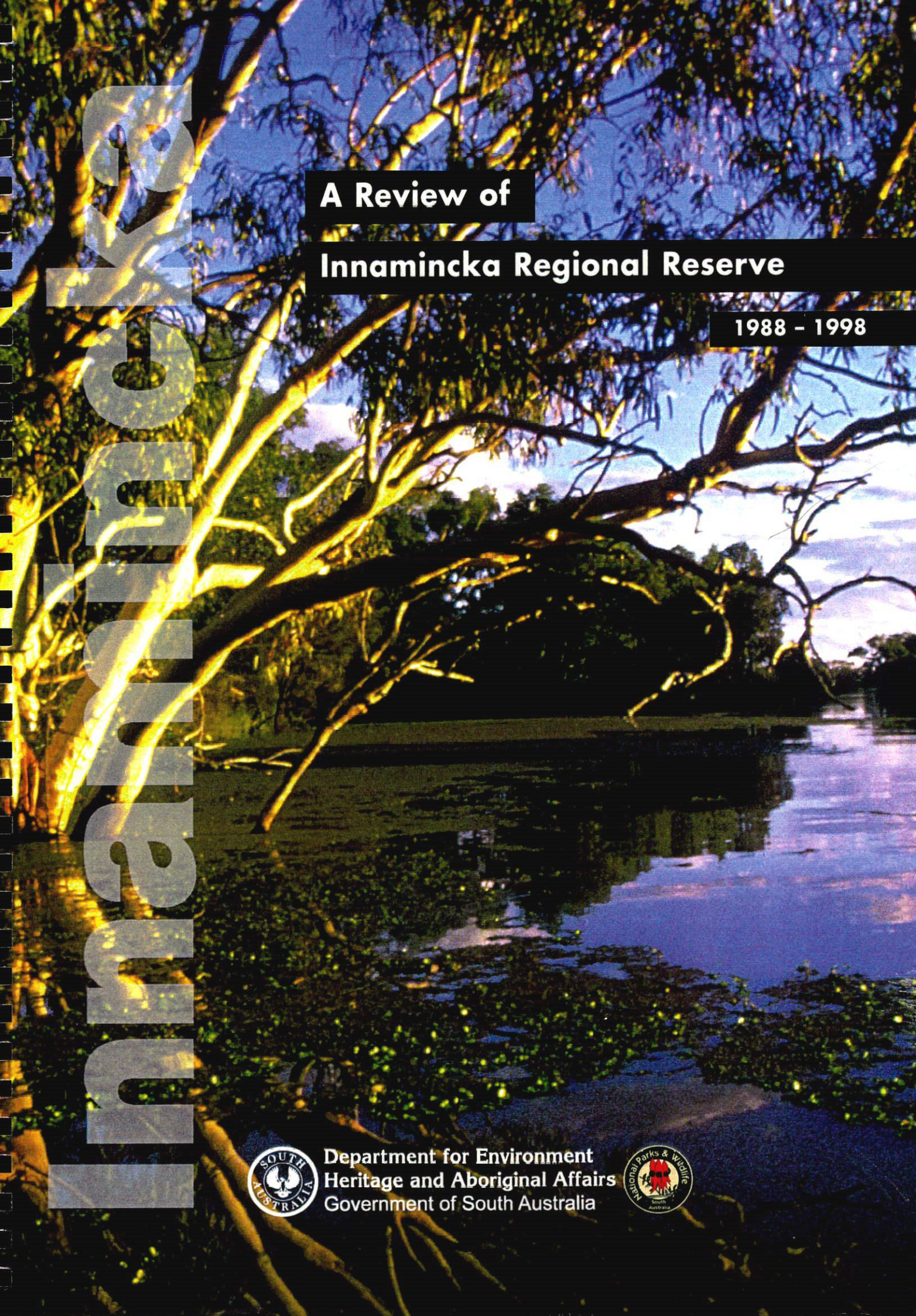

Innamincka

A Review of Innamincka Regional Reserve

1988 - 1998

Department for Environment
Heritage and Aboriginal Affairs
Government of South Australia

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This review has been prepared and adopted in pursuance to section 34A of the National Parks and Wildlife Act, 1972-81

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LIST OF ACRONYMS

ABARE	Australian Bureau of Agricultural and Resource Economics
ANZECC	Australian and New Zealand Environment and Conservation Council
ANPWS	Australian National Parks and Wildlife Service
ANZSES	Australian and New Zealand Scientific Expedition Society
CARRS	Comprehensive, Adequate and Representative Reserve System
CLCZ	Coongie Lakes Control Zone
CLCZ MG	Coongie Lakes Control Zone Management Group
DEF	Declaration of Environmental Factors
DEHAA	Department for Environment, Heritage and Aboriginal Affairs
DENR	Department for Environment and Natural Resources
DNR	Department of Natural Resources – Queensland
GSP	Gross State Product
LEB	Lake Eyre Basin
LEB CG	Lake Eyre Basin Coordinating Group
NPW SA	National Parks and Wildlife South Australia
OPEC	Organisation of Petroleum Exporting Countries
PIRSA	Primary Industries and Resources South Australia
SEA	Social and Environmental Assessment
SEG	Scientific Exploration Group
RCD	Rabbit Calicvirus Disease

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Jenny Bourne co-ordinated, compiled and prepared this review.

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FOREWORD

The proclamation of Innamincka Regional Reserve in December 1988 presented both a solution and a challenge. For the first time in South Australia a multiple-use reserve had been formally dedicated, providing a framework to protect a significant area of natural habitat while allowing use of the natural resources via partnerships with the principals involved in petroleum extraction and pastoral production.

The waters of the Cooper Creek and the associated Coongie Lakes wetland system are recognised internationally for their high biodiversity and the area's natural features attract a growing number of tourists. The Cooper Basin is also one of the State's major sources of hydrocarbons and beef cattle production is a significant enterprise. These values were seen in 1988, and continue to be seen, as worthy of good management and safekeeping.

The challenge of managing both nature conservation and the ecologically sustainable use of natural resources has been addressed by the International Union for the Conservation of Nature which recognises a multiple use category of reserve as an 'area containing predominantly unmodified natural systems, managed to ensure long term protection and maintenance of biological diversity, while providing at the same time sustainable flow of natural products and services to meet community needs'.

The objectives of management for this reserve category are:

- to protect and maintain the biological diversity and other natural values of the area in the long term
- to promote sound management practices for sustainable production purposes
- to protect the natural resource base from being alienated for other land-use purposes that would be detrimental to the area's biological diversity; and
- to contribute to regional and national development.

The *National Parks and Wildlife Act 1972* requires a report to be prepared on each regional reserve at intervals of no more that ten years and prescribes the assessment criteria. This report reveals that the biodiversity and landscape values of Innamincka Regional Reserve have been protected while significant wealth has been generated for South Australia and has provided a stimulus for improved environmental management. While improvements to management will continue to be a priority, I believe the report demonstrates that management has largely met the objectives of ecologically sustainable use of resources, justifying the original decision to establish the reserve and for its continued existence.

The proclamation of Innamincka Regional Reserve ten years ago was an important first step in a process that has resulted in conservation becoming a legitimate and accepted framework for natural resource utilisation over a significant percentage of the arid zone in South Australia - without the Regional Reserve concept this might not have been the case.

I look forward to the community's support in the future management of this most significant Reserve. In accordance with the provisions of Section 34A (5) of the *National Parks and Wildlife Act 1972*, I have much pleasure in presenting this report on the use and management of Innamincka Regional Reserve to Parliament.

HON DOROTHY KOTZ MP
MINISTER FOR ENVIRONMENT AND HERITAGE
MINISTER FOR ABORIGINAL AFFAIRS

EXECUTIVE SUMMARY

1. The National Parks and Wildlife Act was amended in 1987 to enable the development of multiple-use reserves with a conservation function by creating a Regional Reserve category.
2. This report assesses the outcomes of the 10 years of cooperative management. It includes
   i. assessments of the impact of the utilisation of the natural resources on the conservation of the wildlife, natural and historic features of the reserve
   ii. assessments of the impact or potential impact on the utilisation of the natural resources of the reserve on the economy of the State, and
   iii. recommendations as to the future status under the *National Parks and Wildlife Act* of the land constituting the reserve.
3. Innamincka Regional Reserve is located over 1 000 kilometres northeast of Adelaide on the border between South Australia and Queensland, in one of the most arid landscapes in Australia. It is a diverse area comprised of wetlands (which are listed as wetlands of international importance) surrounded by dunes, interdune flats, swamps, stony plains and tablelands.
4. There are significant sites of Aboriginal and European cultural importance. The area contains many sites of particular significance to Aboriginal people and of archaeological significance. It is also the place where the famous explorers Burke, Wills and Gray perished.
5. The dominant land uses of the Reserve are conservation of the wildlife, landscape and historic features, petroleum production, tourism and pastoral production.
6. A working group made up of a land manager from each of the principal land management agencies viz DEHAA, Santos and Innamincka Pastoral Company liaise regularly to discuss on-ground management.

Petroleum

7. Over the period 1988 to 1998 oil and gas exploration and production within the reserve has contributed over $ 2 600 million to the State's Gross State Product (GSP). This has created net incomes of over $ 1 400 million and created over 4 080 jobs per annum. The estimated economic impact of oil and gas exploration and production from the reserve area in the next ten years is about $ 950 million and 1 475 jobs per annum.
8. These activities have been assessed as having a high though temporary impact on the landscape features of the reserve and a low impact on its wildlife and cultural features.

This report recommends that

1) at least the same level of regulation be applied to any future petroleum licence holders in the reserve to ensure the current level of protection of wildlife, landscape and Aboriginal heritage features is maintained.

2) a review of the boundaries of, and management arrangements for, the Coongie Lakes Control Zone is undertaken to establish whether the current Zone includes adequate representation of wetland areas of prime ecological importance and provides adequate protection to those wetlands.

Tourism

9. Over the last decade tourism within the reserve has contributed over $9.4 million to the State's GSP. This expenditure has supported net incomes for South Australians of approximately $ 7.5 million and over 31 jobs per annum. The net value of tourism over the next ten-year period is likely to grow and it is estimated that it will be in the order of $ 15 to $ 18 million.

10. The impact of tourism on natural and cultural features has been low to moderate; provision of facilities (toilets, camp grounds) impact on landscape and wildlife in local areas.

This report recommends that the visitor infrastructure Development Plan for the reserve be reviewed to ensure that infrastructure developments and visitor management prescriptions proposed in the draft development plan adequately provide for visitor needs and protect the landscape, wildlife, and cultural features of the reserve.

Pastoralism

11. Over the ten years of the reserve, Innamincka Pastoral Company operations have contributed over $ 3.3 million to the State's GSP. This has created net incomes for South Australians of approximately $ 3.3 million and created around 12 jobs per annum. The contribution of the company to GSP over the next ten years should be at least as good as the previous ten years.

12. The presence of pastoralism in the area is evidenced by station improvements and stock which impact on the wilderness features of the landscape but are also regarded as part of the cultural heritage of the area.

13. Research indicates that the selective nature of cattle grazing and the preference of cattle for wetlands can lead to alteration in plant community composition and diversity and thence to altered habitats. This report recognises that exclosure fencing has removed stock impacts from the priority wetland areas of Coongie Lakes and Cullyamurra Waterhole. To ensure maintenance of the biodiversity values of the reserve's significant wetlands, stock management in grazed wetland areas needs to be closely monitored and reviewed.

This report recommends that early discussions be held with the pastoral lessee to review stock management regimes with the objective of reducing stock impacts on the remainder of the significant wetlands of the reserve.

