 INVESTMENT PLAN

13.1.1 CONTEXT & PRINCIPLES

Following on from this strategy, we are developing an investment plan based on the priorities developed in this process. The investment plan will include:

- Detail of the proposed actions/projects and responsibility for implementation;
- The assumptions underpinning the chosen actions;
- Costings, and the investment required for each action/project;
- The expected return on investment; including how the projects address the targets outlined in this strategy;
- A Monitoring and Evaluation Strategy;
- Articulation with existing policies and plans – all levels of government (including LGAs), sub-regional, and catchment;
- A risk management profile for each activity; and
- Timelines, milestones and performance indicators for each action.

Principles

During the course of strategy development, we have confirmed with the community and other stakeholders that the following principles will be used for targeting investment:

- equity of opportunity associated with a balance in issues and areas of need for NRM;
- across government, non-government and community stakeholders;
- across the region;
- across assets;
- public benefit;
- maximum impact of the investment;
- important threat or valued asset is addressed;
- multiple outcomes, particularly in relation to several assets or threats being addressed with the one action;
- addresses cause rather than symptoms; and
- the critical nature/urgency of the actions.

13.1.2 PROGRAMS

NACC NRM programs will be key instruments for providing the delivery of NRM outcomes in the Region. The programs will be aligned with related Local Government and State Government programs to enable the resource condition changes through local delivery action plans.

The increasing pressure from development on natural resources in the Region will make integrated NRM increasingly important. To achieve integrated NRM outcomes all key stakeholders need to be provided the same opportunity and access to participate. Many of the processes that threaten NRM in the Region apply across a range of natural resource assets and management actions to address threatening processes can achieve benefits for a range of natural resource assets. Therefore, for efficient and effective NRM, integration is to be applied from the outset to ensure sustainable outcomes.

The Investment Plan will include 15 programs, and Expressions of Interest for projects have been sought from a very wide range of potential partners. The Investment Plan is being developed to coincide with the final submission of the accredited strategy (January 2004).

The programs, which are summarised in table 42, are as follows:

1. Biosecurity
2. Building Healthy Waterscapes
3. Caring for our Coast, Sea and Islands
4. Conserving our Terrestrial Diversity
5. Integrated Catchment Management
6. Managing Salinity
7. New Opportunities: Balancing Development and the Environment
8. Resource Assessment
9. Sharing Indigenous Knowledge
10. Supporting Environmental Education and Knowledge
11. Sustaining Agricultural Production
12. Understanding our Climate and Managing our Air
13. Using Water Wisely
14. Farm Forestry
15. Delivering Natural Resource Management
13.1.3 COST/BENEFIT ANALYSIS

The cost benefit ratio of actions and targets has been considered at several points in our strategy process, and in addition will be a key element in developing projects for investment.

In the “Community Preference” process which contributed to prioritisation of the targets, elements of Cost/Benefit analysis such as value, geographic scale, and timeframe were included. Actions and targets were considered highly if the following criteria were met:

- the action would protect a high value asset;
- the action would deliver significant improvement in a wide area;
- the action would contribute to building long-term capacity.

In the Investment Planning process, Expressions of Interest have been called for project proposals that will address priority targets. Proponents have been asked to address the issue of return on investment by explaining how their project demonstrates a good return on investment and contributes to the public good, and by explaining the consequences of taking no action. The following principles underpin the investment planning process and have been made clear in project guidelines:

- The overarching principle is return on investment in terms of NRM outcomes;
- The investment proposal must demonstrate a high public good element;
- Preference will be given to projects that provide leverage to effect major or additional changes.

When full project submissions are called for, there will be a requirement for a more detailed explanation of the Costs/Benefits of the proposal. This will include all the environmental, heritage, social and economic implications of the project, with quantification where possible, and to include the implications of taking no action.

13.2 POTENTIAL INVESTORS/PARTNERS

An important factor in the investment plan will be identification of investors. There is an expectation that the Commonwealth and State governments will contribute, both through the National Action Plan for Water Quality and Salinity and the National Heritage Trust, and also by partnering the region with joint activities and developing synergies between various government and regional projects.

In addition, we are keen to develop other partnerships – particularly with industry. There are many vibrant industries in the region, from large corporations such as mining companies, to small businesses involved in farming, fishing and NRM. There are many opportunities for these to contribute, both financially and in-kind, to the actions identified by this strategy.

Local government also has an important part to play. As discussed on p141 LGA’s role in environmental issues has tended to be either indirect or opportunistic. There are, however, many opportunities for greater strategic involvement, and for shires to benefit from improved NRM in their areas.

13.3.1 RESOURCE ASSESSMENT/MONITORING AND EVALUATION

Many of the actions identified in this strategy relate to Resource Assessment. In this region there is a paucity of baseline data for most natural resources. In the section on MER (p111) we indicated an intention to not only include an allocation of funds for monitoring and evaluating for each project, but also to develop a specific regional project focussed on monitoring.

13.4 GOVERNANCE AND ADAPTIVE MANAGEMENT

13.4.1 GOVERNANCE AND PARTNERSHIPS

NACC has come a long way since its inception as NAIMS several years ago. During the course of this strategy development we have matured considerably as an organisation. We now have strong leadership through our Chair and Executive Committee, firm and accountable management systems through our Management Committee and Executive Officer, a skilled and committed staff in our regional and local NRM officers, and an enthusiastic community with great expectations for the future.

Good governance by NACC is a high priority and we are also conscious that partnerships with other organisations are essential to successfully integrate NRM into all facets of the region. It has been interesting to note that several of the MATs developed in this process were to do with coordination of effort. A key target under the “Community and Infrastructure”
**Table 42. Description of Programs to be included in the Investment Plan**

<table>
<thead>
<tr>
<th>Program Name</th>
<th>Aim: Primary Focus of the program</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1 Biosecurity: Securing Our Assets</strong></td>
<td>This integrates management and prevention of agricultural, aquatic, marine and environmental weeds, pests and diseases.</td>
</tr>
<tr>
<td><strong>2 Building Healthy Waterscapes</strong></td>
<td>This program will protect and restore priority waterscapes in the region. This may include: Reducing the impacts of agricultural and industrial land uses on waterscapes; Strategic management of threats including eutrophication, contamination, erosion and sedimentation; Increasing the extent and health of riparian vegetation; Protecting key habitats and improving knowledge of aquatic biodiversity; Reducing the impacts of recreation and urban development.</td>
</tr>
<tr>
<td><strong>3 Caring for Our Coast, Sea and Islands</strong></td>
<td>This aims to increase understanding, and enable integrated, ecologically-sustainable management of coastal, marine and island systems. It includes using a variety of means to minimise the impacts of terrestrial land use, industry, infrastructure and recreation on physical assets and cultural and aesthetic values.</td>
</tr>
<tr>
<td><strong>4 Conserving Our Terrestrial Diversity</strong></td>
<td>This aims to ensure the long term conservation of terrestrial biodiversity elements including: Native Vegetation Extent, Threatened Species and Communities, Other Ecosystems at risk, Representative Landscapes; the Reserve System; Knowledge and capacity of best practice.</td>
</tr>
<tr>
<td><strong>5 Integrated Catchment Management</strong></td>
<td>This program will develop and promote natural resource management planning and implementation at the catchment scale.</td>
</tr>
<tr>
<td><strong>6 Managing Salinity</strong></td>
<td>This aims to limit rising groundwater and the spread of dryland salinity, and productively use saline land. Management may involve engineering and agronomic options, fencing and revegetation, catchment-scale planning and extension activities.</td>
</tr>
<tr>
<td><strong>7 New Opportunities: balancing development and the environment</strong></td>
<td>This will promote the sustainable use of natural resources by industry and the development of new natural-resource-based industries. It will support planning for population and economic growth with minimal impacts on natural resources, conservation values or landscape amenity.</td>
</tr>
<tr>
<td><strong>8 Resource Assessment</strong></td>
<td>This program will identify issues and collect and manage natural resources data and information to support baseline knowledge, and to document changes in Resource Condition. This may include developing indicators and standards against which NRM progress can be measured.</td>
</tr>
<tr>
<td><strong>9 Sharing Indigenous Knowledge</strong></td>
<td>This aims to increase the capacity of NRM stakeholders to access and understand Aboriginal perspectives of the environment. It similarly aims to increase the capacity of Aboriginal people to be actively engaged in all aspects of NRM.</td>
</tr>
<tr>
<td><strong>10 Supporting Environmental Education &amp; Knowledge</strong></td>
<td>This improves and promotes knowledge and understanding of NRM in the region. The program will ensure the regional community is equipped to effectively contribute to improving resource condition. Target audiences may include schools and educational institutions, community, local government, industry and the NACC network.</td>
</tr>
<tr>
<td><strong>11 Sustaining Agricultural Production</strong></td>
<td>This promotes and supports best practice agricultural production whilst protecting our natural resources. Issues may include soil condition and structure, wind and water erosion, soil biology, farming systems, and off-farm impacts.</td>
</tr>
<tr>
<td><strong>12 Understanding our Climate and Managing our Air</strong></td>
<td>This will identify risks and manage the impacts of climate change and seasonal variability. It will also support initiatives to reduce the region’s greenhouse emissions, and to monitor and reduce localised human impacts on air quality.</td>
</tr>
<tr>
<td><strong>13 Using Our Water Wisely</strong></td>
<td>This aims to encourage equitable &amp; efficient use of surface and groundwater by balancing social, economic and environmental requirements. This may include: Investigating Environmental and Social Water Requirements for all groundwater dependent waterscapes; Reducing the impacts of agricultural and industrial land uses on water quality; Ongoing monitoring of quantity and quality of water resources in the region and dissemination of information to the community; Developing reliable water provisions to all rural areas.</td>
</tr>
<tr>
<td><strong>14 Farm Forestry</strong></td>
<td>This will promote the development of commercial and agro-forestry including integration with other land-uses.</td>
</tr>
<tr>
<td><strong>15 Delivering Natural Resource Management</strong></td>
<td>This underpins the delivery mechanism for NRM in the region. The program will ensure the Regional Group has the capacity and the resources to effect change, implement the accredited regional NRM strategy and manage NRM funding.</td>
</tr>
</tbody>
</table>

Implementation of the above programs is the most important part of the NRM process and the wider regional community has a critical role to play in implementing this Strategy. A partnership approach is crucial to the successful implementation of this Strategy. Partners will be working over a broad scale (from individual sites within a property to whole catchments), to achieve the priority outcomes identified in the Strategy.
The asset was “clear governance and decision making framework for regional delivery of NRM” (IN.R2). A similar issue arose in other assets, in particular in Coastal and Marine, and there is clearly a need to clarify some of the roles and responsibilities for NRM and to work together more effectively.

NACC has a role not only to help coordinate NRM and manage funding in the region, but also to be a catalyst for action by other parties. We are therefore very keen that this strategy is widely read and that it encourages many others to join with us in helping to strengthen the management of our natural resources in the Northern Agricultural Region.

13.4.2 CAPACITY BUILDING FOR NACC

Building the capacity of the NACC team has been an important and exciting spin-off from strategy development. In order to maintain this momentum, and to assist in strengthening leadership and governance of NRM, and building the capacity of the whole region, there is also a need for a focused project on this issue. This will include capacity building in monitoring and evaluation to ensure that the whole community understands the issues.

13.4.3 ADAPTIVE MANAGEMENT

One of the keys to good management is the ability to adapt to change, and indeed to embrace it. As discussed in the Monitoring Evaluation and Reporting (MER) section of this document, evaluation is critical to the ability to adapt. We are committed to developing a MER system that provides a structured framework, while at the same time, being flexible enough to include feedback loops at all levels that continually inform us about desirable changes.

13.4.4 CAPACITY

Without a well-developed capacity to implement change, investing in NRM solutions would be counterproductive. We need to enable learning at the individual, community and organisational level. We need to build on existing capacity using local expertise and knowledge, learn from each other through sharing resources experience and expertise, and have access to relevant scientific and technical information.

NRM problems are complex and occur on various spatial and temporal scales. They are also likely to involve difficult trade-offs between alternative land uses, and different community aspirations and values – at local, regional, state and national level. As individuals within communities and Government we all require the skills, knowledge (and the commitment) to respond effectively to new NRM challenges, and adopt an integrated approach in a search for long-term solutions. Thus we envisage that investment in capacity building, and in enhancing the capability of all of us to be actively involved at all stages of NRM planning and implementation, will be a critical component of our future work. This will promote local ownership and increase the uptake of existing and newly developed sustainable NRM practices and processes.

Moreover, we need to strengthen strategic leadership skills within the community so that we can efficiently integrate the complex set of actions needed for effective natural resource management, and assist in directing and implementing change.
### APPENDIX I - THE NACC TEAM

In May 2004, at the completion of the community consultation and finalisation of the draft strategy, the following were members of the NACC strategy team.