Water Extraction

14. The chief concern with regard to the maintenance of the integrity of the wetlands of the reserve is the upstream extraction of significant amounts of water from Cooper Creek and its catchment in Queensland.

15. The Queensland Government has proposed a Cooper Creek Water Management plan which would allow a further increase in withdrawals of water from the system. This could pose a significant threat to these wetlands of international importance. The South Australian Government Submission to the Queensland Government on this Plan recommends that no additional water be allocated from the Cooper system and that a high level commitment be accorded to negotiations for the cross-border Agreement on water resource issues. These recommendations are consistent with protecting the wetlands of the reserve.

This report recommends that the South Australian Government maintain its commitment to the maintenance of water flows to meet environmental requirements as per the Heads of Agreement.

Management Structures

16. The Innamincka Working Group is an informal and successful communication forum between the three primary land managers.
17. The Coongie Lakes Control Zone Management Group was established to oversee petroleum exploration and production activities within the Coongie Lakes Control Zone. The involvement of the CLCZ MG in the oversight of the Western Prospects seismic survey in 1997 and 1998 achieved positive outcomes which met both community and environmental concerns.
18. The Far North Consultative Committee has provided an adequate forum for communication between the land managers of the reserve and other stakeholders.
19. The Management Plan for Innamincka Regional Reserve was gazetted in 1993. Many of the objectives of the plan have been met but there are no clear goals and objectives for management of the conservation features of the reserve.

This report recommends that the Management Plan for Innamincka Regional Reserve be revised in the near future and that this revision provide:

1.) ecological and wildlife conservation objectives and priorities for the reserve including monitoring requirements and performance measures

2.) a structure, terms of reference and formal reporting mechanism for an integrated reserve management group comprising representatives from the petroleum industry, petroleum industry regulators, pastoral lessee, pastoral lease assessment officer, National Parks and Wildlife SA, Aboriginal community

Reserve Status under the Act

It is recommended that the Innamincka Regional Reserve remain a Regional Reserve as classified under the National Parks and Wildlife Act at least until the next review within the next ten years.

1 INTRODUCTION

1.1 Regional Reserves

The *National Parks and Wildlife Act 1972* provides for the establishment and management of reserves for public benefit and enjoyment, to provide for the conservation of wildlife in a natural environment, and for other purposes. These reserves fall into five categories namely, National Parks, Conservation Parks, Recreation Parks, Game Reserves and Regional Reserves. The *National Parks and Wildlife Act 1972* applies to all reserves constituted under the Act.

Regional Reserves proclaimed under Section 34A of this Act and managed pursuant to Section 37 Objectives of Management also provide for the conservation of wildlife or the natural or historic features of that land while, at the same time, permitting the utilisation of the natural resources of that land.

1.2 Background to Regional Reserves

Regional Reserves are the direct result of a desire by government to have conservation recognised as a major land use public land while permitting the use of natural resources of those lands.

The original *National Parks and Wildlife Act* in 1972 provided for reserves under that Act with two major roles; conservation of natural and historic features and public benefit and enjoyment. The Act did include provisions to permit mining access in reserves, but prior to 1985 this provision was rarely implemented. Government policy adopted in that year has resulted in virtually all new reserves being proclaimed with provision for mining access.

The *National Parks and Wildlife Act 1972* was amended in 1987 to make provision for multiple-use reserves by creating a new classification of Regional Reserve. The constitution of these reserves aimed to provide the government with an opportunity to exercise a management regime that would maximise the conservation of key biodiversity assets while allowing for pre-existing and future land use such as mining and pastoralism.

Furthermore, it permitted the Government to develop partnerships with the mining and pastoral industries thereby facilitating improved standards of land management. Quite apart from the projected improvement in the overall management of lands of such reserves, the philosophy behind the regional reserve concept was expected to filter through to the broader management community operating in similar environments. The intention was that, together with the national land care strategy and the establishment of best practice environmental codes of practice by major mining companies, a more sustainable approach to land management generally would ultimately develop in these areas.

There was a strong body of opinion that the Regional Reserve concept was an arrangement that unacceptably watered down the significance of conservation and appeared incapable of adequately addressing the protection of the highly significant areas. In view of this, it was argued that pre-existing industries should be excluded from the most significant conservation areas of reserves for example the Coongie Lakes Wetlands of Innamincka Regional Reserve.

It needs to be stressed that the establishment of the Regional Reserve classification was aimed at facilitating the only available and realistic opportunity for conservation as a legitimate land use, to sit at the table alongside mining and pastoralism. A major issue that had driven the establishment of the Regional Reserve classification was the protection of the Coongie Lakes.

The Regional Reserve model was seen as having other benefits. It created a context within which legitimate exploitative industries would operate in a conservation framework. It was

never intended that the model could, or would, be used as a vehicle for conservation interests to oust the interests of the other land users. If decisions are to be taken subsequently that result in the discontinuation of one or more land uses, such decisions would be based on contemporary judgements of prevailing economic, environmental and social considerations.

Regional Reserves fall into IUCN Category VI Protected Areas which is defined as *'areas containing predominantly unmodified natural systems, managed to ensure long-term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs'* (IUCN 1994). The key words here are **sustainable** with respect to production objectives, and **protection and maintenance** with reference to biological diversity.

The Regional Reserve classification is not fixed, as it does not prevent all or part of such a reserve from being re-constituted as another class of reserve under the Act at some future date, subject to a resolution of both Houses of Parliament (DELM 1993).

Over the last ten years the *National Parks and Wildlife Act 1972* has provided a multiple land use management regime within a conservation framework for defined areas that have conservation values but are subject to other legitimate land uses. The Regional Reserve mechanism provides for:

- a conservation focus
- conservation management planning and implementation
- security of tenure for lands reserved under the Act
- managed utilisation of natural resources, and
- regulation for the management of human activity.

The major challenge for regional reserve management is to establish strategies that successfully integrate the different uses for which a reserve has been set aside. These strategies would require evaluation in a management plan.

The *National Parks and Wildlife Act 1972* also provides for agreements between the Minister of Environment and Heritage and Minister of Primary Industries and Energy and holders of mining tenements to prescribe the way in which natural resources will be utilised in regional reserves. These agreements recognise and make provisions for protecting the conservation values of these lands.

All other provisions of the Act apply to Regional Reserves.

1.3 Purpose of this Review

This is a Ministerial Review required pursuant to *National Parks and Wildlife Act 1972* Section 34A (5).

The Minister must within ten years of the constitution of a Regional Reserve:

(a) prepare a report :

(i) assessing the impact of the utilisation of natural resources on the conservation of the wildlife and the natural and historic features of the reserve

(ii) assessing the impact or the potential impact of the utilisation of the natural resources of the reserve on the economy of the State, and

(iii) making recommendations as to the future status under this Act of the land constituting the reserve, and

(b) cause a copy of the report to be laid before each House of Parliament.

1.4 Interpretation

In undertaking the review, it has been necessary to ensure that the requirements of the Act are properly addressed. To facilitate this process, an interpretative analysis of Section 34A of the Act was conducted and is provided in Appendix A. This analysis has been used to guide the conduct of the review. It is also useful in guiding readers of the report.

During the conduct of the review, issues emerged that will need to be addressed in the ongoing management of the reserve. Some of these relate to the scope and quality of baseline data upon which critical analysis of management should rely and which will be essential for the conduct of future Section 34A reviews. Other issues relate directly to the standards and aspects of management that need to be addressed on an ongoing basis.

Recommendations for management, while not a requirement in the context of the Section 34A review, are included in this report for the purposes of identifying those issues that will be need to be addressed in reviewing the plan of management for this Reserve.

1.5 Scope of this Report

The review of Regional Reserves assesses the impacts of utilisation of natural resources on the wildlife, natural and historic features of these reserves and on the State's economy. The review has been prepared to meet the purposes of Section 34A(5) of the *National Parks and Wildlife Act 1972* (see Appendix A).

The process of consultation and data collection is described below.

Sections of Chapter 3 provide a description of the location, context for management, landscape, wildlife and cultural features of the reserve. Chapter 3 also provides an overview of the natural resource utilisation and developments that have occurred within the reserve over the review period.

Chapter 4 provides a discussion and assessment of the impacts of resource utilisation on the natural features of the reserve.

Chapter 5 discusses and assesses the impacts of resource utilisation on the cultural features of the reserve.

Chapter 6 provides a summary of the assessment of the impacts and potential impact of resource utilisation on the economy of the State. The full report and economic assessment prepared by the South Australian Centre for Economic Studies is provided as Attachment 1.

Chapter 7 presents issues raised by individuals, interest groups and stakeholders who provided a submission to this review.

Chapter 8 discusses the implications of the findings of this review.

Chapter 9 presents recommendations regarding the future status and management of the reserve.

Appendix B provides lists of plant and animal species known to occur within the reserve.

Appendix C provides a summary of monitoring and research that has been conducted within the reserve.

1.6 Review Process

The data used in compiling this report has been drawn from existing monitoring programs, audit reports and relevant research. In particular the pastoral lease assessment reports prepared by the Biodiversity and Monitoring section of the Department for Environment, Heritage and Aboriginal Affairs provided the data for the assessment of impacts of pastoralism. Data on developments and audits of seismic activities held by Primary Industries and Resources South

Australia, Petroleum Group has provided an assessment of impacts of petroleum exploration and production activities. Impacts of tourism have been discussed and assessed using the knowledge of National Parks and Wildlife staff and surveys undertaken by students and amateur scientific groups. Further information was sought from other areas within the Department for Environment, Heritage and Aboriginal Affairs and South Australian Tourism.

The impact of the utilisation of the resources of the reserve on the economy of the State was assessed and reported on by the South Australian Centre for Economic Studies.

Stakeholders have been involved in several ways. An advertisement in the weekend *Advertiser* and letters to over 80 key stakeholders and individuals sought input to the review. A meeting of stakeholders was held in early 1998. At this meeting working groups covering the key topics of the review were established. These groups coordinated input from each stakeholder sector viz conservation of wildlife and natural features, conservation of cultural features, pastoralism, tourism and petroleum.

2 INNAMINCKA REGIONAL RESERVE

2.1 Introduction

Innamincka Regional Reserve is 13 818 square kilometres in size. It is located in the far northeast of the State of South Australia and bounded to the east by the South Australia - Queensland border. Innamincka township, on the banks of Cooper Creek, is located within but excluded from the reserve and is 1100 km from Adelaide via the Strzelecki Track. Innamincka Regional Reserve is within the Marree Soil Conservation District. (Figure 1).

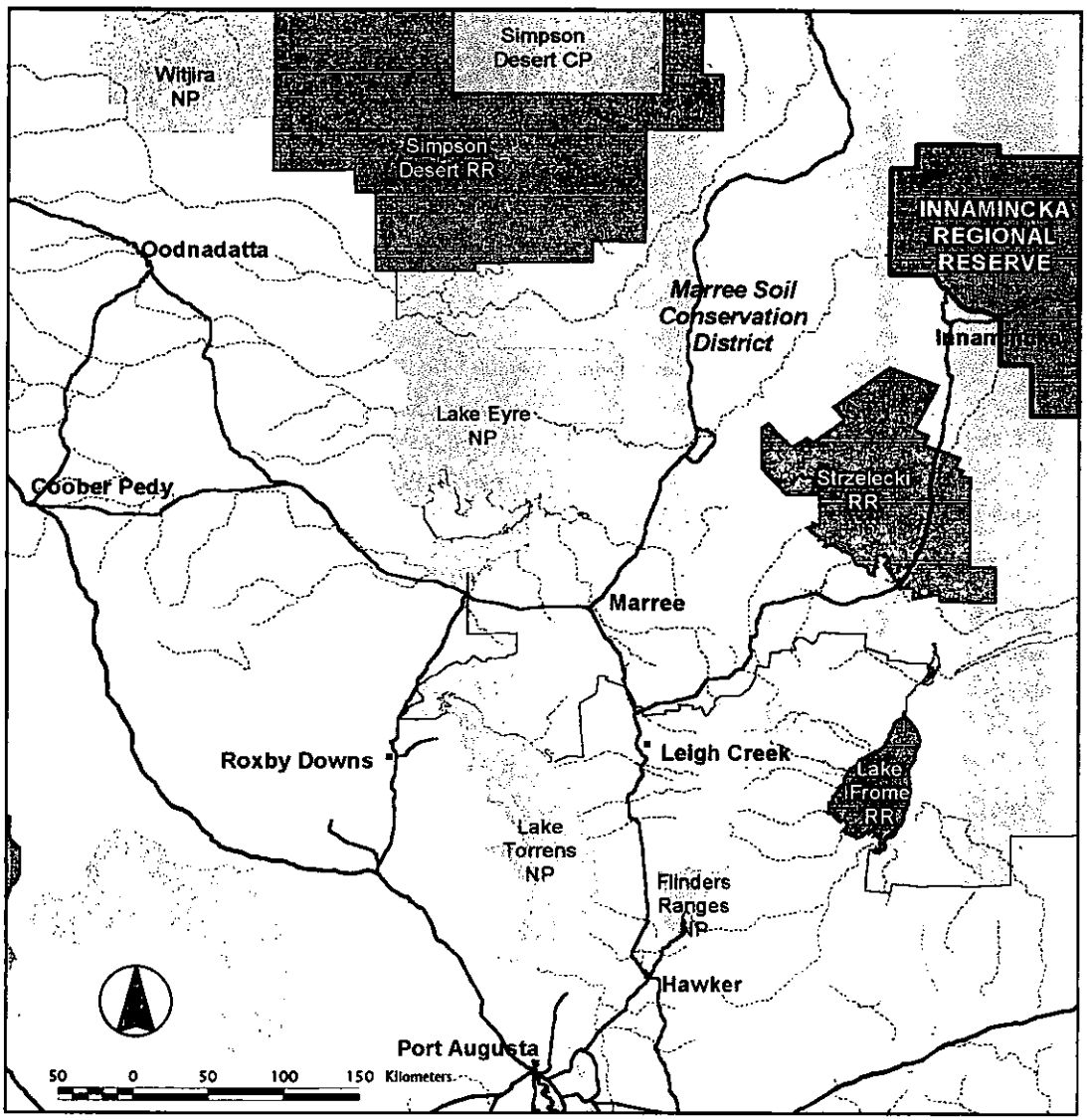


Figure 1 Location of Innamincka Regional Reserve

Innamincka Regional Reserve is located in one of the most arid areas in Australia and the world. The long-term average annual rainfall (110 years of records) is 172.5 mm but the area is renowned for its unpredictable and highly variable rainfall (80.7% variation). Over the last 110 years average or above average rainfall has been received 39% of years and droughts (less than 75 mm in summer and 50 mm in winter) 29% of years. On average 42% of rain is received in the summer months January to March (Campbell 1994).

The landscape consists of a combination of extensive flood plains, channels and lakes (Cooper Land System), dune fields, swamps and lakes (Kertietoonga land system), dune fields (Marqualpie and Della land systems) and the stony tablelands and plains (Merninie, Koonchera and Bloodwood land systems).

The major wetlands, swamps and lakes derive water from flow events in Cooper Creek. The majority of these flows result from summer monsoonal rainfall in central Queensland. Local runoff from the stony tablelands also supplies water to waterholes and swamps but on a less frequent and more erratic basis.

The area has many sites and stories of particular significance to Aboriginal people. Prior to European colonisation the fresh and often abundant water in a desert environment sustained relatively high populations of Aboriginal people from the Yandruwandha, Yarrawarka and Dieri Aboriginal groups. The level of occupation is indicated by the many large midden, burial and other sites to be found on the periphery of water bodies. The area also provided materials for tools; particularly grinding stones which were valuable trading items.

The non-aboriginal cultural heritage of the area is also of significance. The first graves of the ill-fated explorers Burke, Wills and Gray occur on the reserve. The Australian Inland Mission nursing home building, a ruin since the 1950s is now restored as the Regional Reserve office.

The dominant land uses are the conservation of the wildlife, landscape and historic features of the area, petroleum and natural gas production, tourism and pastoral production. Innamincka Regional Reserve has been pastoral grazing land since the 1870s and has been leased and managed by the Kidman family company since the early 1900s. Interest in the potential for petroleum in the area began in the 1950s and today the petroleum resources of the reserve are extracted and refined by Santos Ltd. There have always been visitors to the area as it had been a feature of long distance Aboriginal trading routes, early European explorers and today a growing tourism industry.

2.2 Context for Management

The Minister has the control and administration of reserves constituted under the *National Parks and Wildlife Act 1972* (hereafter referred to as the Act), and all reserves are under the management of the Director. Innamincka Regional Reserve (hereafter referred to as the reserve) was gazetted as a reserve under the Act on 22nd December 1988.

The principal land uses within the reserve are; conservation of natural and historic features, petroleum and natural gas exploration and production, tourism and pastoralism. These land uses are constrained by a number of instruments:

- conservation is determined by National Parks and Wildlife Act 1972, Aboriginal Heritage Act 1988 and the Heritage Act 1993
- the management of petroleum activities within Innamincka Regional Reserve is primarily via the Petroleum Act 1940, the Cooper Basin (Ratification) Act 1975, the National Parks and Wildlife Act 1972 and the Agreement between the Petroleum Exploration Licence holders Delhi Petroleum and Santos and the Government made pursuant to Section 40A of the National Parks and Wildlife 1972
- pastoral land use is constrained by a lease pursuant to Section 35 of the Act between the Minister and the pastoral operators, Innamincka Pastoral Company a subsidiary of S. Kidman and Co.
- management of the reserve is also determined by the Management Plan prepared pursuant to Section 38 of the National Parks and Wildlife Act 1972.

Partnerships between the three land users were achieved through an Agreement with the Petroleum Exploration Licensees, a Lease issued to Innamincka Pastoral Company and the Innamincka Regional Reserve Management Plan.

Agreement with Petroleum Exploration and Production Licensees

Agreement was made under Section 40A of the Act between the exploration companies and the Government. In reaching this agreement in 1988, the companies recognised that the Coongie Lakes Control Zone (CLCZ) (see Figure 2) is a discrete area of particular environmental significance within the reserve, and voluntarily accepted an agreed methodology for exploration and extraction criteria in the CLCZ in recognition of these features of significance. The CLCZ Management Group (CLCZ MG) administers petroleum activities within the CLCZ

This group is an advisory and administrative group, without authority, which :

- sets administrative procedures
- assesses and reviews proposals for petroleum operations, and
- forwards recommendations to Primary Industries and Resources South Australia on proposed operations.

Primary Industries and Resources South Australia remains the final approval agency for petroleum exploration and production activities.

The CLCZ MG was convened for the first time in September 1995. Post 1999, the function and existence of this group will depend on the granting of any licence consequent to existing PEL licenses.

Lease to Innamincka Pastoral Company

A lease was issued to Innamincka Pastoral Company Pty Ltd under Section 35 of the Act to allow for continuation of occupation and pastoral activities by the Innamincka Pastoral Company while at the same time providing for the management of conservation objectives. The term of the lease is 45 years, and it provides one right of renewal and, for the review of rent at seven yearly intervals. It also specifies a maximum stocking rate and that stocking must not have the effect of depreciating the ordinary capacity of the premises for depasturing stock. The lease specifies that the lessee shall not pollute any watercourse, lake or other body of water. The lease provides that all improvements erected by the lessee for pastoral purposes are to be done at their expense and remain the property of the lessee. The cost of providing and maintaining improvements that benefit both parties is to be shared through the establishment of joint agreements. Also specified are conditions for insurance and indemnity, for resumption of and compensation for the lease or part of lease, and makes provision for tourist facilities. The lease requires that the lessee obtain consent from National Parks and Wildlife South Australia prior to building or altering structures and NPWSA must consult the lessee prior to making improvements.

The Plan of Management for the reserve required under the Act provides objectives for pastoral land and for pastoral lease assessment as carried out on all other Pastoral Leases within the State.

Innamincka Regional Reserve Management Plan

The first Management Plan for Innamincka Regional Reserve prepared pursuant to Section 38 of the Act was gazetted on 9 September 1993. Having adopted this plan of management, the provisions must be carried out and operations must not be undertaken in relation to the reserve unless they are in accordance with the plan of management.

In managing reserves, and developing the management plan the Minister is required to have regard for the objectives under section 37 of the Act which in sub-section (j) make special provision for multiple land use:

Section 37:

a) the preservation and management of wildlife
b) the preservation of historic sites, objects and structures of historic or scientific interest within reserves
c) the preservation of features of geographical, natural or scenic interest
d) the destruction of dangerous weeds and the eradication or control of noxious weeds and exotic plants
e) the control of vermin and exotic animals
f) the control and eradication of disease of animals and vegetation
g) the prevention and suppression of bush fires and other hazards
h) the encouragement of public use and enjoyment of reserves and education in, and a proper understanding and recognition of, their purpose and significance
i) generally the promotion of the public interest and
j) in relation to managing a regional reserve to permit the utilisation of natural resources while conserving wildlife and the natural or historic features of the land.

The objectives of the management plan for Innamincka Regional Reserve are:

- to protect and conserve the natural, historic and cultural features and native wildlife (animals and plants) of the reserve
- to provide appropriate recreational opportunities, interpretation and information to the public on the values and agreed uses of the reserve
- to allow for the continuation of existing legal uses of resources via the development of leases and agreements, and to provide for a multiple use management framework in the management planning process
- to consult regularly, in the case of hydrocarbon and mineral developments, with the Department of Primary Industries and Resources (formerly Department of Mines and Energy) and the mineral or petroleum licensee regarding activities within the regional reserve
- to consult in the case of the pastoral lessee prior to making improvements, and
- to periodically review the regional reserve classification according to requirements of the *National Parks and Wildlife Act, 1972* (DELM 1993).

Management and Consultative Structures

In addition to the aforementioned Coongie Lakes Control Zone Management Group that oversee petroleum activities in the CLCZ there are two other fora for management of the reserve.

The Far North Consultative Committee (FNCC) constituted under the Act provides a forum for stakeholders to comment on the management of the reserve. The FNCC has received and passed on comments on limitations of reserve management.

The Innamincka Working Group (IWG) consists of representatives of the three land managers of the reserve viz, the National Parks and Wildlife District Ranger, Santos' Environmental Advisor, and the Innamincka Pastoral Company (S. Kidman and Co.) Landcare Officer. It is through this group that the day to day on ground activities on the reserve are communicated.

Communications are a loose arrangement based on regular discussions about activities, no formal meetings or minutes have been kept.

Achievements in Partnership

The proclamation of the Innamincka Regional Reserve gave formal recognition to conservation as a major land use over a most environmentally significant portion of the arid zone of northeast South Australia. For the first time in the State, a multiple-use reserve had been dedicated for management outcomes.