<table>
<thead>
<tr>
<th>NACC Management Committee &amp; support</th>
<th>Regional NRM Team</th>
<th>Local NRM Officers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Position / Representation</strong></td>
<td><strong>Name</strong></td>
<td><strong>Position</strong></td>
</tr>
<tr>
<td>Chair</td>
<td>Elizabeth Eaton</td>
<td>Strategy Coordinator</td>
</tr>
<tr>
<td>Vice-Chair / Yarra Yarra sub-region</td>
<td>Chris King</td>
<td>Strategy Facilitator</td>
</tr>
<tr>
<td>Secretary / West Midlands sub-region</td>
<td>Gary Dring</td>
<td>Regional NRM Facilitator</td>
</tr>
<tr>
<td>Treasurer / Greenough sub-region</td>
<td>Yvonne Maraden</td>
<td>Biodiversity Planner</td>
</tr>
<tr>
<td>Dept of Agriculture</td>
<td>Paul Findlater</td>
<td>Biodiversity Support</td>
</tr>
<tr>
<td>Dept of Conservation and Land Management</td>
<td>Anthony Desmond</td>
<td>&quot;</td>
</tr>
<tr>
<td>Dept of Environment</td>
<td>Ron Shepherd</td>
<td>&quot;</td>
</tr>
<tr>
<td>Midwest Development Commission</td>
<td>Priscilla Clayton</td>
<td>Coastal &amp; Marine Support</td>
</tr>
<tr>
<td>Forest Products Commission</td>
<td>Owen Donovan</td>
<td>Farm Forestry</td>
</tr>
<tr>
<td>Community (non-aligned)</td>
<td>Jamie Falls</td>
<td>Indigenous Support</td>
</tr>
<tr>
<td>Community (non-aligned)</td>
<td>Geoff Erickson</td>
<td>Sustainable Agriculture</td>
</tr>
<tr>
<td>Community (non-aligned)</td>
<td>Chris Tucker</td>
<td>Water Resources</td>
</tr>
<tr>
<td>Greenough sub-region</td>
<td>Yvonne Maraden</td>
<td>&quot;</td>
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<tr>
<td>Greenough sub-region</td>
<td>Greg Burrows</td>
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<tr>
<td>Moore sub-region</td>
<td>Sarah Mason</td>
<td>Coastal &amp; Marine Strategic</td>
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<td>Moore sub-region</td>
<td>Cynthia McMorran</td>
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<td>John Longman</td>
<td>Data Management</td>
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<tr>
<td>Yarra Yarra sub-region</td>
<td>Max Hudson</td>
<td>Communications Officer</td>
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<tr>
<td>Executive Officer</td>
<td>John Braid</td>
<td>Land Threat Assessment</td>
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<tr>
<td>Administration Officer</td>
<td>Shirley McShane</td>
<td>&quot;</td>
</tr>
<tr>
<td>Admin Officer Support</td>
<td>Dawn Solomon</td>
<td>&quot;</td>
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</tbody>
</table>

Others who have been part of the team during strategy development are: Bronte Grant (coastal and marine); Lisa Smith, Paul Burke, Kelly Burton (local NRMOs); Michelle Pond (Finances); Wally Barnes, Mike Anspach, Roger Forte, Brian Cahill and Mike Kerkmans (sub-regional representatives on NACC); Kelly Gillen, Jason Lette, John Scharf and Mark South (government representatives on NACC); Leanne Hartley (rivercare); Michael Bates (deceased, previous Chair of NACC).
## APPENDIX II - MORE DETAIL ON COMMUNITY ENGAGEMENT

### Meetings and interest groups
Supporting information for Community Engagement Plan (pp14-16).

<table>
<thead>
<tr>
<th>Location</th>
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<tbody>
<tr>
<td>Port Denison</td>
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<td>Geraldton</td>
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<td>Irwin/Mingenew Bus Trip</td>
<td>Mullewa</td>
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<table>
<thead>
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<td>Pindar-Tardun</td>
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<tr>
<td>Morawa</td>
<td>Perenjori</td>
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<td>East Three Springs</td>
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<td>Kalannie, Buntine</td>
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<td>Gooorow</td>
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<td>Buntine</td>
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<table>
<thead>
<tr>
<th>Location</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irwin</td>
<td>Mingenew/Irwim Group and School</td>
</tr>
<tr>
<td>Badgingarra</td>
<td>General Community – Badgingarra, Dandarsgan</td>
</tr>
<tr>
<td>Jurien Bay</td>
<td>General Community – Cervantes, Jurien</td>
</tr>
<tr>
<td>Leeman</td>
<td>General Community – Greenhead, Leeman</td>
</tr>
<tr>
<td>Eneabba</td>
<td>General Community – Eneabba</td>
</tr>
<tr>
<td>Three Springs</td>
<td>General Community – Three Springs</td>
</tr>
<tr>
<td>Neergabby</td>
<td>General Community – Gingin</td>
</tr>
<tr>
<td>Gingin</td>
<td>Gingin Primary School</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Badgingarra</td>
<td>Mainly landowners</td>
</tr>
<tr>
<td>Guilderton</td>
<td>Coastal and fishing communities</td>
</tr>
<tr>
<td>Jurien &amp; Greenhead</td>
<td>Coastal and fishing communities</td>
</tr>
<tr>
<td>Moore</td>
<td>Previous participants</td>
</tr>
<tr>
<td>Geraldton</td>
<td>Previous participants</td>
</tr>
<tr>
<td>Eneabba</td>
<td>Previous participants</td>
</tr>
<tr>
<td>Lancelin</td>
<td>Coastal and fishing communities</td>
</tr>
<tr>
<td>Abrolhos Islands</td>
<td>Island Advisory Group</td>
</tr>
<tr>
<td>Gingin</td>
<td>Gingin</td>
</tr>
<tr>
<td>Moora</td>
<td>WALGA NRM rep</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenough</td>
<td>8 local LGAs, plus WALGA NRM rep</td>
</tr>
<tr>
<td>Geraldton</td>
<td>Northern Zone, Three Springs, Gingin, Dalwallnul</td>
</tr>
<tr>
<td>Moora</td>
<td>WALGA NRM rep</td>
</tr>
<tr>
<td>Midland</td>
<td>Noongar Reference Group</td>
</tr>
<tr>
<td>Lancelin</td>
<td>Noongar Native Title Claim group</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moora &amp; Mullewa (MAT workshops)</td>
<td>Moore River Settlement, Mullewa groups - Yamali &amp; Noongar</td>
</tr>
<tr>
<td>“You- Decide” Workshops Priority setting</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX III - INDIGENOUS CONSULTATION AND ENGAGEMENT

We have been very fortunate in the NAR to have the services of an Indigenous Officer who has assisted in developing ways of engaging Indigenous people in the regional NRM process. While Indigenous people participated in the mainstream consultation process, it has been determined that the timeframe for the development of this document did not allow for true and comprehensive consultation with Indigenous stakeholders. Additional ongoing effort is required to ensure better Indigenous engagement in future. While the journey could not be claimed to be complete, considerable progress has been made and there has been significant Aboriginal input into this strategy.

The Commonwealth have indicated that the following points represent good practice in meeting the requirement for INRM. Plans to demonstrate proper consultation with Indigenous groups in their region. Against each point we have demonstrated our achievements, or our progress towards meeting best practice and in some instance where we aim to progress in future

1. Inclusion of at least 2 Indigenous people on each regional body

Two reference groups have been formed for consultation with both Yamaji and Nyoongar people in the development of this strategy. Direct consultation has also taken place between Indigenous representatives and the executive of the Northern Agricultural Catchments Council (NACC). In addition to assisting with strategy development, the two reference groups are considering ways in which they can contribute directly to the operations of NACC.

2. Local Indigenous people and organisations with interests in land management issues

Yamatji Land & Sea Council and the South West Aboriginal Land & Sea Council are both important organisations in the region. They have a key role in relation to land in that they assist native title claimants to acquire property within the claim boundary. In addition, bodies such as the Indigenous Land Corporation, ATSIC and ATSIS are important. NACC, through our Indigenous Support Officer, has established and provides executive support to two NRM Indigenous Reference Groups. Both groups are made up of representatives of the key stakeholder agencies, as follows:

- ATSIS – Community service provider;
- ATSIC – policy development role (the proposed dismantling of ATSIC is expected to result in the formation of regional consultative bodies);
- Department of Indigenous Affairs – Heritage sites and Aboriginal Lands Trust estate;
- Native Title Representative Bodies – Yamatji Land & Sea Council and the South West Aboriginal Land & Sea Council have a responsibility to inform all NT Claimants of matters pertinent to Native Title; and
- Indigenous Land Corporation (ILC) – Land acquisition and management.

The establishment of these two Indigenous Reference Groups, made up of service providers to Indigenous people, has enabled identification and initial consultation with Indigenous NRM stakeholders in the NAR.

3. List the Indigenous organisations and individuals who were consulted in the process of developing the INRM plans

The process of developing Management Action Targets (MAT’s) through community consultation included meetings with specific Indigenous community interest groups and the participation of Aboriginal people in ‘whole of community’ workshops. Many individual Aboriginal people were contacted to provide personal feedback. Apart from the members of the two Indigenous Reference Groups above, the following Indigenous groups were specifically consulted:

- Region 5 Working Party of the Single Noongar Claim – Native Title
- Naaguja NT Working Group – Native Title
- Mullakwa Aboriginal Community
- Mullakwa Employment and Economic Development Aboriginal Corporation (MEEDAC)
- Wila Gutharra Aboriginal Community Corporation
- Mogumber Farm Community
- Billinu Aboriginal Corporation

See also list of Aboriginal groups in the region at the end of this section (p 163)
4. Identify Aboriginal owned properties in the region. Identify areas of public land where native title rights and interests may continue

As “Aboriginal Land” is held in a variety of tenures, it is best described as “that land which has been acquired for the use and/or benefit of Aboriginal people”.

Reserves and other Trust Properties

The Aboriginal Lands Trust (ALT) is a significant landholder. The ALT estate includes former reserves and properties designated for the use and benefit of Aboriginal people. The ALT has landowner responsibilities for all properties held by the Trust. A major role of the ALT is to facilitate the “hand-over” of these properties and the landowner responsibilities to Aboriginal interests.

Heritage Sites

The definition of Aboriginal land is inclusive of all Aboriginal heritage sites. There are over 500 Aboriginal heritage sites in the NAR, ranging in size from small campsites and shell middens to whole river systems, as is the case with the Irwin River. Some of the more culturally sensitive sites have restricted access and information about their exact location is suppressed. Most registered sites are in accessible locations and are in danger of being damaged by increased human impact as tourist sites. NACC is aware of information on numerous Aboriginal heritage sites being collected but not available to the public. The site information is being collected and maintained, by representatives of Native Title Claimants, to support Native Title claims in the region. All Aboriginal sites are subject to the Aboriginal Heritage Act however, only those sites

<table>
<thead>
<tr>
<th>Property #</th>
<th>Name and/or Location</th>
<th>Area (Ha)</th>
<th>Land and tenure (lease expiry)</th>
<th>Activities</th>
<th>Major Aboriginal Stakeholders</th>
</tr>
</thead>
<tbody>
<tr>
<td># P28607 Carnamah</td>
<td>2,169.6</td>
<td>Proclaimed Reserve: Leased to A &amp; L Bell (2007)</td>
<td>Primary Production Wheat &amp; sheep and other livestock</td>
<td>A &amp; L Bell Piniddy A/C</td>
<td></td>
</tr>
<tr>
<td># P28608 Three Springs</td>
<td>1,459.6</td>
<td>Proclaimed Reserve:</td>
<td>No available information</td>
<td>Aboriginal Lands Trust</td>
<td></td>
</tr>
<tr>
<td># P28609 Carnamah</td>
<td>2,018.6</td>
<td>Proclaimed Reserve: Leased to G.R Thomas &amp; B.W. Bell (2013)</td>
<td>Primary Production Wheat &amp; sheep and other livestock</td>
<td>G.R Thomas &amp; B.W. Bell Piniddy A/C</td>
<td></td>
</tr>
<tr>
<td># 1981/166 Kardaldu Farm Mullewa-Carnarvon Rd. Mullewa</td>
<td>477.6</td>
<td>Freehold; Managed by Wandanooka Aboriginal Corp for the ALT</td>
<td>Horticulture Grazing</td>
<td>Wandanooka A/C MEEDAC</td>
<td></td>
</tr>
<tr>
<td># P17702 Mogumber Cemetery Mogumber West Rd.</td>
<td>0.4</td>
<td>Proclaimed Reserve:</td>
<td>Heritage site – Cemetery</td>
<td>Aboriginal Lands Trust</td>
<td></td>
</tr>
<tr>
<td># 2366 Moora LIA</td>
<td>7.9</td>
<td>Reserve: Leased to Central Midlands Progress Assoc, Inc (2007)</td>
<td></td>
<td>Central Midlands Progress Assoc, Inc</td>
<td></td>
</tr>
<tr>
<td># 1459/647 Moora</td>
<td>4.1</td>
<td>Freehold: Leased to Central Midlands Progress Assoc, Inc (2007)</td>
<td></td>
<td>Central Midlands Progress Assoc, Inc</td>
<td></td>
</tr>
</tbody>
</table>
recorded on the Department of Indigenous Affairs Aboriginal Sites Register in the NAR are listed.