To achieve this goal, effective partnerships needed to be developed (as described above) between the Government and the major users of the natural resources of the reserve. While broader community consultation has occurred through the auspices of the Far North Consultative Committee, the major stakeholders and signatories to the agreements are involved in petroleum exploration and production and pastoralism. It is to the credit of those partners that in the decade following proclamation, there have been a number of significant achievements that can be directly attributable to the partnership arrangements. These include:

- joint working groups have been set up and operate successfully
- monitoring enclosures have been erected
- monitoring assessments have been jointly undertaken
- agreements have been reached to fence off the Coongie Lakes and Cullyamura Waterhole for environmental reasons
- cooperation and assistance has occurred with feral animal control operations
- a watching brief has been maintained on weed species
- improved methods and work standards have been introduced into the petroleum industry
- exploration activity in the Coongie Control Zone has been undertaken with environmental sensitivity
- cooperation has occurred with reserve administration, including the provision of air transport, accommodation and meeting venues

2.3 Natural Features

Conservation Values

The reserve contains a diverse range of arid and wetland ecosystems, and is regarded as an outstanding natural area. This has been officially recognised in a number of ways:

- Australia signed the *Convention on Wetlands of International Importance Especially as Waterfowl Habitat* (the Ramsar Convention) in 1975 This convention provides a framework for global action for conservation and sustainable wise use and fair and equitable sharing of the benefits arising from the utilisation of wetlands. The Cooper Creek and Coongie Lakes Wetlands portion of the reserve is listed as a wetland of international significance under this Convention in June 1987
- the Coongie lakes part of the reserve is listed in the *Directory of Important Wetlands in South Australia* (Morelli and deJong 1996) and
- the Cooper Creek floodplain in South Australia and the Coongie Lakes are listed on the Register of the National Estate (Figure 2).

Landscapes

The natural landscape of Innamincka Regional Reserve is dominated by the wetlands of the Cooper Creek and the Coongie Lakes, and their flood plains. These wetlands are a huge mosaic of lakes, channels and interdune floodouts and, following the recession of floodwaters, extensive grass and herb lands. Skirted by coolibah trees, the lakes present an expanse of water in a desert environment. The waterholes of the Cooper Creek are virtually permanent and desert river red gums and coolibahs shade their banks. Strzelecki Creek, which leaves the Cooper downstream from the township of Innamincka, receives flows from Cooper Creek in some flood years.

To the east of the wetlands are stony tablelands, often referred to as 'jump-up country' where flat topped mesa hills are covered with red varnished gibber stones. The tablelands are dissected by creek lines lined with the distinctive mineritchie (red mulga) with its red, curled bark and the white trunks of stunted river red gums. These tablelands include the geologic feature, the Innamincka Dome.

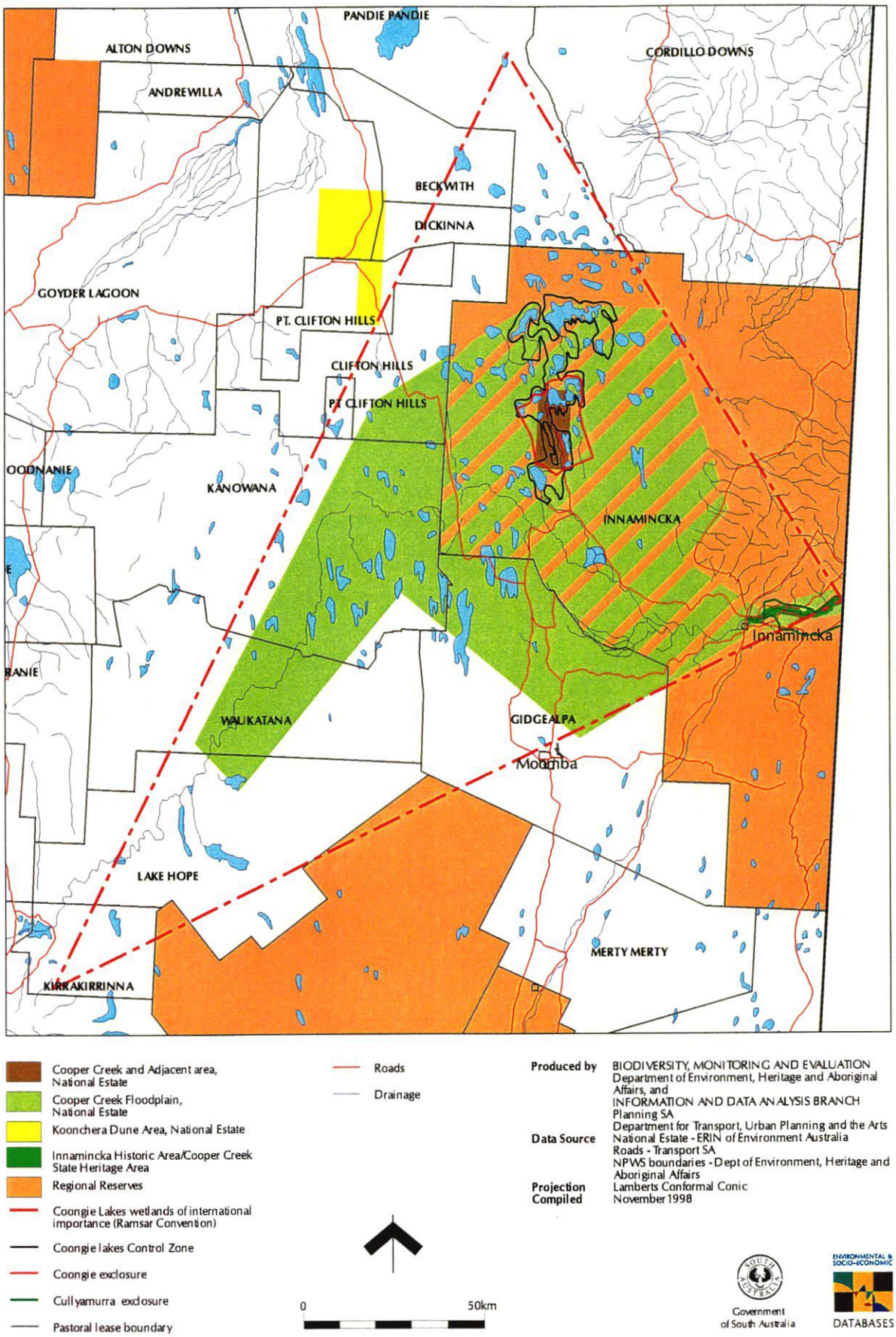
To the west, north and south of the wetlands are sandy deserts of three distinct types varying in colour from red dunes covered in spinifex through orange to pale dunes. In the expanse of desert dunes this variety of sandhill landscapes provides spectacular views.

The reserve provides examples of a wide variety of arid landscapes. The enjoyment of these landscapes is gained through a sense of space and solitude provided by the vast panoramas of hot, dry, wilderness through which meanders the mosaic of Coongie Lakes and the oasis of Cooper Creek waterhole (Figure 3).

The significance of this landscape to the Australian people is recognised in several ways (see Figure 2). There are two sites listed on the Register of the National Estate for natural features at Innamincka Regional Reserve. The Cooper Creek Floodplain (listed 1990) is a large area that extends downstream along the Cooper and beyond the boundary of the reserve. The Coongie Lakes and Adjacent Area (listed 1980) is contained within the Cooper Creek Floodplain and is wholly within the reserve.

A strip two kilometres wide centred on the main channel of the Cooper Creek and extending from the Queensland border downstream for forty kilometres, is a State Heritage Area. The site was declared for Aboriginal, non-Aboriginal and natural heritage values. The natural heritage values include the areas natural beauty, extensive permanent waterholes and habitat for abundant fish and bird life.

Figure 2 Areas of Conservation Significance



Reservation of representative examples of the Channel Country Biogeographic Region of Australia is a high priority for the National Reserves System. Innamincka Regional Reserve contributes to this by embracing 100% of the Merninie environmental association and 35% of the Cooper Creek Environmental Association and small portions of Piniewirie, Stony Desert and Della Desert Environmental Associations (Thackway et al 1995, associations after Laut et al 1977).

Habitats

There are three broad groups of habitats within the reserve. The most significant group of habitats is the complex of wetland waterholes, lakes and floodplains of the Lower Cooper floodout including the Coongie Lakes of the Cooper Land System. The other habitats are the stony desert (Merninie Land System) and the sandy deserts that are described here as three the land systems: Marqualpie, Della and Kertietoonga (Barratt and Bourne 1995) (see Figure 3).

Cooper Land System

The Lower Cooper floodout and Coongie Lakes are a unique near natural wetland within the Channel Country biogeographic region and play a substantial role in the hydrological and ecological functioning of the Cooper Creek basin. The flows and flooding of the lake system are dependant on the late summer and early autumn rains in the catchment some 800 km upstream. Although flows reach Cullyamurra waterhole nearly every year, not all flows reach Coongie Lakes. However most years the lake system has an inflow of water, which stimulates breeding in the fish populations and fish-eating birds. Flows along the Strzelecki occur on a less frequent basis.

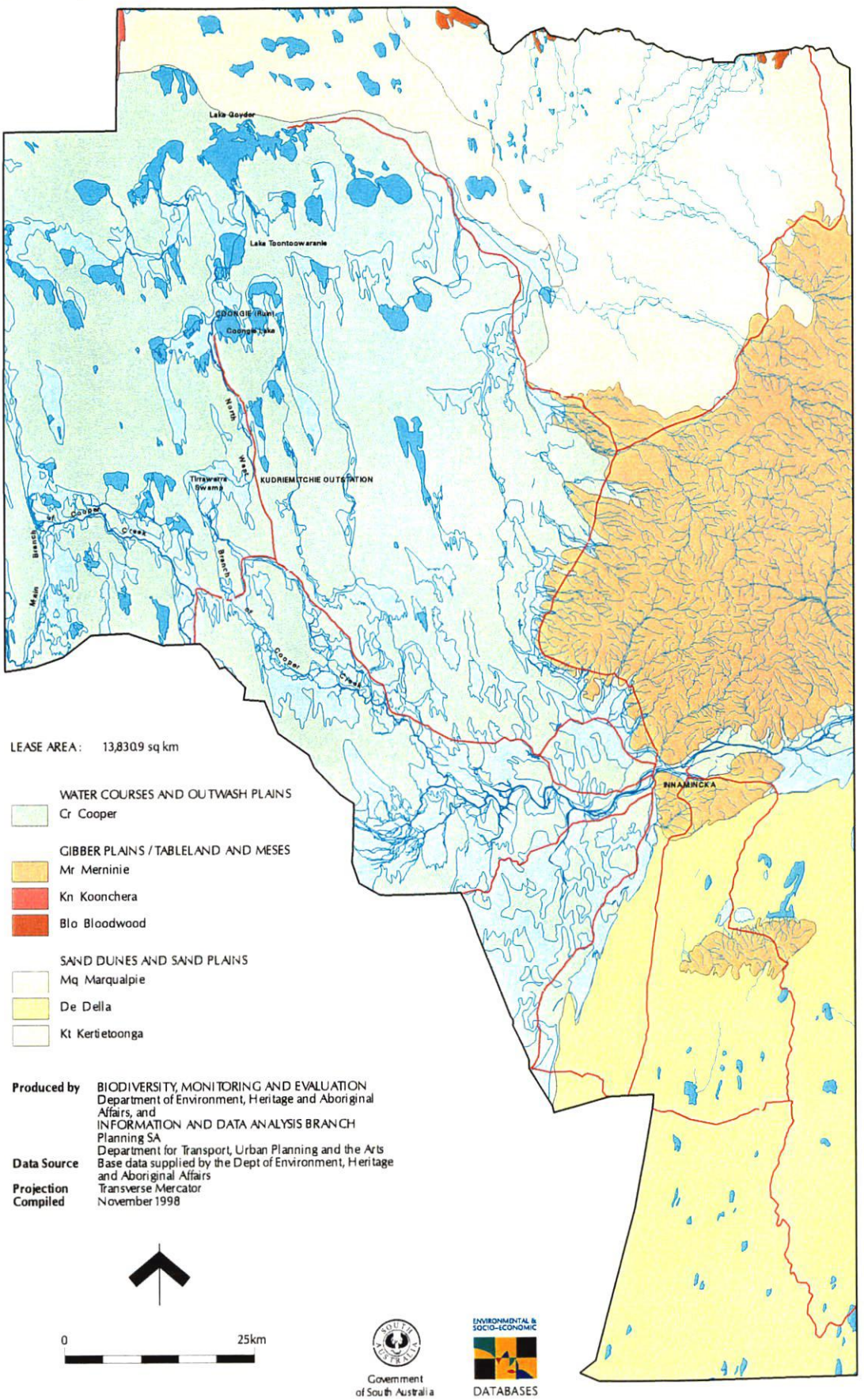
The variability of the flows, rainfall and the vast flat landscape gives rise to a great variety of habitats across the floodplain. Sixty wetland habitats based on the levels and frequency of inundation, soil types and vegetation species and structure have been described within the Cooper Land System (Mollenmans et al. 1984). These habitats do not include the variety of aquatic habitats that are also diverse temporally and spatially. In addition 23 habitats were described for the lake margins of the Coongie Lakes Control Zone (Barratt 1987). These descriptions provide some insight into the complexity of the diversity of Cooper Creek and its floodplains.

The major waterholes on the main channel of the Cooper supports tall woodland consisting of river red gum and coolibah, with bean tree, eurah and Broughton willow, whitewood and native orange. Braided channels and temporary waterholes on both the Cooper and Strzelecki Creeks have similar soils and vegetation. Lignum grows in dense thickets on the banks of the creeks and in large swamps on gray self-mulching, cracking clay soils (eg Tirrawarra Swamp).

The extended flood plains support open woodland consisting of coolibah, whitewood and spotted emu-bush and a shrub layer of old-man saltbush and Queensland bluebush with lignum. Crabhole flats are flooded less frequently and do not have a tree cover but support a shrubland dominated by Queensland bluebush. Water bodies when present contain mats of duckweed and water primrose.

The lake margins support coolibah, and a variety of floodplain vegetation associations. Lake floors when dry, support a variety of different ephemeral herblands and grasslands of high biomass which are of great value to the pastoral industry and provide the nutrient input which gives rise to the boom in freshwater fish and insects following flooding.

Figure 3: Land Systems of Innamincka Regional Reserve



Cooper Creek in flood also provides a greater diversity of aquatic habitats including braided and single channels, floodplains, waterholes, flooded plains and interdune corridors. The lakes are shallow, intermittent, variable in depth, strongly affected by wind action, variable in temperature, dissolved oxygen concentrations and salinity and subject to day/night thermal stratification. The biota living in these aquatic habitats are tolerant of extreme environmental conditions, spatially and temporally patchy in community composition and abundance. They exhibit flexible life history strategies, have an opportunistic response to flow variation and are dependent on drought refugia.

Merninie Land System

The Merninie Land system consists of a pattern of stony tablelands, long silcrete gibber slopes and local ephemeral creeks. The flat topped mesas support a variety of shrubs and low trees including eremophilas, saltbush, gidgee, red mulga and mulga. The stony slopes and alluvial fans emanating from the mesas support Mitchell grass, and copperburrs. The creek-lines that dissect the mesas are lined with red mulga, gidgee and deeper channels contain waterholes lined with arid-form river red gums.

Koonchera Land System

A small area of Koonchera land system occurs in the northwest of Innamincka Regional Reserve. This land system comprises gently undulating gibber plains, crossed by major drainage with run-on depressions and swamps and limited occurrences of red dunes. Koonchera is key habitat for the Kowari, Kultarr and Fawn Hopping Mouse.

Bloodwood Land System

Several small patches of this land system occur near the northern edge of the reserve. It consists of scattered dunes and sand plains interspersed with gibber gravel flats. Red irregular shaped sand dunes support an overstorey of sandhill spider-flower and sandhill wattle with a sandhill canegrass shrub layer. The sandplains support bloodwood and lobed spinifex and the gibber gravel plains, Mitchell grass, neverfail and herbs.

Marqualpie Land System

The Marqualpie land system is one of four sand dune land systems and consists of a pattern of low, stable, crescent and irregular shaped red dunes, with numerous small interdune claypans and lakes. Lobed spinifex hummock grassland forms the cover on these dunes with sandhill wattle, whitewood and needlewood being the common emergent species in the sparse overstorey.

Areas enclosed in the crescent shaped dunes form swampy soils and vegetation consists of lignum, Queensland bluebush and swamp canegrass. The more open swales support bloodwood.

The Montecleary Creek and tributaries dissect the land system and are lined with riparian woodlands of river red gum, coolibah, river cooba, whitewood and bloodwood, the species mix dependant on inundation frequency.

Kertietoonga Land System

Kertietoonga land system covers a small area in the north of the reserve. It consists of red dune fields with semi mobile crests in places and a perennial cover of sandhill canegrass and lobed spinifex; interdune swamps with starbush, blackbush and neverfail.

Interdune drainage and lakes are ephemeral, lakes support coolibah over samphire or lignum shrubland.

Della Land System

Della land system occurs in the south of the reserve. It consists of red longitudinal sand dunes that support whitewood, narrow leafed hopbush, sandhill wattle, needlewood and senna species with an understorey of annual grasses and copperburrs. Sandy interdune swales support colony wattle, whitewood, straggly corkbark, emubushes and annual grasses and forbs. Interdune flats with cracking clay soils support grasslands consisting of Mitchell grass, neverfail and mulka with poverty bush and copperburr species. Claypan swamps support lignum, canegrass and Queensland bluebush. Occasional small rises support chenopod shrublands of low bluebush and cottonbush.

Wildlife

The diversity of wildlife in the reserve largely results from the variety of habitats associated with the wetlands and their location in an arid environment. The South Australian Biodiversity Database (Robinson et al. 1995) contains records for 471 species of vascular plants and 233 species of vertebrate animals present within the reserve.

Species lists are shown in Appendix B. The studies that have contributed to these data and our knowledge of the flora, fauna and ecology of the region are outlined in Appendix C.

Plants

Plants of conservation significance which occur in the area and are recorded on the SAFLORA database.

Endangered

Osteocarpum pentapterum	five-wing bonefruit

Vulnerable

Eremophila bignoniiflora	white tree-fuchsia

Rare

Wahlenbergia aridicola	dryland bluebell
Gratwickia monochaeta	no common name
Adriana hookeri	water bush

Mammals

The mammal fauna remaining in the area, with the exception of the Red Kangaroo and the Dingo, consists of small sized marsupials and rodents listed in Appendix B. Most appear to be common and widespread in appropriate habitats. However the Dusky Hopping Mouse and the Plains Rat both of which were collected 20 years ago have not been located in recent years despite searching at the most recent recorded localities as part of the Rare Rodents Research Project (see Appendix C).

Another species of interest is the Kowari which has been recorded just outside the north west corner of the reserve on the gibber plains in the Koonchera Land System also known as Sturt Stony Desert.

An important isolated population of the Water Rat occurs in the Cooper Channel and some of the lakes and swamps of the Coongie system.

Birds

The reserve supports at least 180 bird species (Appendix B) or nearly a quarter of Australia's bird species. This diversity of birds is greater than for any other area of the Australian arid zone for which data exists. The breeding aggregations of raptors along Strzelecki Creek are of Australian significance.

Many bird species of conservation significance occur in the area. The Night Parrot which until recently was presumed extinct was sighted by S. Parker (then curator of birds in the South Australian Museum) in 1979 near Lake Perigundi about 80 kms west of the reserve. There have been occasional unconfirmed sightings of the night parrot on the reserve. The Bush Stone

Curlew, Grey Falcon, Flock Bronzewing, and Barking Owl are known to occur in the reserve. Also occurring in the reserve are near endemic sub-species of Red-rumped Parrot, Blue-bonnet, Mallee Ringneck and Jacky Winter (Reid pers. comm.).

Waterbird diversity is particularly high with 73 waterbird species and another 13 wetland dependant species recorded of which 43 waterbird and 9 wetland dependant species have been recorded breeding. Waterbird aggregations are very high and in times of flood over 100 000 individuals have been recorded. The wetlands in the area can also provide an important drought refuge for waterbird populations.

The Cooper Creek and Coongie Lakes support breeding pairs of the following threatened waterbird species: White-bellied Sea-eagle, Freckled Duck, Musk Duck, Brolga, Little Egret and Intermediate Egret. The Magpie Goose, Latham's Snipe, Painted Snipe, Spotless Crake, Baillon's Crake, Australasian Shoveler and Plumed Whistling Duck have been recorded as present but are not known to breed in the area.

The most abundant species when flooding events occur are: Grey Teal, Pink-eared Duck, Wood Duck, Australian Pelican, Great Cormorant, Black Swan, Eurasian Coot, Black-tailed Native-hen, and Red-necked Avocet.

Fish

Cooper Creek and Coongie Lakes within the reserve support an assemblage of at least 12 indigenous fish species from eight families. Two endemic species of fish the Lake Eyre Callop and Cooper Creek Tandan are endemic to the Cooper Creek catchment. Missing from within the reserve are two of the fourteen fish species recorded from the Cooper channel: the Leathery Grunter, which is doubtfully recorded from the Cooper system, and the Lake Eyre Hardyhead, which is found downstream of Coongie lakes often in higher salinity habitats. Only two exotic fishes have been recorded in the reserve, the gold fish and the plague minnow. The native species of fish are numerically dominant. The fauna is an excellent example of an indigenous assemblage that is largely unaltered in its ecology and population structure. Coongie Lakes is a feeding ground, spawning ground, nursery and migration path for most of the indigenous species of Cooper Creek fish. Larval densities of major species reach extreme levels in the reserve during major floods (Puckridge pers. comm.).

Reptiles

The wetland contains a morphologically distinct form of freshwater turtle *Emydura* c.f. *macquarii*. This poorly studied form appears to be confined to the Cooper System and may eventually be described as a separate species. During drought large numbers are concentrated in the permanent waterholes which provide critical refuge habitat for the continued survival of this distinct form (Ehmann pers. comm.).

The Plains Lashtail *Amphibolurus burnsi* formerly known as *A. gilberti* occurs in the Cooper Basin. It is arboreal and has a preference for coolibahs (Ehmann pers comm). A Red Tailed Skink was recently found at sites on the Merninie Land System, a new record for the State.

The Red-naped Snake and Black-headed Goanna and Woma python occur in the reserve. These species are considered rare in South Australia and at the national level. The Inland Taipan is known from cracking clay soils of the lower Cooper basin flood plains and some other inland areas (Cogger 1993, Hutchinson pers. comm.).

Frogs

Ten frog species have been recorded in the reserve, a rich frog community for central Australia. The Marbled Frog, Red Tree Frog and Desert Froglet are the most widespread. The Desert Froglet and the Green Tree Frog only occur in South Australia in the Innamincka Regional Reserve with the remainder of their populations being found upstream in Queensland. Gunther's or Broad-palmed Frog is considered to have conservation significance. Other species are *Limnodynastes spenceri*, the Water-holding Frog, Trilling Frog, a Burrowing Frog (*Cyclorana cultripes)* and an undescribed species of *Uperolia*.

Aquatic Invertebrates

Although not systematically sampled, the macro-invertebrate fauna of Coongie Lakes appears to have comparable species richness to that of the better known River Murray. At a higher taxonomic level, 46 macro-invertebrate families have been identified. Sponges are common throughout the system and molluscs are also widespread with the mussel *Velesunio wilsonii* particularly common in the lakes. Gastropods, *Austropeplea lessoni* and *Physastra gibbosa* are abundant in the littoral zone of channels. *Macrobrachium australiense* is the dominant crustacean in frequently flooded areas.