Freehold Acquisition

Aboriginal people have access to a variety of support services when acquiring land for commercial purposes, such as via the land acquisition programs of the ILC and Native Title representative bodies. The Indigenous Land Corporation (ILC) provides benefits to Indigenous people through two primary functions, Land Acquisition and land Management Assistance. These two broad functions are delivered through an application based system with submissions from Indigenous groups against Cultural, Social, Economic and Environmental Programs. The Department of Employment and Workplace Relations will deliver the former ATSIC and ATSIS Business Development Program. This program provides the opportunity for the purchase of commercially sustainable properties. The fickle nature of the rural industries economy means a low rate of success for aspiring Indigenous land managers. Yamatji Land & Sea Council and the South West Aboriginal Land & Sea Council assist native title claimants to acquire property within the claim boundary. The acquisition of freehold land by NT claimants is a priority for both Native Title representative bodies. The Federal and State governments provide economic development assistance to Indigenous people. The federal government’s Indigenous Employment Policy incorporates Indigenous enterprise development strategies. The state government, through the Office of Aboriginal Economic Development and the Regional Development Commission, provide Aboriginal Economic Development Officers based in the region. Department of Training and Education, through the TAFE system, support the delivery of a range of courses specific to the needs of Indigenous land managers and people with an interest in the land.

Listed below are some of the properties in the NAR that are for the use and benefit of Aboriginal people. The list is incomplete, as concise information on other Aboriginal owned/managed land is not readily available. Further investigation is required to identify all Aboriginal land managers and NRM issues on privately held Aboriginal land. Generally, the list does not include urban residential properties; privately acquired (without assistance from an Aboriginal specific program) rural land; urban commercial operations (except when the operation has NRM as an identified commercial activity; benevolently bequeathed property not on the public register and commercial operations where an Aboriginal stakeholder has an undisclosed interest.

### Other Aboriginal Lands in the Northern Agricultural Region

<table>
<thead>
<tr>
<th>Property Name and/or Location</th>
<th>Area (Ha)</th>
<th>Land and manager information</th>
<th>Activities</th>
<th>Major Aboriginal Stakeholders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gunnadoo Farm, Coalseam Rd Walkaway Shire of Greenough</td>
<td>120</td>
<td>Freehold property divested to Geraldton Streetworker Aboriginal Corporation by the ALT in 2001</td>
<td>Tourism Social programs Training venue CDEP Horticulture - Native plant propagation</td>
<td>Geraldton Streetworker Aboriginal Corporation</td>
</tr>
<tr>
<td>Two locations Adjacent to Coalseam N.P. Shires of Mullewa &amp; Morawa</td>
<td>12,000 in two adjoining holdings</td>
<td>Freehold property acquired by Bundibunna A/C for social purposes</td>
<td>Currently leased for cropping and grazing</td>
<td>Bundibunna A/C Mullewa Wadjari NTWG Ken Papertalk</td>
</tr>
<tr>
<td>Yallallie Farm North West Road Dandaragan Shire</td>
<td>~2000</td>
<td>Dandaragan</td>
<td>Wheat &amp; sheep</td>
<td>Beemurrab Aboriginal Corporation</td>
</tr>
<tr>
<td>Hobby Farms Near Geraldton and other major centres. More than 10 properties Under 5 Hectares.</td>
<td></td>
<td>Freehold lifestyle properties</td>
<td>Small farming Various small scale commercial ventures.</td>
<td>Multiple ATSIS</td>
</tr>
<tr>
<td>Mt View Adjacent to Kalbarri N.P. Shire of Northampton</td>
<td></td>
<td></td>
<td>Wheat &amp; sheep</td>
<td>Beemurrab Aboriginal Corporation</td>
</tr>
</tbody>
</table>
5. The plan should build partnerships with local Indigenous organisations

NACC recognise the importance of maintaining and developing partnerships with all stakeholders. Particular care and attention is being taken when developing partnerships with Indigenous groups as NACC are aware of the trepidation some groups may have in forming relationships with non-Indigenous entities. NACC have identified existing partnerships and relationships Indigenous groups have with NRM stakeholders in the NAR. As part of the ongoing process of Indigenous community engagement, these relationships will be investigated further and, if required, strategies will be put in place to enhance their effectiveness and sustainability.

6. Include information on the region’s Indigenous history, heritage and interests

The Indigenous history of the NAR is diverse and complex. Traditionally, the NAR has been occupied by, at least 8 and as many as 12, language groups from two main cultural groups since long before white settlement. The domestic arrangements varied from permanent and semi-permanent settlements to nomadic, seasonal migration. Early white explorers recorded evidence of permanent structures in the Greenough area. The oral history, passed on through story telling, of many groups describe the extent of their country by identifying locations and landmarks.

7. Include recognition that there are Indigenous interests in most natural resources

Indigenous people of the NAR have an ongoing interest in the region’s natural resources as a source of traditional food and medicine. Also, the creation stories of Noongar and Yamaji people centre around the work of the Rainbow Serpent. Aboriginal mythology maintains that the Serpent provided the natural resources and created the natural features of the land to sustain those resources. In some traditional cultures, totemic responsibility for a plant or animal is ascribed. The clearing of land and the introduction of exotic pests has meant many of the plants and animals important to Indigenous people are no longer present or in scarce supply in the NAR.

8. Include recognition of Indigenous cultural interests in water management

Water management is important and of particular interest to Aboriginal people. Apart from being critical to survival, water quality and quantity is seen as providing a direct link to the moods of the Rainbow Serpent. When Aboriginal people visit a body of fresh water, such as a lake or river, ritual homage is often paid to the resident spirit of the Rainbow Serpent. E.g. people from some of the Yamaji language groups either cast sand on the water or spurt water from their mouth into the pool. Those Indigenous people charged with maintaining Aboriginal culture, recognise any change in the supply or quality of water as an indication of the displeasure of the Rainbow Serpent.

9. Recognise the need for protection of Indigenous cultural heritage places as part of Indigenous Natural Resource Management;

While NACC believes the maintenance of Indigenous sites of significance is important, this aspect of NRM is seen as the responsibility of the Department of Indigenous Affairs and Native Title representatives. Where appropriate, NACC will support the protection of Aboriginal sites of environmental significance.

For items 6, 7, 8 and 9 see other sections in the strategy on Indigenous issues – eg pages 34-36. There are also Management Action Targets related to Aboriginal issues – see MATs listed under Resource Conditions targets CM.R5 (p136), CM.R13 (p137), and CA.R5 (p139).

The two locations below are examples of Aboriginal heritage sites that are culturally significant to Aboriginal people. The environmental status of these sites is linked to the spiritual well-being of the Indigenous people associated with them.

- Ellendale Pool on the Greenough River is culturally significant to at least three of the Yamaji language groups in the area
- Round Pool on the Moore River at Mogumber is of particular cultural significance to the Yued people of the area.

10. Capacity building programs should recognise and include Indigenous knowledge


11. Identify the need for ongoing Indigenous participation in NRM

We have been fortunate to have the full-time services of an Indigenous Officer in the development of this strategy. In addition to making a direct contribution to the strategy, and facilitating the participation of Aboriginal representatives via the formation of
reference groups, this officer has played a significant role as part of the strategy team in building a better understanding among team members of the special interests, skills and needs of Aboriginal stakeholders. Maintaining and improving the understanding of these matters by all stakeholders (including some members of the indigenous community), will be continued in future.

The expectation is that, in future, the officer will expand the Indigenous Reference Groups (IRG’s) to include further identified key stakeholders from the Indigenous community. In recognising the diversity within the Aboriginal Communities of the NAR, individual and localised approaches to engaging these people will be developed with the advice and assistance of the IRG’s. Once relationships have been established at a local (sub-region) level, Indigenous involvement in all NRM activities will be encouraged and developed.

As well as encouraging and supporting the participation of Indigenous people in on-ground works projects, a key component of the Indigenous engagement process will be the identification of individuals who can represent Indigenous views in the decision making process. Where required, support will be offered to assist individuals and groups to be effective in their role.

**List of Aboriginal groups in the NAR:**

There are approximately 75 Aboriginal Corporations active in the NAR. These organisations operate across a broad range of interest areas with the level of activity ranging from dormant to full-time. Listed below are some of the Indigenous organisations that have been identified as stakeholders in NRM.

- Barrel Well Community Nanda Aboriginal Corporation
- Billinue Community Aboriginal Corporation
- Bundiyarra Aboriginal Community A/C
- Bundy Bunna Aboriginal Corporation
- Carnamah Aboriginal Corporation
- Dalwallinu and Districts A/C
- Geraldton Streetwork Aboriginal Corporation
- Kardaloo Aboriginal Corporation
- Marra Aboriginal Corporation
- Mingen A/C
- Mooniemia Aboriginal Corporation
- Murchison Region Aboriginal Corporation
- Naaguja Warangkarri Aboriginal Corporation
- Nganjunga-Ngurra Aboriginal Corporation
- Nhunadar Watchinar Parnba Community Aboriginal Corporation
- North Midlands Aboriginal Corporation
- Pindiddy Aboriginal Corporation
- South West Aboriginal Land & Sea Council A/C
- Wandanooka Aboriginal Corporation
- Wheatbelt Aboriginal Corporation
- Wila Gutharra Community Aboriginal Corporation
- Yamaji Languages Aboriginal Corporation
- Yamatji Barna Baba Maaja (Land & Sea Council)
- Yanay Yanma A/C
To meet accreditation criteria, we have prioritised (or ranked) major threatening processes within the NAR. This provides an indicative overview of some of the key causes of degradation of natural assets. The methodology we have used for ranking threats at a regional scale is outlined here; it could also be applied at other scales. In a separate but similar exercise, we have also scored each threat in relation to the feasibility of managing the current impact. There is further discussion of this on page.

Ranking Threats

The “Threat Ranker” is a simple tool that ranks threats. Using a set of criteria, a threat is assigned a score, then the series of scores are ranked. This is based on current impacts, any predictions of future impacts need to be noted. The scoring criteria are as follows:

- **Current Scale of Threatening Process**: the area for which threats are being ranked needs to be determined prior to ranking e.g. regional, subregional, catchment etc, then the level of area affected by the threatening process is entered.

- **Severity of Current Impact**: severity relates to how quickly the threatening process impact on the asset and the level of degradation. Weeds for example can slowly (to moderately) degrade remnant vegetation or pasture quality whereas waterlogging or salinity can result in complete degradation of an asset.

- **Timeframe of the Current Impact**: this relates to how long-term the effects will be.

**Feasibility of Managing the Current Impact**

Feasibility is scored using three criteria, and a similar spreadsheet to that above:

- Current level of technical knowledge on managing the impact of the threatening process;

- Logistical capacity for managing the impact – what is the feasibility in terms of resources and capacity to manage/ameliorate the impact of any one threatening process.

- Willingness to manage the impact (political/social) – what is the perceived willingness of social and political communities to undertake management of the impact of a threat.

**Discussion**

To date the ranking has been applied to individual assets, but the methodology could be used at a variety of scales and across sets of assets. Within and across assets the threat ranking provides a basis for which threatening processes are having the most immediate impact and those that are most feasible to manage. NACC has undertaken a community engagement process in which the community highlight major NRM issues and threatening processes. The identification of these threatening processes through the engagement process has been based on personal experiences and knowledge. The outcomes and priorities for management from the engagement process has not differed greatly from the threat ranking methodology.
APPENDIX V - “YOU DECIDE” WORKSHOP RESULTS

The outcomes from the YOU Decide workshops are displayed below. The decisions reached have layered levels of decision upon levels of decision. The process has focused on intuitive decision making and trust in regional community. Community input into the process is of paramount importance because the regional community must be able to see “themselves, their concerns and their ideas on how to do this” in this strategy for it to receive the level of investment that will make a difference to the condition of our natural resources.

It is important to note that these results do not indicate where investments should be made. There is a subsequent stage of planning which needs to determine the cost of each area of action, and hence what is the relative investment. It does however show you the level of effort that the regional community feels should be expended on different areas of activity.