Little is known of the plankton and micro-invertebrate fauna of the Cooper channel as a whole, but sampling of Coongie lake and the adjacent channel contained 42 rotifer species, 12 cladocerans, 4 copepods and 3 protozoa. There were a further 18 taxa identified only to genus.

2.4 Cultural Features

Aboriginal

Prior to the 1930s the Yandruwandha, Yauraworka and Dieri people lived in the area now known as the Innamincka Regional Reserve.

Early European accounts indicate that the region was densely settled. The banks of Cooper Creek are described as lined with huts, graves and well-trodden paths with permanent camps established at the more reliable waterholes. People moved up and down the creek channels and between lakes during flood cycles exploiting the abundant resources of the wetlands. Fish, turtles, waterbirds, mussels and frogs were all eaten together with a range of marsupials and reptiles. There are detailed accounts of the range of waterbirds exploited and descriptions of the nets and weirs used to trap fish, yabbies and waterbirds. Grass, acacia and nardoo seed were also important food sources, ground to a paste using grindstones available from local quarries. Early observations suggest large animals such as kangaroos and emus were scarce in this region (Nicholson 1998).

In some areas, rock outcrops show utilisation as grindstone quarries and stone tool manufacturing sites. The grindstones made from these sites were highly valued and used in an extensive trading network with other Aboriginal groups.

As the reserve has not been extensively impacted by development, many of the cultural heritage sites are still intact. Many of these sites and areas are significant according to criteria under the Burra Charter 1987, *Aboriginal Heritage Act 1988* and the Register of the National Estate.

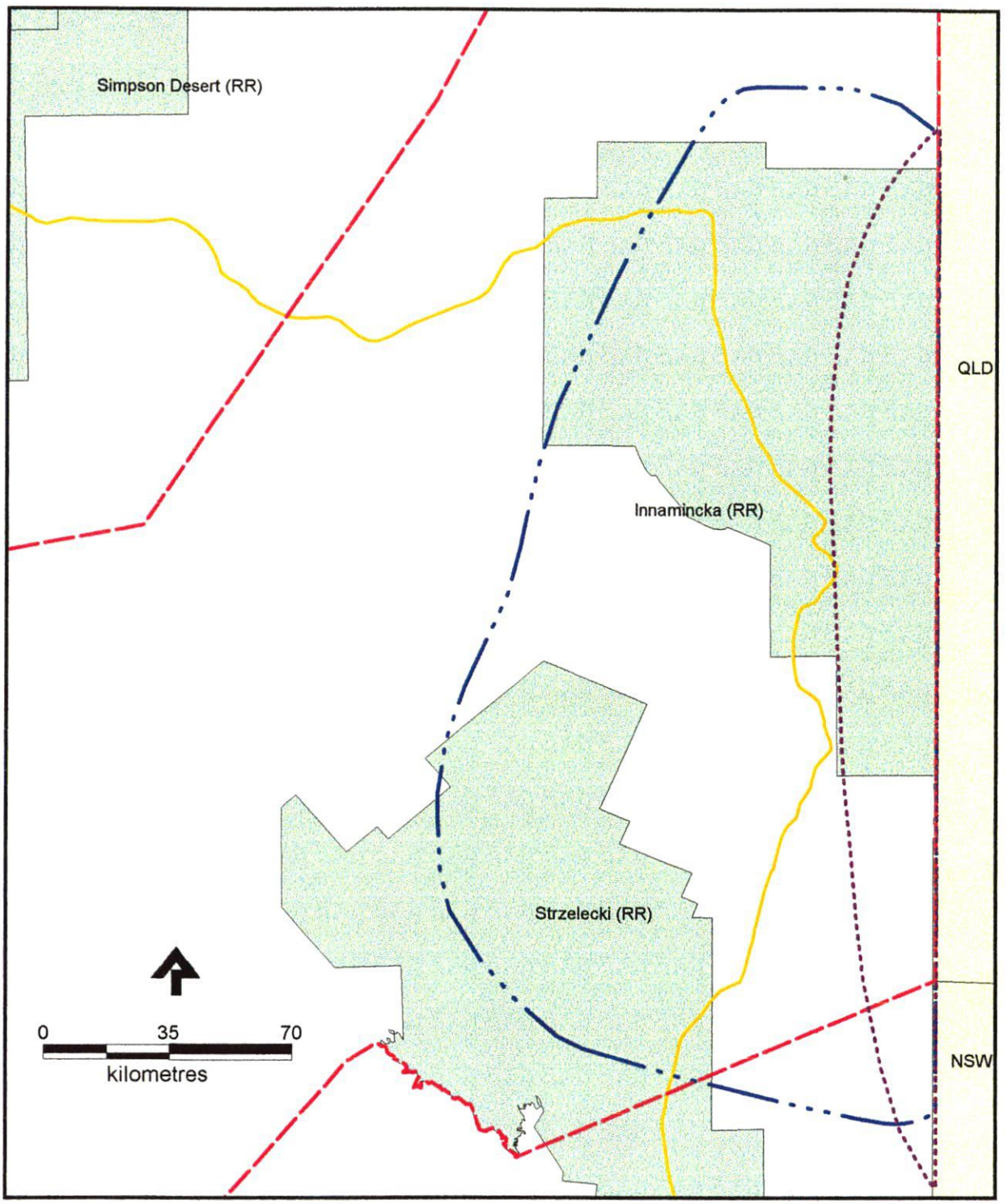
Article 1, section 1.2 of the Burra Charter identifies significance through scientific and social values. This states that 'cultural significance means aesthetic, historic, scientific or social value for past, present or future generations'.

The *Aboriginal Heritage Act 1988* provides protection to Aboriginal sites, objects and remains that are of significance according to Aboriginal tradition or of significance to Aboriginal archaeology, anthropology or history. The Register of Aboriginal Sites and Objects pursuant to Section 9 of the *Aboriginal Heritage Act 1988* lists 127 registered sites for the reserve. Recorded site types include archaeological sites (occupation sites), burials, art sites, tool manufacturing sites, grindstone quarries, remains of wiltja, historic and prehistoric campsites, and stone arrangements. The majority of these sites were recorded between 1982 and 1986 and are near Innamincka and at Coongie Lakes. Several hundred more sites have been reported to the Division of State Aboriginal Affairs but these have not been assessed for addition to the register. Therefore the register cannot be considered to be an indicator of the distribution of sites in the reserve as a whole

As a result of contact with Europeans, Yarrawarka, Yandruwandha and Wangkumura people congregated around the township of Innamincka at about the turn of the century. A number of the burials in this place contain the remains of known individuals and are thus important to local Aboriginal communities. In 1991 this area named 'Innamincka Aboriginal Sites' was registered on the Register of the National Estate. This place was an important focus for Aboriginal settlement, especially in the historic past. It contains a rich collection of sites including, a campsite, mythological/ceremonial site, a quarry, as well as the burial sites

There are at present four Native Title claims over some or all of the reserve (see Figure 4):

- Dieri Mitha SC 95/002
- Dieri/Yandruwandha SC 97/004
- Yandruwandha SC 98/001
- Wangkumara SC 98/044



Legend

- SC 95/002 Dieri Mitha
- SC 97/004 Dieri/Yandruwandha
- SC 98/001 Yandruwandha
- QC 98/044 Wangkumara
- National Park and Wildlife Act Reserves

Map Produced from PAMS, Reserve Planning, Heritage and Biodiversity, DEHAA
Projection: Longitude / Latitude (AGD 66)
Date: October, 1998
Path: R:\richter\maps\general\jennyB.wor

DEHAA
Department for Environment, Heritage and Aboriginal Affairs

Figure 4 Native Title Claims over Innamincka Regional Reserve

Non-Aboriginal

The first European contact with the area was with the explorers and later in the establishment of the pastoral industry, transportation and the settlement of Innamincka.

The first European in the area was Captain Charles Sturt in 1845, at the time Surveyor-General of South Australia. Sturt ventured up the Strzelecki Creek, which he named after the Polish explorer, and beyond to the Stony Desert, and reached the Cooper, a 'magnificent channel covered with waterfowl'. He named it after Charles Cooper, later South Australia's first Chief Justice.

Cooper Creek became well known to the colonies in 1861. It was here that Howitt discovered the bodies of the missing explorers Burke and Wills after their ill-fated expedition to the Gulf of Carpentaria. Howitt marked the places where he buried Burke and Wills by blazing nearby trees. Another search party, led by John McKinlay from Adelaide, discovered non-aboriginal human remains at Lake Massacre, north of the Cooper Creek area. McKinlay assumed that Aborigines had murdered the whole Burke and Wills party.

The first pastoral enterprises established in the area were by Robert Bostock in 1873 and in 1874 by Henry Colless and Joseph Becker. Colless built a house on the south bank of the Cooper near where Burke died. Hector and Norman Wilson took up the Coongie Lakes area in 1875. The station, called Land of Promise, was stocked with 1 000 head of cattle and 1 000 head of sheep (Tolcher 1986).

The long and dramatic pastoral history of the area, recorded in art, poetry and history, is a significant part of the cultural heritage of the region and Australia.

The settlement of Innamincka was surveyed as a town in 1890 and named Hopetoun and soon renamed Innamincka after public outcry. The town provided services and supplies to the local population and droving teams travelling with stock from the north to southern railheads at Farina and Marree in South Australia. The township consisted of a hotel, store, police station, blacksmith and later Australian Inland Mission (A. I. M.) Nursing Home.

Following droughts and floods in 1949-50, the township was abandoned. The A. I. M. Nursing Home closed in 1952 followed by the closure of the police station. Innamincka township was deserted until 1971 when an aluminium-cladding store and hotel were erected near the ruin of the nursing home. An increasing number of tourists many of whom are interested in the area's links to the Burke and Wills expedition of 1860-61 now visit the area, and Aboriginal sites (Iwanicki 1984).

The annual Innamincka picnic race meeting is attended by local people and many visitors and has become an outback South Australian 'bush icon'. The picnic races and pastoralism are part of the non-aboriginal cultural heritage of the region.

The significance of the European settlement of the area is recorded on the State Heritage register. The places listed on the register are:

1. the former A. I. M. Nursing Home in Innamincka township. This building was renovated as the Regional Reserve office and reopened in 1994.
2. Gray's Tree, Lake Massacre. This tree is believed to mark the site of the death and burial of Charles Gray on 17 April 1861. It is one of only two known and tangible pieces of evidence in South Australia of the Burke and Wills Expedition.

3. Innamincka Cooper Creek State Heritage Area. Sites within this area related to the fate of Burke and Wills include:

   - Burke's Tree near Innamincka marks the vicinity where Howitt found Burke's body buried. The body was later exhumed for a hero's burial in Melbourne in January 1863. Sand drift has covered the trunk of this tree bearing the large blaze. A fence was erected around the tree by a local station manager in the early 1900s and remains today. The Barrier Field Naturalists Club of Broken Hill erected the nearby cairn in the late 1930s.
   - The site of Wills' Tree, near which Wills died in a wurlie, and where King buried him with sand and rushes. Howitt's party collected the remains and interred them at this site. This tree does not appear to exist any longer.
   - A recently erected cairn, and tree blazed with King's name (a later event also) mark where King was discovered by Howitt. This tree was broken and killed in a windstorm in 1987. The remains of the tree trunk were pieced together and mounted on a base and reinstalled at the site in 1989.
   - The site of Howitt's camp by Cullyamurra waterhole has been marked by a cairn erected on the basis of information from Howitt's Journal.

Several places within the reserve are listed also on the National Estate. National Estate listing means that the place has heritage value of national significance.

Listed on the National Estate in the historic class are:

- Location of Gray's Death site, Lake Massacre near Innamincka SA
- Location of Burke's Memorial, Innamincka SA; a tree blazed by explorer J. McKinlay.
- Location of Wills Monument and Blazed Tree, Innamincka SA.
- Location of tree blazed by surveyor Howitt, Innamincka SA
- Location of Australian Inland Mission Nursing Home, Innamincka SA
- Innamincka Historic Reserve which includes Aboriginal rock engravings, campsites and graves and the first gravesite of Burke.

2.5 Resource Utilisation

Petroleum

Innamincka Regional Reserve is underlain by the largest and most prolific hydrocarbon province on onshore Australia. These hydrocarbon fields supply natural gas to large parts of southeastern Australia, including the Adelaide, Sydney and Canberra regions, and liquid petroleum products (1.3 million Kilolitres in 1997) are piped to, then exported from, Port Bonython on Upper Spencer Gulf.

The reserve overlies 41% of the South Australian portion of the Cooper Basin and overlying Eromanga Basin (Figure 5). It is estimated that the reserve covers 27% of the known remaining sales gas reserves of the Cooper Basin within South Australia. An estimate of the remaining recoverable oil reserves is not available. This resource is strategically important for the future energy requirements of South Australia New South Wales and potentially Victoria.

The entire Reserve lies within Petroleum Exploration Licenses (PELs) 5 and 6. Santos Limited in conjunction with Delhi Petroleum, have held the area under licence since 1954, and are the operators of PELs 5 and 6. In February 1999, PELs 5 and 6 will be relinquished, at which time it is likely that a number of different operators may move into the region and take up petroleum exploration options.

The *Cooper Basin Ratification Act* Indenture provides for rights to convert PEL 5 and 6 acreage to PPLs as well as installation of gathering pipelines (flowlines) and plant. The Subject Area of this Indenture covers 49% of the reserve (6729 sq km) and the southern portion (0.1%) of the Coongie Lakes Control Zone (1 sq km) (Figure 4).

There is currently no significant mineral exploration or production within the reserve.

Development

Seismic Survey

During the period 1/1/89 to 1/1/98, a total of 9790 km of two dimensional (2D) seismic lines were recorded within the reserve. Prior to proclamation of the reserve 18 382 km of 2D seismic had been recorded in the area now defined by the reserve. Three dimensional (3D) seismic surveys over the reserve for the period 1/1/89 to 1/1/98 totaled 1034 km^2. Prior to 1/1/89 there was no 3D seismic recorded over the reserve. Coverage of 2D and 3D seismic surveys within the reserve are shown in Figures 6 and 7.

Drilling

Prior to 1/1/89, there were 228 wells drilled within the Innamincka Regional Reserve. In the ten year period since the gazettal of the reserve, 125 wells were drilled (Figure 11). These comprised:

- 54 exploratory wells
- 34 appraisal wells, and
- 37 development wells.

About 350 well sites are present within the reserve. Drill pads are typically square in shape and approximately 100 m by 100 m in size. Therefore the total area covered by these well sites is about 0.03% of the total area of the reserve. For each well site a rig access track is built.

Production

As at 1/1/98 there were 51 Petroleum Production Licenses (PPLs) covering an area of 3 963 km^2 within the reserve compared to 18 licenses covering 871 km^2 as at 1/1/89 (Figure 8). An additional eight Petroleum Production Licence applications (PPLas) are registered over the reserve.

As at 1/1/98 there were 112 wells within the reserve producing gas from 32 fields. There were also 16 wells producing oil from six fields.

There are currently 286 km of gas pipelines and 130 km of liquids pipelines within the reserve (Figure 9), as well as a significant amount of gathering pipeline (flowlines from individual wells).

There is a total of 2 107 km of roads within the reserve (as at 1/1/98), compared with 1 309 km as at 1/1/89. These roads make up access tracks to well sites, pipelines, trunklines, flowlines and satellites (Figure 10).

There are nine satellite production plants within the reserve, the more significant being the facilities and camps at Bookabourdie and Dullingari.

Figure 5 Petroleum Industry Features Location Plan

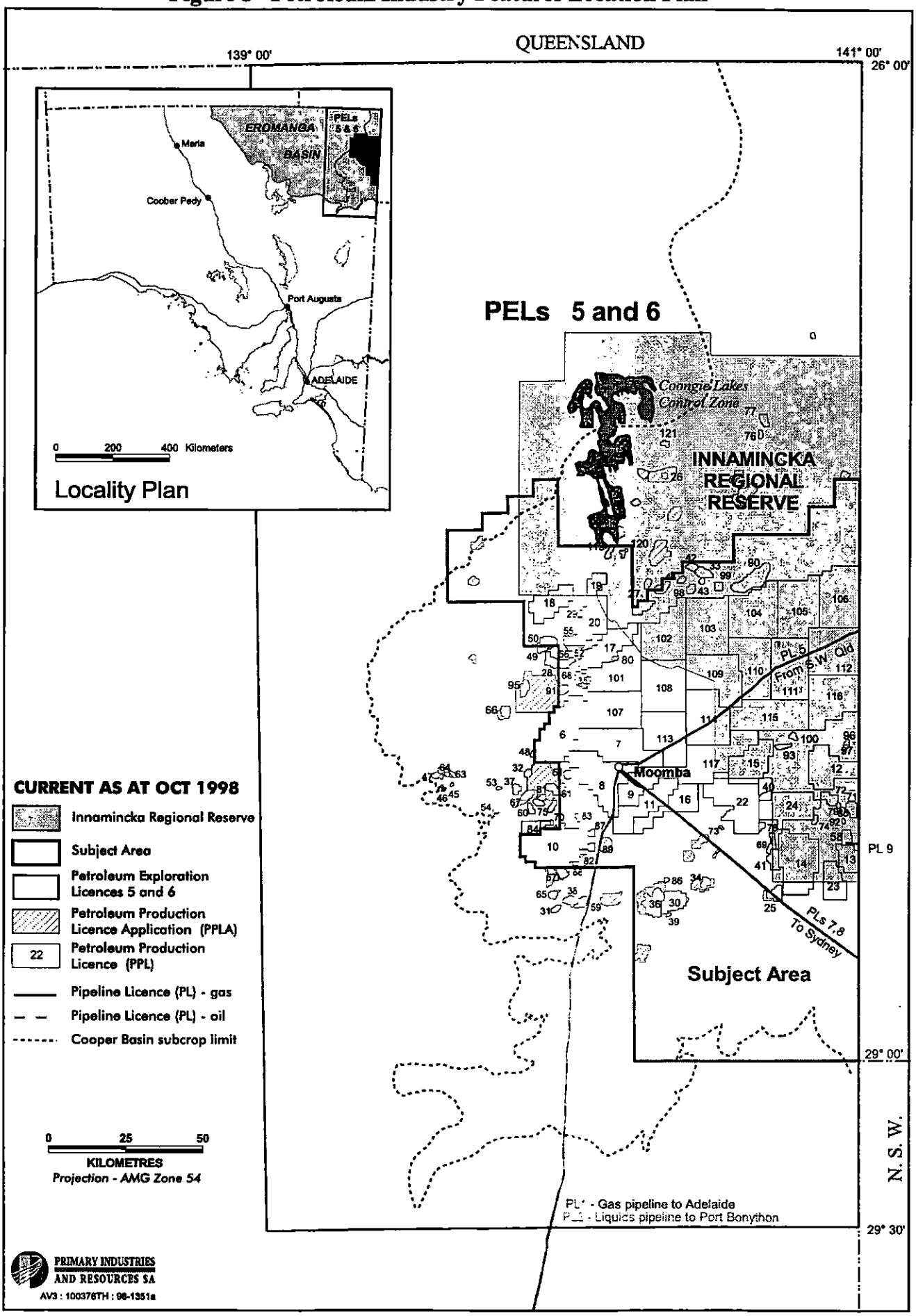
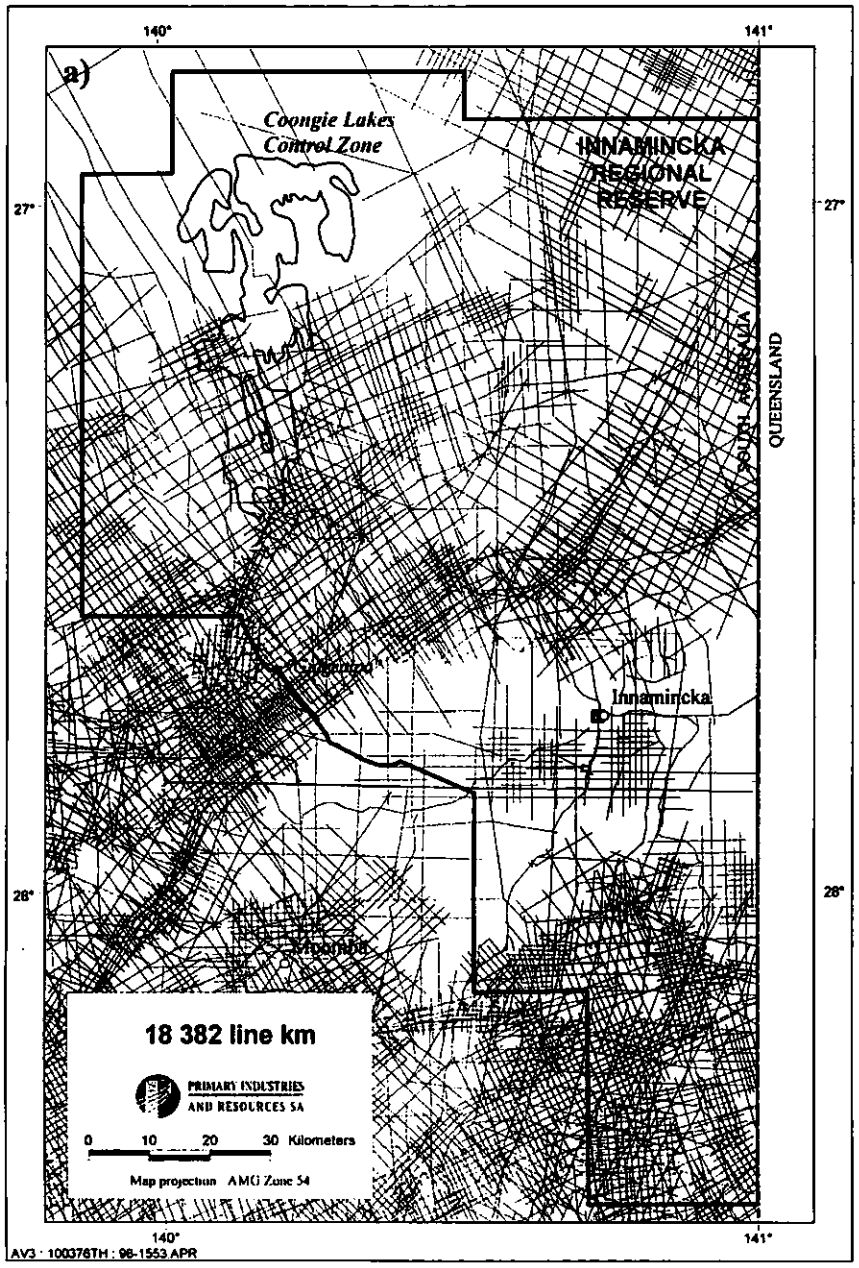