<table>
<thead>
<tr>
<th>Resource Condition Target</th>
<th>Range of %’s</th>
<th>Median</th>
<th>Mean</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset Class: Biodiversity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BD.R1 Maintained and increased native vegetation extent (other than approved clearing applications) by a % per Interim Bio-regionalisation of Australia (IBRA) by 2025</td>
<td>24 – 40%</td>
<td>30</td>
<td>30.6</td>
<td>Essential</td>
</tr>
<tr>
<td>BD.R10 Informed and experienced groups across the NAR with the capacity to understand issues and drive landscape change to a benchmark yet to be determined</td>
<td>15-25%</td>
<td>22</td>
<td>21</td>
<td>Essential</td>
</tr>
<tr>
<td>BD.R5 A yet to be determined increase in the protection and enhancement of key habitats by 2020 including 1. Key habitat for populations of threatened species and communities 2. Granite outcrops 3. Natural saline ecosystems 4. Cave systems Key vegetation habitats e.g. woodlands, heath etc</td>
<td>4-14%</td>
<td>13</td>
<td>11.4</td>
<td>Important</td>
</tr>
<tr>
<td>BD.R4 No major losses to meta populations of threatened species and communities from 2003 and to increase and improve populations by 2020</td>
<td>7-12%</td>
<td>10</td>
<td>9.6</td>
<td>Important</td>
</tr>
<tr>
<td>BD.R3 At least three representative landscapes being managed for conservation of biodiversity by 2020</td>
<td>1-8%</td>
<td>5</td>
<td>4.8</td>
<td>Desirable</td>
</tr>
<tr>
<td>BD.R8 A yet to be determined reduction in the density and distribution of significant environmental weed species affecting high value biodiversity assets by 2020</td>
<td>8-13%</td>
<td>10</td>
<td>10.2</td>
<td>Important</td>
</tr>
<tr>
<td>BD.R9 A yet to be determined reduction in biodiversity impacts of significant invasive animals (native &amp; exotic) by 2020</td>
<td>1-16%</td>
<td>10</td>
<td>8.6</td>
<td>Important</td>
</tr>
<tr>
<td>Resource Condition Target</td>
<td>Range of %'s</td>
<td>Median</td>
<td>Mean</td>
<td>Importance</td>
</tr>
<tr>
<td>---------------------------</td>
<td>--------------</td>
<td>--------</td>
<td>------</td>
<td>------------</td>
</tr>
<tr>
<td><strong>Asset Class: Agricultural Land</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LN.R3 All land managers including government departments are implementing biosecurity measures to industry standards</td>
<td>11-21%</td>
<td>16</td>
<td>16.4</td>
<td>Essential</td>
</tr>
<tr>
<td>LN.R1 All Saline areas stabilised by 2025</td>
<td>28-36%</td>
<td>35</td>
<td>32.5</td>
<td>Essential</td>
</tr>
<tr>
<td>LN.R2 All farmers adopting profitable farming systems practices that reduce the threats to agricultural land</td>
<td>20-41%</td>
<td>30</td>
<td>29.6</td>
<td>Essential</td>
</tr>
<tr>
<td>LN.R4 Over 80% of landholders using best management practices for erosion control</td>
<td>5-10%</td>
<td>7</td>
<td>7.4</td>
<td>Important</td>
</tr>
<tr>
<td>LN.R6 Land managers adopt best management practices for soil acidity</td>
<td>1-7%</td>
<td>6</td>
<td>5</td>
<td>Desirable</td>
</tr>
<tr>
<td>LN.R12 80% of farmers in area of high risk, address the problem of soil structure decline as part of farm management</td>
<td>4-16%</td>
<td>7</td>
<td>8.8</td>
<td>Important</td>
</tr>
<tr>
<td><strong>Asset Class: Water</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WA.R3 Increase the current extent and improve the condition of riparian vegetation along targeted sections of priority waterscapes by 2020, commencing immediately</td>
<td>19-25%</td>
<td>21</td>
<td>21.2</td>
<td>Essential</td>
</tr>
<tr>
<td>WA.R12 Equitable allocation of groundwater resources between economic, environmental and social requirements by 2020</td>
<td>12-29%</td>
<td>14</td>
<td>17.4</td>
<td>Essential</td>
</tr>
<tr>
<td>WA.R1 A reduction in the peaks of surface water runoff from catchments by 2020</td>
<td>14-24%</td>
<td>19</td>
<td>19.4</td>
<td>Essential</td>
</tr>
<tr>
<td>WA.R14 Maintain current water quality in groundwater supply areas within National Water Quality Management Strategy (NWQMS) guidelines by 2015</td>
<td>10-18%</td>
<td>14</td>
<td>14</td>
<td>Important</td>
</tr>
<tr>
<td>WA.R4 Maintain current salinity levels in historically fresh and brackish priority waterscapes by 2020</td>
<td>13-22%</td>
<td>17</td>
<td>16.8</td>
<td>Important</td>
</tr>
<tr>
<td>WA.R5 Level of waterscape contamination (total nitrogen (TN), total phosphorus (TP) and chemical/ heavy metal contaminants) in priority waterscapes within National Water Quality Management Strategy (NWQMS) guidelines by 2025</td>
<td>6-17%</td>
<td>12</td>
<td>11.8</td>
<td>Desirable</td>
</tr>
<tr>
<td><strong>Asset: Coastal and Marine</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CM.R1 By 2015, changes to the economic and governance systems are implemented to facilitate more effective and efficient management of our coastal and marine natural resources</td>
<td>15-26%</td>
<td>20</td>
<td>20.5</td>
<td>Essential</td>
</tr>
<tr>
<td>CM.R16 Preserve integrity of Abrolhos natural systems by 2015</td>
<td>11-26%</td>
<td>18</td>
<td>18.2</td>
<td>Essential</td>
</tr>
<tr>
<td>CM.R2 The condition and function of our geomorphic systems will be maintained and improved by 2009</td>
<td>15-26%</td>
<td>16</td>
<td>18</td>
<td>Essential</td>
</tr>
</tbody>
</table>
## Regional NRM Strategy - Northern Agricultural Region of WA

<table>
<thead>
<tr>
<th>Resource Condition</th>
<th>Target</th>
<th>Range of %'s</th>
<th>Median</th>
<th>Mean</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Asset Class:</strong> Community Assets</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>AR.R1 Regional community capable of managing climate risk and reduce risk of major environmental, economic or social outcomes from drought or coastal land impacts</td>
<td>43-60</td>
<td>-</td>
<td>51.5</td>
<td>Essential</td>
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<tr>
<td>AR.R2 Maintain the quality of air within the region</td>
<td>31-42%</td>
<td>-</td>
<td>36.5</td>
<td>Important</td>
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<tr>
<td>AR.R3 All industry to be economically, socially and environmentally sustainable</td>
<td>9-15%</td>
<td>-</td>
<td>12</td>
<td>Desirable</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Resource Condition</th>
<th>Target</th>
<th>Range of %'s</th>
<th>Median</th>
<th>Mean</th>
<th>Importance</th>
</tr>
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<tbody>
<tr>
<td><strong>Asset Class:</strong> Air</td>
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<tr>
<td>CM.R4 The condition and function of our estuarine systems will be maintained and improved by 2015</td>
<td>7-17%</td>
<td>15</td>
<td>12.6</td>
<td>Important</td>
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<tr>
<td>CM.R8 The condition and function of the seafloor systems will be maintained and improved by 2015</td>
<td>4-10%</td>
<td>7</td>
<td>6.8</td>
<td>Desirable</td>
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<tr>
<td>CM.R9 By 2015, marine biodiversity will be sustainably managed and programs in place to guard against the introduction of pest species</td>
<td>4-14%</td>
<td>9</td>
<td>9</td>
<td>Desirable</td>
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<tr>
<td>CM.R11 By 2015, fish resources will be sustainably managed and programs in place to guard against the introduction of pest species</td>
<td>10-18%</td>
<td>16</td>
<td>14.2</td>
<td>Important</td>
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## Northern Agricultural Catchments Council 2005

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The Northern Agriculture Integrated Management Strategy group (NAIMS) was formed in 1996, with staff of the WA Department of Agriculture and the Water and Rivers Commission being instrumental in its initiation. The first group was a balanced combination of community and agency representatives with 8 community representatives and 8 agencies being represented. The initial motivation for the group was to act as a focus for the coordination of efforts in Natural Resource Management in the region.

One of the early tasks taken on by NAIMS was the preparation of a regional NRM strategy. Considerable work was completed on background scientific information and there was excellent cooperation between the various government agencies in providing data and analyses. In addition, a draft regional strategy was produced by the NAIMS Management Committee. This strategy was informed by a comprehensive community consultation process which had been conducted throughout the region in 1995 and 1996. Because the initial focus was catchment management, much of this effort was directed at landcare and farming groups, and over 350 individuals were consulted. A comprehensive community consultation report was completed. A draft Regional NRM Strategy and draft “Situation Statement” containing the background information were completed early in 2000. These documents, while not as detailed or as strategically sound as this recent strategy, were an important step towards strategic development. We are grateful for the leadership of the early chairman of NAIMS in assisting with this development: David Brindal (Mingenew), Michael Flanigan (Nabawa) and Max Hudson (Goodlands).

Through consultation in the preparation of the draft NAIMS regional strategy, 13 primary regional concerns in natural resource management were identified. It is interesting to note how similar they are to those we have identified in this current strategy:

- Fragmentation of natural vegetation areas over the landscape.
- Changing hydrology and water balance.
- Existing farming systems inadequate in addressing hydrological changes in the landscape.
- Lack of awareness and education of natural resource values.
- Poor communication networks within and between sub-regions.
- Lack of identified research priorities to address key regional issues.
- Marketing opportunities for regional produce and attributes not fully developed.
- Changing dynamics of the regional population.
- Lack of integration of activities between government agencies and the community.
- Decline in quality of soils and land.
- Decline in quality of waterways and wetlands.
- Loss of natural biodiversity.
- Increasing land use demands on natural resources.

In 2002, NAIMS transformed into the Northern Agricultural Catchments Council (NACC) under the leadership of Michael Bates, and with the encouragement of the Commonwealth and State Governments, this current strategy was commenced. One of the risks we have had to manage this time, has been the fact that many community members who were involved with the NAIMS strategy already felt sufficiently “consulted”. However, we have used some innovative approaches this time round and it is pleasing that the responses have been very enthusiastic. In addition, we have embraced a wider range of issues with Coastal and Marine now included, and with a broader emphasis on non-farming issues. The community is now filled with expectation and it is NACC’s responsibility to try to help meet the aspirations that have been voiced.
One of the issues raised in this strategy has been the need to coordinate our efforts, to work cooperatively with other stakeholders and the community, and to reduce the duplication of effort. We have no intention of “reinventing the wheel” and we recognise that while NACC is gaining importance in the region, it is limited in what it can do on its own. In addition, many of the primary responsibilities for issues raised in this publication lie elsewhere – whether with individual landowners or with government. We therefore recognise the importance of other strategies and plans that have been developed to further regional development and NRM. Many are listed in the Bibliography, some of those of regional significance are listed below; this list is incomplete - these are examples of the many that exist.

**Previous regional, sub-regional and catchment plans**

- Draft Regional Strategy Natural Resource Management for the Northern Agricultural Region (NAIMS, 2000)
- Sub-region Strategies and Action Plans Northern Agricultural Region (NAIMS, 1999)
- Moore Catchment Sub-Regional Strategy (Moore Catchment Council, 2000)
- Yarra Yarra Sub-regional NRM Strategy (Yarra Yarra Catchment Council, 1999)
- Local plans: In addition there have been many catchment plans and local area plans prepared over the years. Many of these need to be revisited and any progress evaluated. Recent examples of local action plans are those prepared by the Moore Catchment Council in 2001 for (eg Lower Moore River, Bungalong Creek, Prye Brook, Miling to Watheroo) and by the Gingin LCDC in 2002 for the Gingin and Mungala Brooks.

**Planning strategies**

- Batavia Coast Strategy (Batavia Coast Steering Group 2001)
- Central Coast Regional Profile (Department of Planning and Urban Development 1994)
- Central Coast Regional Strategy: A strategy to guide land use in the next decade (Western Australian Planning Commission, 1996)
- Statement of Planning Policy No.2.6 - State Coastal Planning Policy (Western Australian Planning Commission 2003)
- Draft Gingin Coast Structure Plan (Western Australian Planning Commission, 2003)
- Shire plans: all shires produce regularly updated planning documents; it is essential that these are taken into account in any NRM planning, and that partnerships are made with local government authorities

**Industry strategies**

- Nature-Based Tourism in the Central Coast Region of WA (Priskin/UWA, 2001).
- A Tourism Strategy for the Central Coast (WA Tourism Commission, 1996)
- Farm Forestry in the Northern Agricultural Region: Regional Development and Industry Plan (prepared by a sub-committee of NACC, 2003).
- Sustainable Tourism Plan for the Houtman Abrolhos Islands (Fisheries Western Australia 2001)

**Conservation strategies**

- Final Plan of Management for the Lancelin Island Lagoon Fish Habitat Protection Area (Department of Fisheries, 2001).
- Management of the Houtman Abrolhos system (Fisheries Western Australia. 1998)
- Aquaculture Plan for the Houtman Abrolhos Islands (Fisheries Western Australia 2000)
- Biodiversity audits of many sections of the NAR have recently been completed; while not strategies, they provide important information for strategic development (see various references under eg Desmond, CALM in the Bibliography).
- Various groundwater area management plans have been produced, eg for Gingin, Jurien and Arrowsmith groundwater areas (Water and Rivers Commission/ now Department of Environment)
APPENDIX VIII - LEGISLATION

Following is a summary of Commonwealth and State legislation relevant to NRM issues, with a brief summary of each one.

Commonwealth Environmental Legislation

- Aboriginal and Torres Strait Islander Heritage Protection Act 1984
  This Act preserves and protects places, areas and objects of particular significance to Aboriginals in accordance to Aboriginal tradition.
- Agriculture and Veterinary Chemicals Code Act 1994
  Establishes the National code for labelling and using chemicals. It is administered by the National Registration Authority (NRA) in Canberra, and controls the import, manufacture, registration, packaging, labelling, distribution and retail sale of agricultural and veterinary chemicals in Australia.
- Environmental Protection and Biodiversity Conservation Act 1999
  This Act protects nationally significant environmental assets including World Heritage properties, wetlands of international significance, listed threatened species and ecological communities, and migratory species protected under international agreements. Actions that have, will have, or are likely to have significant impacts on these assets require approval from the Federal Environment Minister.
- Fisheries Management Act 1991
  Western Australian legislation

- Aerial Spraying Control Act 1966
  Controls the aerial spraying of agricultural chemicals. It requires pilots to hold a certificate issued by the Department of Agriculture, prevents spraying of certain chemicals in hazardous areas and requires owners of aircraft modified for aerial spraying to lodge a contract of insurance. The Act also provides for inspection of aircraft and sprayed areas.
- Agriculture and Related Resources Protection Act 1976
  This Act places obligations on the State government, local governments and private landholders to take steps to control “pest” animals and plants. The Act determines declared weeds and pest animals that are required to be controlled by the landowner. The Department of Agriculture can provide you with a list of declared weeds and species in the area.
- Bush Fires Act 1954
  This Act provides for a Board to administer the Act and authorised officers in local authorities are appointed by the Board. By powers vested by the Board, an approved officer may prohibit the use of any vehicle on land within the district during periods of extreme or very high fire danger. The Act also outlines provisions for the prevention, control and extinguishing of bushfires. Includes regulations to restrict burning times, burning during prohibited times and for establishing fire breaks.
- Conservation and Land Management Act 1984
  This act establishes Statutory Authorities, the areas of responsibility covered by the Department of Conservation and Land Management and also provides for conservation agreements over private and pastoral leasehold lands.
- Country Areas Water Supply Act, 1947
  This Act's by-laws enable the Water and Rivers Commission to control potentially polluting activities, regulate land use, inspect premises and take steps to prevent or clean up pollution. This Act can proclaim areas known as Public Drinking Water Source Areas (PDWSA) which can include catchment areas. The Commission uses a three tiered priority classification system to protect water sources in PDWSAs: Priority 1 (P1), Priority 2 (P2) and Priority 3 (P3) – with P1 zones attracting the most stringent conditions in regard to land use and development. (see Allanooka and Dongara-Denison Water Reserves Water Source Protection Plan).
- Environmental Protection Act, 1986
  This Act gives the Environmental Protection Authority the power to assess the impacts of any proposal that will, if implemented, have a significant effect on the environment. This Act allows for the protection of natural resources by the establishment of State environmental protection policies. It is also the main piece of legislation for dealing with pollution prevention in Western Australia by making it an offence to cause pollution. Pollution is defined in the act to mean any direct or indirect alteration of the environment: to its detriment or degradation; to the detriment of any beneficial use; or of a prescribed.
kind. On face value this definition appears to encompass many things; however, the legal scope of the definition is currently relatively narrow. NB: Biodiversity Conservation Act is in development.

- **Environmental Protection Amendment Act 2003**

The Environmental Protection Amendment Act provides improvements to the two key processes of the EPA - environmental protection policies and environmental impact assessment - by clarifying their scope and refining some of the processes. These changes generally give effect to matters that were intended to apply under the Environmental Protection Act 1986 (EP Act), but where some doubt has been raised. This Act provides the key legislation for regulating land clearing and thereby protection of native vegetation and also introduces the offence of causing unauthorised environmental harm.

- **Environmental Protection (South West Agricultural Zone Wetlands) Policy**

The objectives of this Act include mitigating soil erosion, salinity and flooding; conservation of soil, and protection of wetlands from Geraldton to Esperance, excluding the Swan Coastal Plain, that have been entered onto the register for wetlands. Under this policy it is an offence to fill in, excavate, mine, discharge effluent, remove water, damage or clear native vegetation around a registered wetland.

- **Explosives and Dangerous Goods Act 1961**

Many farm chemicals are classified as dangerous goods. Legislation controls the storage, transport, packaging and labelling of dangerous goods. All vehicles transporting dangerous goods must comply with State legislation. The legislation strictly controls quantities carried, placarding of vehicles, packaging methods, mixes of loads and documentation that must be carried.

- **Fish Resources Management Act 1994**

Outlines controls on inland aquaculture operations, and protects certain aquatic species and their environment. An aquaculture licence is not required if you operate a restaurant and keep fish for the purpose of serving it as a meal, or to sell any yabbie, koonac or gilgie taken from a dam or lake on your land to a person that has an aquaculture licence.

- **Fish Resources Management Regulations**

Under these regulations it is an offence to deposit any waste in any place that might result in the pollution of any waters that may contain fish.

- **Health (Pesticides) Regulations 1956**

This act controls the use and disposal of pesticides. The act makes it illegal to use an unregistered agricultural chemical, or use one for an unregistered use without a permit.

- **Health (Adoption of Food Standards Code) Regulations 1992 and Agricultural Produce (Chemical residues) Act 1983**

In Australia the level of pesticide residues allowed in foodstuffs is strictly controlled through Maximum Residue Limits (MRLs). Growers must be aware of MRLs when using pesticides.

- **Heritage of Western Australia Act 1990**

This acts protects places of cultural and heritage significance. It has provisions for heritage agreements and a register of places.

- **Local Government Act 1995**

This Act allows local governments to make by-laws for any purpose. Includes laws for declaring pest plants and requiring landholders to control or eradicate these plants.

- **Occupational Health and Safety Act 1984**

The legislation provides general duty of care provisions for employers, employees, suppliers and manufacturers in all work places including farms.

- **Rights in Water and Irrigation Act, 1914.**

This Act defines how much surface water may be taken from a watercourse, and when a licence is required from the Waters and Rivers Commission to take ground water. Proponents need to obtain a licence from the Water and Rivers Commission if they intend to take ground-water or surface water from a proclaimed area or from artesian areas.

- **Soil and Land Conservation Act 1945**

The objectives of this Act include mitigating soil erosion, salinity and flooding; conservation of soil and land resources; and combating the removal or deterioration of natural or introduced vegetation that may be detrimental to the present or future use of land. The Act gives the Commissioner for Soil Conservation the power, at any time where he believes that an agricultural practice may lead to “land degradation” as defined in the Act, to impose a soil conservation notice. It also gives the Commissioner the power to create soil conservation reserves and enter into agreements with landowners to protect remnant vegetation. In order for the
Commissioner to be informed about activities that may cause land degradation, owners and occupiers are required to notify the Commissioner of certain clearing and drainage works on their land. District advisory committees also advise the Commissioner of such matters and report on issues pertaining to land management, or degradation, within their own land conservation districts.

- **Town Planning and Development Act 1928**
  This Act gives local governments the responsibility for preparing town planning schemes and lists matters which may be dealt with in town planning schemes including the conservation of the natural features of an area and the control of developments in local areas. Statement of Planning Policies can be prepared under the Act to guide development in environmentally sensitive areas within municipalities.

- **Water and Rivers Commission Act 1995**
  This Act has a number of subsidiary Acts and by-laws to protect and manage water resources. These Acts are administered by the Water and Rivers Commission.

- **Western Australian Marine (Sea Dumping) Act 1981**
- **Wildlife Conservation Act 1950**
  This Act is the main statute for the protection of native flora and fauna in Western Australia. The Act is administered by the Department of Conservation and Land Management. The Act protects virtually all forms of native wildlife by regulating the circumstances in which they may be taken, killed, possessed, sold and otherwise dealt with. Rare, endangered and many native species are wholly protected under the Act. Clearing of declared rare flora is an offence, unless approval has been obtained from the Minister for the environment or the Executive Director of the Department of Conservation and Land Management.

- **Wildlife Conservation Regulations 1970**
  The regulations make it an offence for any person to interfere in any manner with the water level or water supply in any nature reserve, or do anything which may interfere in any manner with the natural environment of a nature reserve.

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**ENVIRONMENTAL LEGISLATION - THE BOTTOM LINE**

What you must do to comply - from The Law of Landcare in WA (Clement et al, 2001)

Agricultural and veterinary chemicals

In order to avoid liability for use of agricultural or veterinary chemicals:

- Most people would not transport sufficient quantities by road to be concerned with this legislation. Vehicles should only carry loads of dangerous goods up to 1 tonne (either 1000 litres or 1000 kg)
- Suppliers of hazardous substances must supply, on the first sale of a hazardous chemical, a Material Safety Data Sheet (MSDS) and must supply further copies thereafter on request.
- The employer must keep a register of all MSDSs and apply the information contained within.
- Containers 200 litres or larger must stand vertically on the truck or ute tray. An additional layer of containers may be added if they are secured by rigid sides and ends on the truck and there are pads between the layers.
- Containers smaller than 200 litres may be stacked on the vehicle banded to prevent any movement or contained by rigid sides and ends to secure the load.
- Apply the right chemical (one that is registered for use in your state for that particular crop or pest)
- Apply no more than outlined on the label
- Observe the withholding period as described on the label
- Keep good records of application
- Only use chemicals that have been registered for use by the NRA
- Follow any instructions on the label
- Dispose of unused chemicals in accordance with the label
- Do not offer any advice on the use of chemicals which is contrary to the instructions on the label
- Report any chemical contamination or spill to the DEP and Department of Agriculture as soon as possible
• Obey the terms of any order placed on your land or produce by the Department of Agriculture because of contamination.
• Check that pest control and aerial spraying contactors are licenced.

Aquaculture
If you intend to keep or breed fish, you must obtain a licence from Fisheries WA unless you:

• Keep or breed fish for non commercial or display purposes
• Sell any yabby, koonac or gilgie taken from a dam or lake on your land to a person holding an aquaculture licence, provided your land is not within a prohibited area

Clearing
The main legal controls for clearing vegetation on private land are:

• A landholder must notify the Commissioner for Soil and Land Conservation prior to clearing more than one hectare of native or introduced vegetation (depending on date of prior approval to clear, this includes regrowth)
• The Commissioner can impose a soil conservation notice to prevent clearing where land degradation is likely to occur
• The EPA may assess a proposal to clear where it is of environmental significance, and if it does so the Minister for the Environment must give approval before the clearing can proceed
• It is an offence to clear land which contains declared rare native flora unless approval has been obtained from the Minister for the Environment or the Executive Director of the Department of CALM

Drainage and Pumping
• An owner and occupier of land must notify the Commissioner for Soil and Land Conservation at least 90 days before draining or pumping water as a salinity control measure, where the water is to be discharged onto other land or waters.
• If the Commissioner believes that land degradation may result from the proposed drainage or pumping, he or she can impose a soil conservation notice to prevent it from proceeding
• Where the drainage is into a nature reserve or national park, special permission from CALM may be required
• Because drainage of saline water can have significant cross-boundary effects, landholders carrying out drainage should keep in mind their duty of care to those affected by their actions, and take all reasonable steps to consult with and avoid causing damage to affected persons

Environmental, Heritage and Cultural Protection
• Any discovery of sites, artefacts, remains or other objects suspected of being of Aboriginal origin must be reported to the State Minister for Aboriginal Affairs.
• It is an offence to damage, endanger, deface or interfere with an Aboriginal object or place.
• New developments need to determine if there are any areas of environmental, heritage or cultural significance on a property prior to commencing.
• Proponents of developments should contact their local government as a first step to gaining development approval.

Groundwater
You will require a licence to take groundwater unless:

• Your well is non artesian and it is outside a proclaimed groundwater area
• A declaration has been made by the Governor that exempts non artesian wells in your area from the requirement to hold a licence
• The water is from a natural spring which rises to the surface of your land

Flora and Fauna
Western Australia’s wildlife protection laws make it an offence to harm any native fauna unless:

• You hold a commercial fishing or fish processors licence under the Fish Resources Management Act.
It is an offense to harm native flora unless:
• In the case of protected flora on Crown Land, you hold a licence from CALM
• The flora is not rare, is on private land and is not taken for the purpose of sale
• You harmed the flora by accident, or by reason of an honest and reasonable mistake of fact; or
• The flora (not being rare flora) was harmed as an unavoidable consequence of performing an activity authorised by statute.

Managing Pests
Under Western Australia’s pest management laws, private landholders must:
• Report any declared animal or plant on their land
• Control declared animals or plants on their land
• Not bring into the State any prohibited plant or animal
• Not keep or release any prohibited plant or animal
• The type of control measure necessary for any declared plant or animal is regulated by the category given to the particular pest.
• The poisoning of animal pests is dictated by strict approval, purchase, application and notification guidelines. Contact your local Agricultural Protection Officer for details

Pollution
The Environmental Protection Act prescribes substantial penalties for anyone causing pollution.
To avoid these penalties:
• Do not discharge wastes (such as chemicals, petroleum products, feedlot wastes, etc) into the environment without the approval of the Department of Environmental Protection (DEP) or your local government authority
• Report any spill of pollutants to the DEP
• Obtain approval from your local government to commence any development, such as a piggery or aquaculture farm
• Obtain a works approval or licence from the DEP to begin, expand, or carry on a prescribed cattle feedlot, intensive piggery or abattoir
• Be aware of any special controls on your activities if you are in an area subject to an Environmental Protection Policy.

Pollution of water resources
You can avoid penalties for causing pollution of water resources by:
• Disposing of chemicals and used chemical containers in accordance with the instructions on the label or at an authorised waste disposal facility
• Disposing of dead animals by burial away from a water course or by incineration (where required)
• Using fertilisers sparingly
• Reporting any spill or any other possible source of contamination to your local government or Water and Rivers Commission as soon as possible
• Obtaining approval from the Commission or the Department of Environment Protection before commencing any activity on your land that might pollute ground or surface water

Surface Water
You need a licence to take surface water unless:
• You live outside a controlled area
• You are a riparian owner and take water for ordinary domestic, stock or garden purposes
• The water comes from a spring on your land, or from a wetland or lake entirely on your land
• There is public access to a water course or wetland on Crown land and you take water for stock or ordinary domestic purposes
• The water is surface water runoff which you collect in dams or tanks provided that in doing so you do not diminish the flow of water in any water course or the amount of water in any wetland

You need a licence to divert or dam surface water unless:
• You live outside a controlled area
• The dam is constructed off stream provided it does not sensibly diminish the flow or amount of water in a water course or wetland
APPENDIX IX - BIOREGIONAL SUMMARIES

Derived from the Biodiversity Audit. (Note that the Murchison bioregion has not been described as only 1% lies within the NAR).

**Avon Wheatbelt**

The Avon Wheatbelt (AW) IBRA bioregion is characterised by heavy soils common to the agricultural zone and occurs in the eastern zones of the NAR. The landscape primarily consists of a dissected tertiary laterite plateau and in divided into two sub-regions. AW1 lies to the east of the bioregion and comprises an ancient, gently undulating peneplain with internal drainage residual of ancient drainage systems. These drainage systems now only flow in greater than average rainfall years. The uplands are dominated by yellow sandplains and proteaceous scrub-heath with occasional granite outcrops, in which high numbers of endemic plants are found. The valley floors are mainly Quaternary alluvial and eluvial soils with eucalypt woodlands, Sheoaks and Jams.

AW2 in the western portion of the bioregion forms gently rising hills to low hills with breakaways. A rejuvenated drainage system in AW2 results in continuous streams that flow in average rainfall years. Lateritic uplands and associated sandplains support proteaceous scrub-heath while erosional slopes and valley floors are dominated by Wandoo, York, Casuarina and Jam woodlands.

Agriculture is the primary landuse in this bioregion with the majority of native vegetation cleared for cropping and grazing enterprises.

**Condition**

Vegetation has been highly cleared in the bioregion and generally ecosystems, riparian vegetation and wetlands are in poor condition. Secondary salinity is extensive in the landscape and in some upland seeps. Conservation reserves are generally on uncleared breakaway ridges or sandplain and isolated by wheat fields.

**Jarrah Forest**

The JF region is divided into two subregions of which JF1 extends into the southern boundary of the NACC NRM region. It is characterised by Jarrah/ Marri forest on laterite soils. Geology is dominated by a duri-crusted plateau of the Yilgarn Craton and is deeply dissected with granite outcrops. Jarrah and Marri forest prevails in the west with Bullich and Blackbutt in the valleys. To the east Powderbark Wandoo occurs on the breakaways in amongst Wandoo.

The major landuses are timber plantations and agriculture.

**Condition**

Jarrah and Marri forests, wetlands, riparian zones and terrestrial communities are generally in good condition though some are in fair condition. The condition of most ecosystems is declining though some remain static. Phytophthora dieback is very common and widespread in the Jarrah forest it has been estimated that 15-20% of the Jarrah forest is infected by the pathogen.

**Swan Coastal Plain**

The Swan Coastal Plain (SWA) extends into the southern portion of the NAR and is divided in two subregions, the Dandaragan Plateau (SWA1) and the Swan Coastal Plain (SWA2). Vegetation is dominated by woodlands of Banksia and Tuart on sandy soils with sheoak and Melaleuca on swampy areas. In the coastal areas that comprise SWA1, aeolian and colluvial soils represent three phases of Quaternary dunes and include complex seasonal fresh water wetlands. Younger dunal sands are covered with heath whereas older sands support Jarrah-Banksia associations. The Dandaragan Plateau (SWA2) has been formed from cretaceous marine sediments mantled by sands and laterite with a characteristic vegetation of Banksia woodland, Jarrah-Marri woodlands, Marri woodlands and scrub-heath. Horticulture, residential, nature conservation, grazing and hobby farms are predominant in SWA2, and summer feeding of the endangered Carnaby's cockatoo is important. Agriculture is the main landuse in SWA1.

**Condition**

The Swan Coastal Plain bioregion is subject to a great variety of environmental disturbances due to urbanisation. Phytophthora dieback affects several of the bushland reserves in this area. However there are areas between Lancelin and Cervantes that remain relatively undisturbed. These are likely to be impacted upon with coastal development proposals including a coastal road between the two coastal settlements. The overall condition of terrestrial
and wetland areas in this bioregion is classified as degraded (Bioregional Summary of the 2002 Biodiversity Audit for WA, 2003).

**Geraldton Sandplains**

Extending from just north of Gingin to the Dirk Hartog Islands in the north, the Geraldton Sandplain is divided into three subregions. Major parts of two of these (GS2 & GS3) lie within the NAR boundary with a quarter of GS1 crossing the northern boundary. Sandplains are most extensive where the region overlaps the Carnarvon Basin in the north and the Yilgarn Craton in the southeast. Alluvial plains associated with valleys and hills support York Gum woodlands and coastal aeolian sands are covered by proteaceous heath and Acacia scrubs.

The bioregion contains a high number of rare and endemic species and has state and national recognition as a biodiversity hotspot. Areas well known for high biodiversity importance include Mount Lesueur, the Morseby Ranges and the Houtman Abrolhos Islands.

**Condition**

The majority of remaining vegetation exists on soils unproductive for agriculture and therefore the reserve systems are heavily biased towards sandplain vegetation associations. There are some nature reserves (Pinjarrega, Beekeepers, Southern Beekeepers, Wandana, Toolonga and Zuytdorp) and five National parks (Lesueur, Alexander Morrison, Kalbarri, Badgingarra and Nambung). However there are a number of vegetation associations and ecosystems at risk that, while represented in reserves, are still a high priority for acquisition.

**Yalgoo**

The Yalgoo bioregion is an interzone between the southwest bioregions and the Murchison, most of this bioregion is outside the NACC boundary. Characteristic vegetation associations include Callitris-E. salubris, Mulga, and Bowgada open woodlands and scrubs on earth to sandy-earth plains in the western Yilgarn Craton and southern Carnarvon Basin. A number of ranges occur within the bioregion including Tallering Peak, Jaspilite Ranges, Mt Gibson Ranges, Warradagga Rock and the Mt Singleton Ranges. There are rare fauna (Western Spiny Tailed Skink & Carnaby Cockatoo), plants (Acacia vassalii, Darwinia masonii and Eucalyptus crucis subsp. praecipua) and ecosystems.

The predominant landuse is pastoral grazing and mining with small areas set aside for conservation.

**Condition**

The condition of the Yalgoo bioregion has been classed fair to high but degradation is visible primarily from sheep grazing and feral herbivores. At least half of the vegetation associations are poorly or not reserved and management of reserves is difficult due to remoteness and lack of resources.

**Threatening Processes**

Threatening processes are those that reduce the quality, quantity and/or viability of biodiversity values (as described above). In the context of the above described biodiversity values these threatening processes can be biophysical and/or anthropocentric in nature. The source of biophysical threats usually stems from some change imposed by human intervention in the landscape i.e. clearing, introduction of exotics or landuses that are incompatible with the natural environment.

Given that the current mosaic of landuses is unlikely to be reversed, there is a need to develop sustainable practices for the use of land that optimises benefits for humans needs and minimises the decline of biodiversity. In doing this there is a need to further raise the awareness and knowledge of how biodiversity functions across agricultural landscapes and the efforts that are required by individual landholders to conserve what remains. Landscape approaches to NRM in targeted areas are needed to achieve multiple benefits for landholders and biodiversity.
PRIORITISATION OF THREATS TO AGRICULTURAL LAND

The Department of Agriculture has a statewide responsibility for advising on agricultural land related threats. The Salinity Investment Framework which is centered on an appreciation of the biophysical and socio-economic assets, provides a framework in which to report on these threats and is based on a value versus threat matrix. The issues are further assessed by weighting them according to private/public benefit and availability of technology/procedures to ameliorate the issue. The value versus threat matrix determines the relative priority of assets and soil landscape zones of each asset, defined by the Tier that they fall under.

According to the ‘Preliminary Agency Statement of Natural Resource Management Priorities In WA (2003)’ the term ‘asset’ indicates an item of value and a ‘threat’ indicates the predicted severity and urgency of the impact of salinity on the asset, resulting in a loss of asset value. A Natural Resource Management Issues Database was developed by the Department of Agriculture, which contained information and values in the spatial framework of soil landscape zones. These zones delineate broad terrain types based on geomorphological criteria and are useful for gaining a regional perspective of landscape related issues. In this report, assessment was based upon the timing of impact and impact scale of relevant processes, as described in the table below. The value of the asset is based on the average value of agricultural land ($/ha) determined from year 2000 BankWest data. The threat value table for the agricultural land asset for the south-west, therefore only gives a broad comparative assessment of the issues facing various zones within south-western WA, and needs to be interpreted at that level (Department of Agriculture, CALM, Environment and Fisheries 2003).

### APPENDIX X - STATE PRIORITISATION OF THREATS

#### PRIORITISATION OF THREATS TO AGRICULTURAL LAND

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### APPENDIX X - STATE PRIORITISATION OF THREATS

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### Categories for assessment of land resource threats (Source; Schoknecht, unpublished).

<table>
<thead>
<tr>
<th>THREAT CATEGORY</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGH</td>
<td>Current/imminent risk of high impact</td>
</tr>
<tr>
<td>MODERATE</td>
<td>Current/imminent risk of moderate impact OR medium-term risk of high impact</td>
</tr>
<tr>
<td>LOW</td>
<td>Current/imminent risk of low OR medium-term risk of low-moderate impact OR long-term risk of low–high impact</td>
</tr>
</tbody>
</table>

### Definition of Terms

- **Current/imminent** (within 0-20yrs): High impact (majority of asset at risk)
- **Medium-term** (within 20-75yrs): Moderate impact (some of asset at risk)
- **Long-term** (greater than 75yrs): Low impact (minority of asset at risk)
Agricultural land asset: Priority ranking of Natural Resource Management issues over the nine Soil Landscape Zones in the Northern Agricultural Region and for the regional average (based on the NR Issues Database - Department of Agriculture Western Australia).

<table>
<thead>
<tr>
<th>RESOURCE THREAT</th>
<th>NAR AVERAGE</th>
<th>221 GERALDTON COASTAL ZONE</th>
<th>222 DANDARAGAN PLATEAU ZONE</th>
<th>223 VICTORIA PLATEAU ZONE</th>
<th>224 ARROWSMITH ZONE</th>
<th>225 CHAPMAN ZONE</th>
<th>226 LOCKIER ZONE</th>
<th>231 PORT GREGORY COASTAL ZONE</th>
<th>KALBARRI SANDPLAIN ZONE</th>
<th>IRWIN RIVER ZONE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind erosion</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Ag. Nutrient export</td>
<td>M</td>
<td>H</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>Animal (feral) sp.</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>Diseases (animal)</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Irrigation water management</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Loss of native veg. - salinity</td>
<td>M</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Plant (weed) sp.</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
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<td>M</td>
</tr>
<tr>
<td>Soil health</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Soil structure decline/compaction</td>
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<td>L</td>
<td>M</td>
<td>M</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>L</td>
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<td>L</td>
</tr>
<tr>
<td>Subsurface and subsoil acidification</td>
<td>M</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
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<td>M</td>
<td>L</td>
</tr>
<tr>
<td>Water erosion</td>
<td>M</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Acid sulfate soils</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Damage to infrastructure</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>L</td>
<td>M</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Groundwater management</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Land salinisation</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Loss of native veg. - clearing</td>
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<td>M</td>
<td>M</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Protection of prime ag land</td>
<td>L</td>
<td>H</td>
<td>H</td>
<td>L</td>
<td>M</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Surface water supply</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>Water repellence</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Waterlogging/inundation</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>
PRIORITISATION OF WATERSCAPES

In 2002, the Water and Rivers Commission conducted a Statewide Waterways Needs Assessment, which ranked the waterways of the NAR on the basis of condition and pressure. This work was further expanded through the Salinity Investment Framework (2003) which categorised assets according to their values and threats. A further assessment of the NAR’s priorities for waterscapes was undertaken as part of the Preliminary Agency Statement of Natural Resource Management Priorities in Western Australia (2003). Through this process, the Department of Environment categorised each of the waterscape and groundwater assets in the NAR using a value versus threat matrix approach.

The major categories of waterscape assets in the NAR, based on their relative value and the level of threat impacting them, are outlined in the table below. The waterscape value/threat matrix, together with knowledge about the urgency and cost-effectiveness of the available options to address particular threats, can be used in the process of prioritising Management Actions and as a basis for investment planning. It should be noted, however, that the prioritisation of various assets will be subject to review as more information becomes available. There is currently a significant gap in technical information for wetlands and this needs to be addressed before a comprehensive priority list for waterscapes can be developed.

These priorities are as follows:

<table>
<thead>
<tr>
<th>HIGH VALUE</th>
<th>MEDIUM VALUE</th>
<th>LOW VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HIGH THREAT</strong></td>
<td><strong>MEDIUM THREAT</strong></td>
<td><strong>LOW THREAT</strong></td>
</tr>
<tr>
<td>Gingin Brook</td>
<td>Namming Lakes</td>
<td>Eneminga Swamp</td>
</tr>
<tr>
<td>Conservation category wetlands</td>
<td>Karakin Lakes</td>
<td>Nambeing Swamp</td>
</tr>
<tr>
<td>Hill River Estuary</td>
<td>Gingin Catchment Lakes</td>
<td>Leeman Lakes</td>
</tr>
<tr>
<td>Hutt River</td>
<td>Greenough River Estuary</td>
<td>Mullering Brook</td>
</tr>
<tr>
<td>Irwin River Estuary</td>
<td></td>
<td>Boothendarra Creek</td>
</tr>
<tr>
<td>Moore River Estuary</td>
<td></td>
<td>Nambung River</td>
</tr>
<tr>
<td>Murchison River Estuary</td>
<td></td>
<td>Frederick Smith Creek</td>
</tr>
<tr>
<td>Lower Moore</td>
<td>Bowes Estuary</td>
<td></td>
</tr>
<tr>
<td>Wannamal Lake System</td>
<td>Greenough River</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Arrowsmith River</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Caren Caren Brook</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Minyulo Brook</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Murchison River</td>
<td></td>
</tr>
<tr>
<td><strong>Irwin River</strong></td>
<td><strong>Bowes River</strong></td>
<td><strong>Yarra Monger Tributary</strong></td>
</tr>
<tr>
<td><strong>Lake Moore</strong></td>
<td><strong>Buller River</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Lake Pinjarrega</strong></td>
<td><strong>Eneabba Creek</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Mongers Lakes</strong></td>
<td><strong>Hutt Estuary</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Yarra Yarra Lakes</strong></td>
<td><strong>Oakagee River</strong></td>
<td></td>
</tr>
</tbody>
</table>
1. protect and restore native vegetation and terrestrial ecosystems;
2. protect and restore freshwater ecosystems;
3. protect and restore marine and estuarine ecosystems;
4. control invasive species;
5. mitigate dryland salinity;
6. promote ecologically sustainable grazing;
7. minimise impacts of climate change on biodiversity;
8. maintain and record indigenous peoples’ ethnobiological knowledge;
9. improve scientific knowledge and access to information; and
10. introduce institutional reform. (Environment Australia, 2001)

CALM as the lead state government agency for biodiversity conservation have outlined four key areas for priority action in the Preliminary Agency Statement of Natural Resource Management Priorities in Western Australia (2003).

- Bio-subgroup 1: Biodiversity inventory and establishment of a Comprehensive, Adequate and Representative (CAR) terrestrial conservation reserve system and marine conservation reserve system.
- Bio-subgroup 2: Effective management and protection of conservation reserves and other recognised special conservation value areas.
- Bio-subgroup 3: Recovery of threatened species and threatened ecological communities other significant species and areas of exceptional diversity or endemism.
- Bio-subgroup 4: Conservation of landscape/seascape scale ecological systems and processes (integrating reserve and off-reserve conservation).

Western Australia is currently preparing a state biodiversity strategy to complement the National Strategy for the conservation of Australia’s Biological Diversity and would fit within the context of the National framework for management and monitoring of Australia’s native vegetation. A regional biodiversity conservation action plan for the NAR would enable State priorities to be reflected in strategic management actions identified for the region and would fit within the National Framework for management and monitoring of Australia’s native vegetation.

Areas likely to be covered in such a plan could be:

- Improvement of baseline data on aquatic, marine and terrestrial biodiversity;
- Prioritisation of remnant vegetation to be included in the formal reserve system to meet CAR (Comprehensive, Adequate & Representative) requirements;
- Investigation and Promotion of systems to integrate multiples landuses with biodiversity conservation outcomes;
- Landscape scale (strategic) approaches to

<table>
<thead>
<tr>
<th>PRIORITY ACTION</th>
<th>CORRESPONDING RCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducing the peaks of surface water runoff from catchments, and the damage it does to rivers and wetlands</td>
<td>WA.R1</td>
</tr>
<tr>
<td>Ensuring surface water is allocated equitably and sustainably between environmental, social and economic uses</td>
<td>WA.R2</td>
</tr>
<tr>
<td>Increasing the extent and improving the condition of riparian vegetation</td>
<td>WA.R3</td>
</tr>
<tr>
<td>Reducing salinity levels in rivers and wetlands that were once fresh</td>
<td>WA.R4</td>
</tr>
<tr>
<td>Improving the quality of water in rivers, wetlands and estuaries by reducing contamination from nutrients, chemicals and heavy metals</td>
<td>WA.R5; WA.R6</td>
</tr>
<tr>
<td>Improving the knowledge of rivers and wetlands and working to maintain or restore their condition</td>
<td>WA.R7</td>
</tr>
</tbody>
</table>
conservation and vegetation management across multiple tenures;

- Partnerships and collaboration in the conservation of threatened species and communities;
- Protection of high value wetlands and aquatic biodiversity;
- Coordinated approach to monitoring and evaluation of threatening processes and mitigation;
- Investigation into methods for providing incentives and marketing potential for biodiversity conservation;
- Raising awareness and capacity of community to achieve biodiversity conservation outcomes.

One prioritised tool for biodiversity management is landscapes.

While there is generally a focus on single taxa in relation to management of threatened flora and fauna, this is not an appropriate management scale for the most common or widespread species. It is important to manage for these species at spatial scales that address the key processes that will influence the management goal that is set. Some areas, such as the conservation reserves of the Lesueur - Coomallo area, for example, are of such a size as to require management on a broad scale. There are also a number of critical processes that impact on common or widespread taxa that occur on large spatial scales.

Management to meet our biodiversity goal can be planned and conducted at a variety of scales. The most appropriate scales for the NAR are the scale of the individual specimen, the patch scale (the level of a concise native remnant vegetated patch), landscape scale and bioregional scale (the level of IBRA subregions or regions). Landscape scale can generally be defined as being of a sufficient size to sample all landforms of the landscape (i.e. from the top of the hill to the bottom of the valley). In the Wheatbelt landscape, scale is described as being in the range of 10,000ha. Although the NAR has areas with different landscape sequences and scales than in the Wheatbelt, the relevant scale for the Northern Agricultural Region can be assessed and identified in the development of Biodiversity Conservation Plan, 10,000ha can be used as a general guide to the required spatial scale of management.

Fragmentation of habitat is a good example to illustrate the requirement for landscape scale management. Clearing for agriculture and infrastructure has resulted in patches of remnant vegetation that vary in size and connectivity to other remnants. This exposes remnants to a range of threatening processes that cannot be dealt with by focusing wholly on individual species or individual remnant patches. As many of these remnants gradually lose species there is a need to provide connections to allow reinvasion and to ensure enough habitat is available within a landscape for species to feed, shelter and breed. To meet our goal for biodiversity we also need to manage threats at the landscape scale, as few individual patches are large enough to provide everything that many species require.

PRIORITIES FOR GROUNDWATER

The Department of Environment has categorised each of the waterscape and groundwater assets in the NAR using a value versus threat matrix process similar to the approach developed by the Salinity Investment Framework (SIF). The values and threats used to prioritise the assets are outlined in the Draft Preliminary Agency Statement of Natural Resource Management Priorities in Western Australia (2003).

The major categories of groundwater assets in the NAR, based on their relative value and the level of threat impacting them, are outlined in the table below. These priorities will be used as a basis for investment planning.

<table>
<thead>
<tr>
<th>PRIORITY ACTION</th>
<th>CORRESPONDING RCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ensuring groundwater is allocated equitably and sustainably between environmental, social and economic uses</td>
<td>WA.R11</td>
</tr>
<tr>
<td>Improving the efficiency of water use</td>
<td>WA.R12</td>
</tr>
<tr>
<td>Improving the quality of groundwater by reducing contamination from nutrients, chemicals, heavy metals and salinity</td>
<td>WA.R14</td>
</tr>
</tbody>
</table>
Groundwater assets in the NAR as defined by the value – threat matrix.

<table>
<thead>
<tr>
<th>HIGH VALUE</th>
<th>MEDIUM VALUE</th>
<th>LOW VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrowsmith GW Area (Port Gregory WR) Buntine/Marchagee Braided Saline Drainage Line Lake Thetis</td>
<td>Arrino Bores WR Badgingarra WR Cervantes WR Coomberdale WR Dandaragan WR Green Head WR Horrocks Beach WR Jurien - Turquoise Coast WR Kalbarri WR Leeman WR</td>
<td>Moora WR Mount Peron WR Port Gregory WR Private sources for industry &amp; commerce (RIWIA) Private stock &amp; irrig’n sources (RIWIA) MW Gascoyne GW Area (Yilgarn Block) Utcha Swamp Arrowsmith River Wetlands Guragara Lakes</td>
</tr>
<tr>
<td>Private sources for landscape and recreation irrigation (RIWIA) MW New Norcia GW Area</td>
<td>Yarra Monger Tributary</td>
<td></td>
</tr>
</tbody>
</table>
PRORITISATION OF TERRESTRIAL BIODIVERSITY

The Australian Government has identified priorities for action in "National Objectives and Targets for Biodiversity Conservation" (Environment Australia, 2001). WA is a signatory to this document and is in the process of developing a State Biodiversity Strategy. These priorities aim to address the decline of Australia's biodiversity and are very relevant to the NAR.

These priorities are as follows:

- protect and restore native vegetation and terrestrial ecosystems;
- protect and restore freshwater ecosystems;
- protect and restore marine and estuarine ecosystems;
- control invasive species;
- mitigate dryland salinity;
- promote ecologically sustainable grazing;
- minimise impacts of climate change on biodiversity;
- maintain and record indigenous peoples’ ethnobiological knowledge;
- improve scientific knowledge and access to information; and
- introduce institutional reform.

(Environment Australia, 2001)

CALM as the lead state government agency for biodiversity conservation have outlined four key areas for priority action in the Preliminary Agency Statement of Natural Resource Management Priorities in Western Australia (2003).

- Bio-subgroup 1: Biodiversity inventory and establishment of a Comprehensive, Adequate and Representative (CAR) terrestrial conservation reserve system and marine conservation reserve system.
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- Bio-subgroup 3: Recovery of threatened species and threatened ecological communities other significant species and areas of exceptional diversity or endemism.
- Bio-subgroup 4: Conservation of landscape/seascape scale ecological systems and processes (integrating reserve and off-reserve conservation).

Western Australia is currently preparing a state biodiversity strategy to complement the National Strategy for the conservation of Australia's Biological Diversity and would fit within the context of the National framework for management and monitoring of Australia's native vegetation.

Areas likely to be covered in such a plan could be:

- Improvement of baseline data on aquatic, marine and terrestrial biodiversity;
- Prioritisation of remnant vegetation to be included in the formal reserve system to meet CAR (Comprehensive, Adequate & Representative) requirements;
- Investigation and Promotion of systems to integrate multiples landuses with biodiversity conservation outcomes;
- Landscape scale (strategic) approaches to conservation and vegetation management across multiple tenures;
- Partnerships and collaboration in the conservation of threatened species and communities;
- Protection of high value wetlands and aquatic biodiversity;
- Coordinated approach to monitoring and evaluation of threatening processes and mitigation;
- Investigation into methods for providing incentives and marketing potential for biodiversity conservation;
- Raising awareness and capacity of community to achieve biodiversity conservation outcomes.
- Incorporation of community values.

One prioritised tool for biodiversity management is landscapes

While there is generally a focus on single taxa in relation to management of threatened flora and fauna, this is not an appropriate management scale for the most common or widespread species. It is important to manage for these species at spatial scales that address the key processes that will influence the management goal that is set. Some
areas, such as the conservation reserves of the Lesueur – Coomallo area, for example, are of such a size as to require management on a broad scale. There are also a number of critical processes that impact on common or widespread taxa that occur on large spatial scales.

Management to meet our biodiversity goal can be planned and conducted at a variety of scales. The most appropriate scales for the NAR are the scale of the individual specimen, the patch scale (the level of a concise native remnant vegetated patch), landscape scale and bioregional scale (the level of IBRA subregions or regions). Landscape scale can generally be defined as being of a sufficient size to sample all landforms of the landscape (i.e. from the top of the hill to the bottom of the valley). In the Wheatbelt landscape, scale is described as being in the range of 10,000ha. Although the NAR has areas with different landscape sequences and scales than in the Wheatbelt, the relevant scale for the Northern Agricultural Region can be assessed and identified in the development of Biodiversity Conservation Plan, 10,000ha can be used as a general guide to the required spatial scale of management.

Fragmentation of habitat is a good example to illustrate the requirement for landscape scale management. Clearing for agriculture and infrastructure has resulted in patches of remnant vegetation that vary in size and connectivity to other remnants. This exposes remnants to a range of threatening processes that cannot be dealt with by focusing wholly on individual species or individual remnant patches. As many of these remnants gradually lose species there is a need to provide connections to allow reinvasion and to ensure enough habitat is available within a landscape for species to feed, shelter and breed. To meet our goal for biodiversity we also need to manage threats at the landscape scale, as few individual patches are large enough to provide everything that many species require.
### APPENDIX XI - GROUNDWATER ALLOCATION IN THE ARROWSMITH, JURIEN AND GINGIN AREAS

<table>
<thead>
<tr>
<th>Aquifer</th>
<th>Sustainable Allocation Limit (m³/year)</th>
<th>Amount Allocated (m³/year)</th>
<th>Amount Remaining (m³/year)</th>
<th>Amount Remaining (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ARROWSMITH GROUNDWATER AREA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superficial</td>
<td>22 600 000</td>
<td>7 158 070</td>
<td>15 441 930</td>
<td>68</td>
</tr>
<tr>
<td>Surficial</td>
<td>2 500 000</td>
<td>0</td>
<td>2 500 000</td>
<td>100</td>
</tr>
<tr>
<td>Otorowiri</td>
<td>700 000</td>
<td>0</td>
<td>700 000</td>
<td>100</td>
</tr>
<tr>
<td>Parmelia</td>
<td>49 100 000</td>
<td>4 249 080</td>
<td>44 850 920</td>
<td>91</td>
</tr>
<tr>
<td>Yarragadee</td>
<td>105 900 000</td>
<td>59 237 250</td>
<td>46 662 750</td>
<td>44</td>
</tr>
<tr>
<td>Cattamarra</td>
<td>1 250 000</td>
<td>0</td>
<td>1 250 000</td>
<td>100</td>
</tr>
<tr>
<td>Eneabba</td>
<td>2 500 000</td>
<td>1 400 000</td>
<td>1 100 000</td>
<td>44</td>
</tr>
<tr>
<td>Lesueur</td>
<td>3 500 000</td>
<td>200 000</td>
<td>3 300 000</td>
<td>94</td>
</tr>
<tr>
<td>Fractured Rock</td>
<td>200 000</td>
<td>35 000</td>
<td>165 000</td>
<td>82</td>
</tr>
<tr>
<td><strong>Total Arrowsmith</strong></td>
<td>188 250 000</td>
<td>72 279 400</td>
<td>115 970 600</td>
<td>62</td>
</tr>
<tr>
<td><strong>JURIEN GROUNDWATER AREA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superficial</td>
<td>34 000 000</td>
<td>11 293 990</td>
<td>2 706 010</td>
<td></td>
</tr>
<tr>
<td>Surficial</td>
<td>4 100 000</td>
<td>0</td>
<td>4 100 000</td>
<td>100</td>
</tr>
<tr>
<td>Mirrabooka</td>
<td>500 000</td>
<td>0</td>
<td>500 000</td>
<td>100</td>
</tr>
<tr>
<td>Otorowiri</td>
<td>800 000</td>
<td>0</td>
<td>800 000</td>
<td>100</td>
</tr>
<tr>
<td>Leederville/Parmelia</td>
<td>13 000 000</td>
<td>5 397 500</td>
<td>7 602 500</td>
<td>58</td>
</tr>
<tr>
<td>Yarragadee</td>
<td>36 300 000</td>
<td>5 703 843</td>
<td>30 596 157</td>
<td>84</td>
</tr>
<tr>
<td>Cattamarra</td>
<td>2 100 000</td>
<td>0</td>
<td>210 000</td>
<td>100</td>
</tr>
<tr>
<td>Eneabba</td>
<td>900 000</td>
<td>0</td>
<td>900 000</td>
<td>100</td>
</tr>
<tr>
<td>Lesueur</td>
<td>5 700 000</td>
<td>4 500 000</td>
<td>1 200 000</td>
<td>21</td>
</tr>
<tr>
<td>Fractured Rock</td>
<td>600 000</td>
<td>355 000</td>
<td>245 000</td>
<td>41</td>
</tr>
<tr>
<td><strong>Total Jurien</strong></td>
<td>98 000 000</td>
<td>27 250 333</td>
<td>48 859 667</td>
<td>50</td>
</tr>
<tr>
<td><strong>GINGIN GROUNDWATER AREA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superficial</td>
<td>241 200 000</td>
<td>159 535 118</td>
<td>81 664 882</td>
<td>34</td>
</tr>
<tr>
<td>Surficial</td>
<td>24 500 000</td>
<td>12 700 019</td>
<td>11 799 981</td>
<td>48</td>
</tr>
<tr>
<td>Poison Hill</td>
<td>3 800 000</td>
<td>0</td>
<td>3 800 000</td>
<td>100</td>
</tr>
<tr>
<td>Mirrabooka 1</td>
<td>3 700 000</td>
<td>3 961 390</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Leederville 2</td>
<td>7 400 000</td>
<td>8 791 450</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Leederville/Parmelia 3</td>
<td>31 300 000</td>
<td>33 239 735</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Yarragadee</td>
<td>24 070 000</td>
<td>23 081 500</td>
<td>988 500</td>
<td>4</td>
</tr>
<tr>
<td>Cattamarra</td>
<td>300 000</td>
<td>0</td>
<td>300 000</td>
<td>100</td>
</tr>
<tr>
<td>Lesueur</td>
<td>2 000 000</td>
<td>2 000 000</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fractured Rock</td>
<td>300 000</td>
<td>0</td>
<td>300 000</td>
<td>100</td>
</tr>
<tr>
<td><strong>Total Ginn</strong></td>
<td>338 570 000</td>
<td>243 309 212</td>
<td>98 853 363</td>
<td>29</td>
</tr>
</tbody>
</table>

1 2 3 Aquifers over-allocated

(Water Resources and Licensing, April 21st 2004).
## APPENDIX XII - GLOSSARY/ACRONYMS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGA</td>
<td>Arrowsmith Groundwater Area</td>
</tr>
<tr>
<td>ATBA</td>
<td>Australian Terrestrial Biodiversity Assessment</td>
</tr>
<tr>
<td>AW</td>
<td>Avon Wheatbelt (IBRA Bioregion)</td>
</tr>
<tr>
<td>CALM</td>
<td>Conservation and Land Management, Department of</td>
</tr>
<tr>
<td>CAR</td>
<td>Comprehensive Adequate and Representative (of reserves)</td>
</tr>
<tr>
<td>CSIRO</td>
<td>Commonwealth Scientific &amp; Industrial Research Organisation</td>
</tr>
<tr>
<td>DET</td>
<td>Department of Education and Training</td>
</tr>
<tr>
<td>DIA</td>
<td>Department of Indigenous Affairs</td>
</tr>
<tr>
<td>DPI</td>
<td>Department of Environment</td>
</tr>
<tr>
<td>DRF</td>
<td>Declared Rare Flora</td>
</tr>
<tr>
<td>EPBC</td>
<td>Environmental Protection and Biodiversity Conservation</td>
</tr>
<tr>
<td>EWR</td>
<td>Environmental Water Requirements</td>
</tr>
<tr>
<td>GGA</td>
<td>Gingin Groundwater Area</td>
</tr>
<tr>
<td>GS</td>
<td>Geraldton Sandplain (IBRA Bioregion)</td>
</tr>
<tr>
<td>HRZ</td>
<td>High Rainfall Zone (Farming System)</td>
</tr>
<tr>
<td>IBRA</td>
<td>Interim Biogeographic Regionalisation of Australia</td>
</tr>
<tr>
<td>ICM</td>
<td>Integrated Catchment Management</td>
</tr>
<tr>
<td>INRM</td>
<td>Integrated Natural Resource Management</td>
</tr>
<tr>
<td>JF</td>
<td>Jarrah Forest (IBRA Bioregion)</td>
</tr>
<tr>
<td>JGA</td>
<td>Jurien Groundwater Area</td>
</tr>
<tr>
<td>LAP</td>
<td>Local Action Plan</td>
</tr>
<tr>
<td>LCDC</td>
<td>Land Conservation District Committees</td>
</tr>
<tr>
<td>LGA</td>
<td>Local Government Authorities</td>
</tr>
<tr>
<td>MAT</td>
<td>Management Action Target</td>
</tr>
<tr>
<td>MER</td>
<td>Monitoring Evaluation and Reporting</td>
</tr>
<tr>
<td>MHS</td>
<td>Medium and low rainfall medium heavy textured soils (Farming System)</td>
</tr>
<tr>
<td>MSS</td>
<td>Medium and low rainfall sandplain soils (Farming System)</td>
</tr>
<tr>
<td>MUR</td>
<td>Murchison (IBRA Bioregion)</td>
</tr>
<tr>
<td>NAIMS</td>
<td>Northern Agriculture Integrated Management Strategy</td>
</tr>
<tr>
<td>NACC</td>
<td>Northern Agricultural Catchments Council</td>
</tr>
<tr>
<td>NAP</td>
<td>National Action Plan for Salinity and Water Quality</td>
</tr>
<tr>
<td>NAR</td>
<td>Northern Agricultural Region</td>
</tr>
<tr>
<td>NHT</td>
<td>Natural Heritage Trust</td>
</tr>
<tr>
<td>NLWA</td>
<td>National Land and Water Audit</td>
</tr>
<tr>
<td>NRM</td>
<td>Natural Resource Management</td>
</tr>
<tr>
<td>PSSA</td>
<td>Particularly Sensitive Sea Area</td>
</tr>
<tr>
<td>PZ</td>
<td>Pastoral Zone (Farming System)</td>
</tr>
<tr>
<td>RCT</td>
<td>Resource Condition Target</td>
</tr>
<tr>
<td>ROA</td>
<td>Reef Observation Area</td>
</tr>
<tr>
<td>RTP</td>
<td>Rural Towns Program</td>
</tr>
<tr>
<td>SIF</td>
<td>Salinity Investment Framework</td>
</tr>
<tr>
<td>SWA</td>
<td>Swan Coastal Plain (IBRA Bioregion)</td>
</tr>
<tr>
<td>SWR</td>
<td>Social Water Requirements</td>
</tr>
<tr>
<td>TEC</td>
<td>Threatened Ecological Communities</td>
</tr>
<tr>
<td>WA</td>
<td>Western Australia</td>
</tr>
<tr>
<td>WADA</td>
<td>Western Australian Department of Agriculture</td>
</tr>
<tr>
<td>WDC</td>
<td>Wheatbelt Development Commission</td>
</tr>
<tr>
<td>WRC</td>
<td>Water and Rivers Commission</td>
</tr>
<tr>
<td>UWA</td>
<td>University of Western Australia</td>
</tr>
<tr>
<td>YAL</td>
<td>Yalgoo (IBRA Bioregion)</td>
</tr>
</tbody>
</table>
APPENDIX XIII - ACKNOWLEDGEMENTS

We are very grateful to the following for assisting in the development of this strategy:

- The Commonwealth Government and the Government of Western Australia for funding this strategy process, and their agencies and staff for supporting us in conducting it;
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- Duncan Peter (NACC Regional NRM Facilitator) for our links with the Commonwealth;
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  - Sue Middleton – Community Engagement information;
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We acknowledge with enormous gratitude the contribution of the late Michael Bates, Chair of NACC at the commencement of this strategy process, who tragically died of complications from a farming accident in December 2003. Michael’s vision, leadership and commitment were important to all of us and he was an excellent ambassador for the region. We thank him for supporting and leading the NACC team so effectively.
The following references were used in preparing this strategy, and many will be useful for readers to follow up on more detailed information. Note because of space constraints, and in the interests of easy reading, not all these references are specifically cited in the text of the strategy document. References marked with an asterisk (*) were prepared with the assistance of local community consultation and input.

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