Figure 6 Innamincka Regional Reserve - 2D Seismic Line Coverage

1st Jan 1989



1st Jan 1998

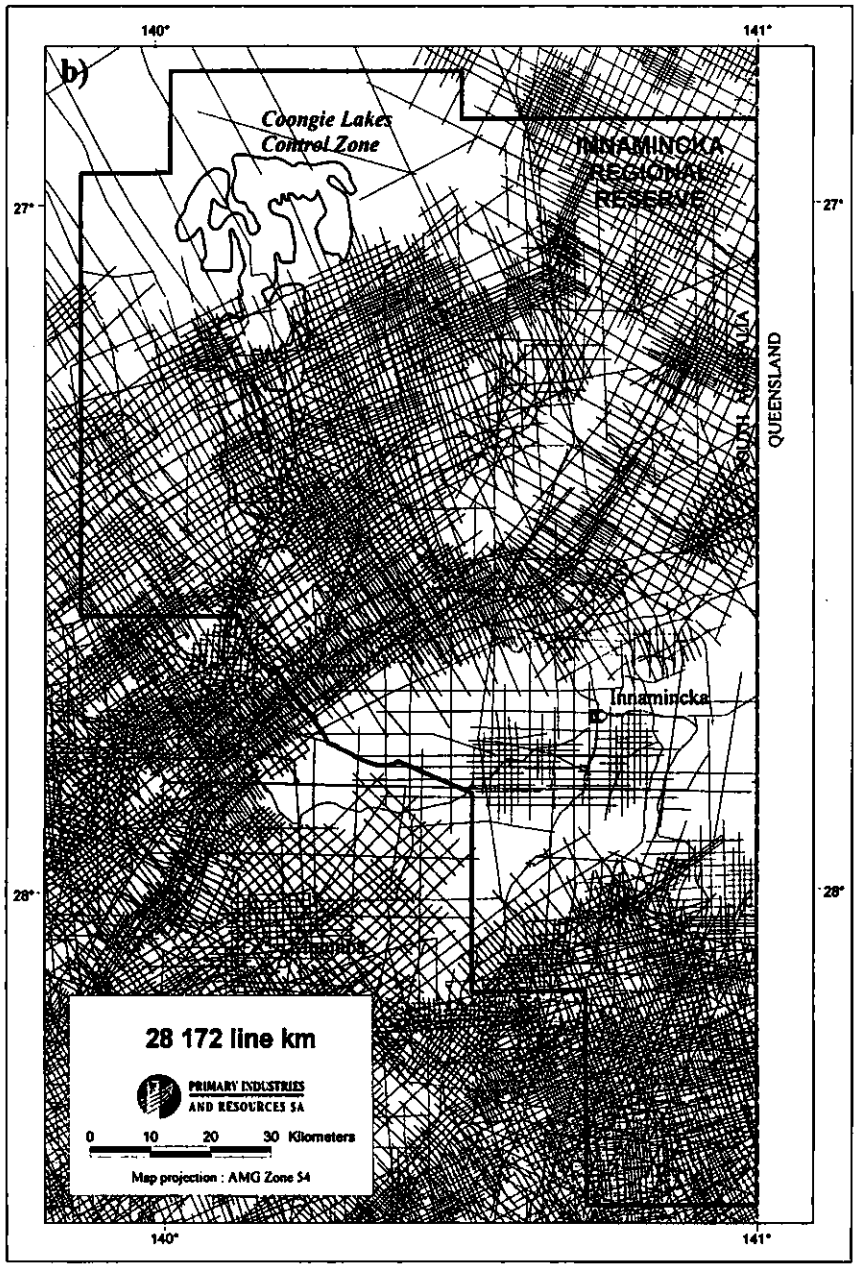


Figure 7 Innamincka Regional Reserve - 3D Seismic Line Coverage

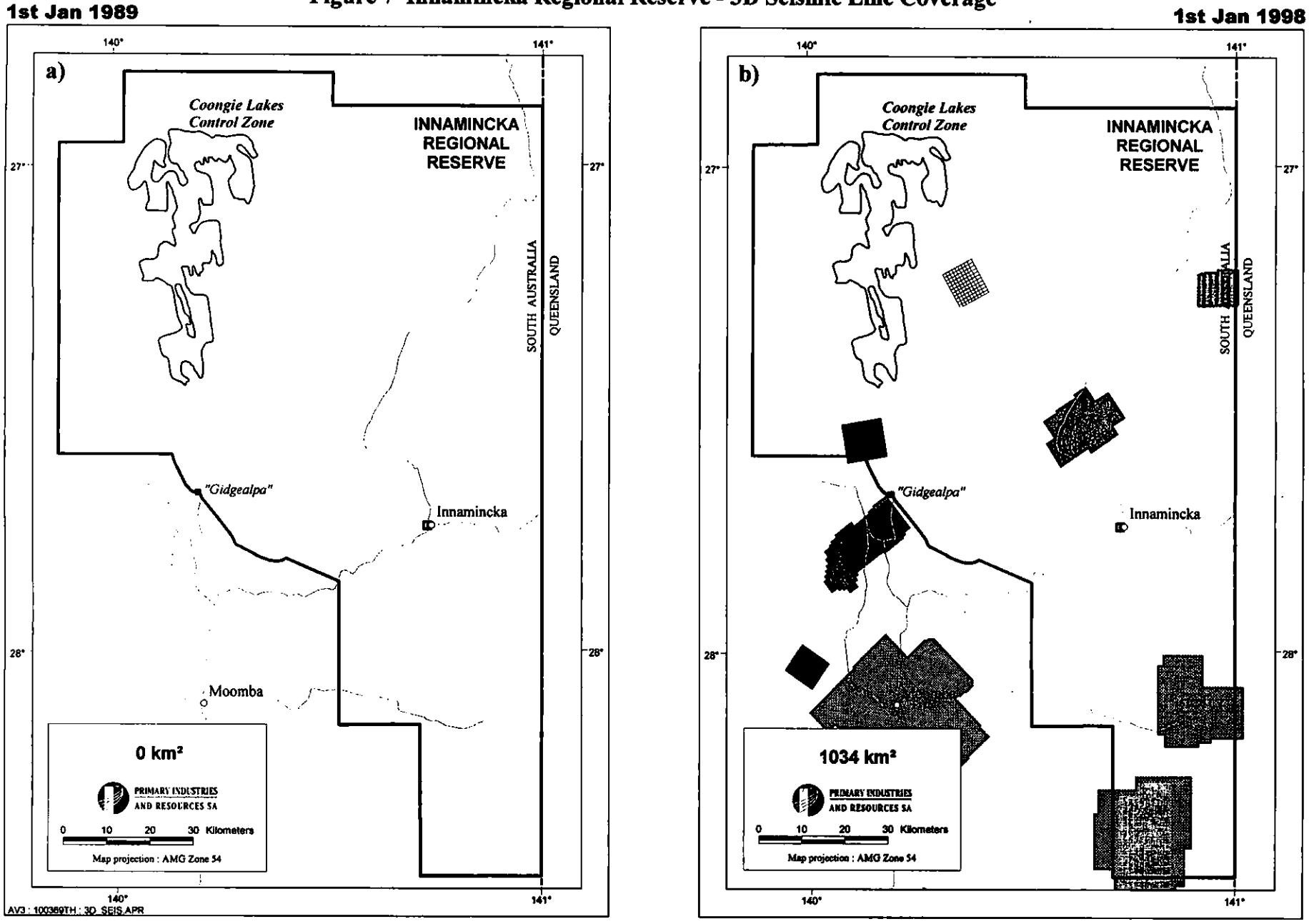


Figure 8 Innamincka Regional Reserve - Petroleum Production Licences (PPLs)

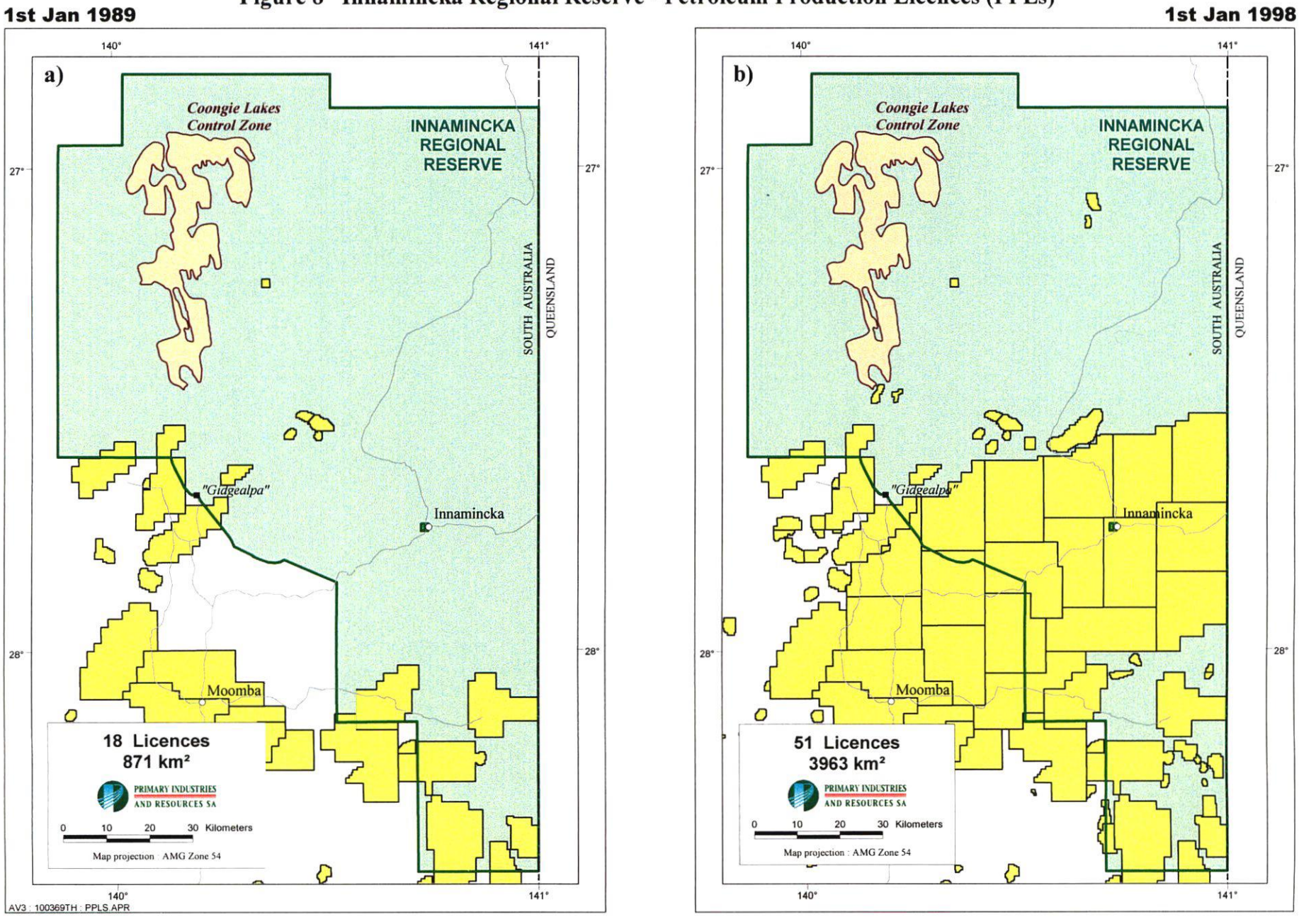
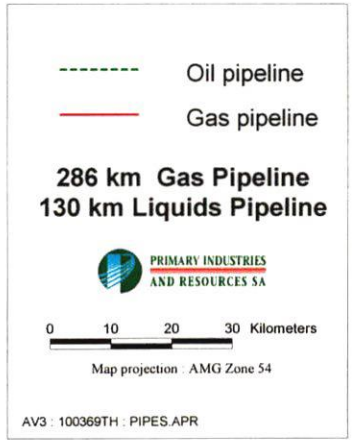


Figure 9 Innamincka Regional Reserve - Petroleum Gas and Liquids Pipelines



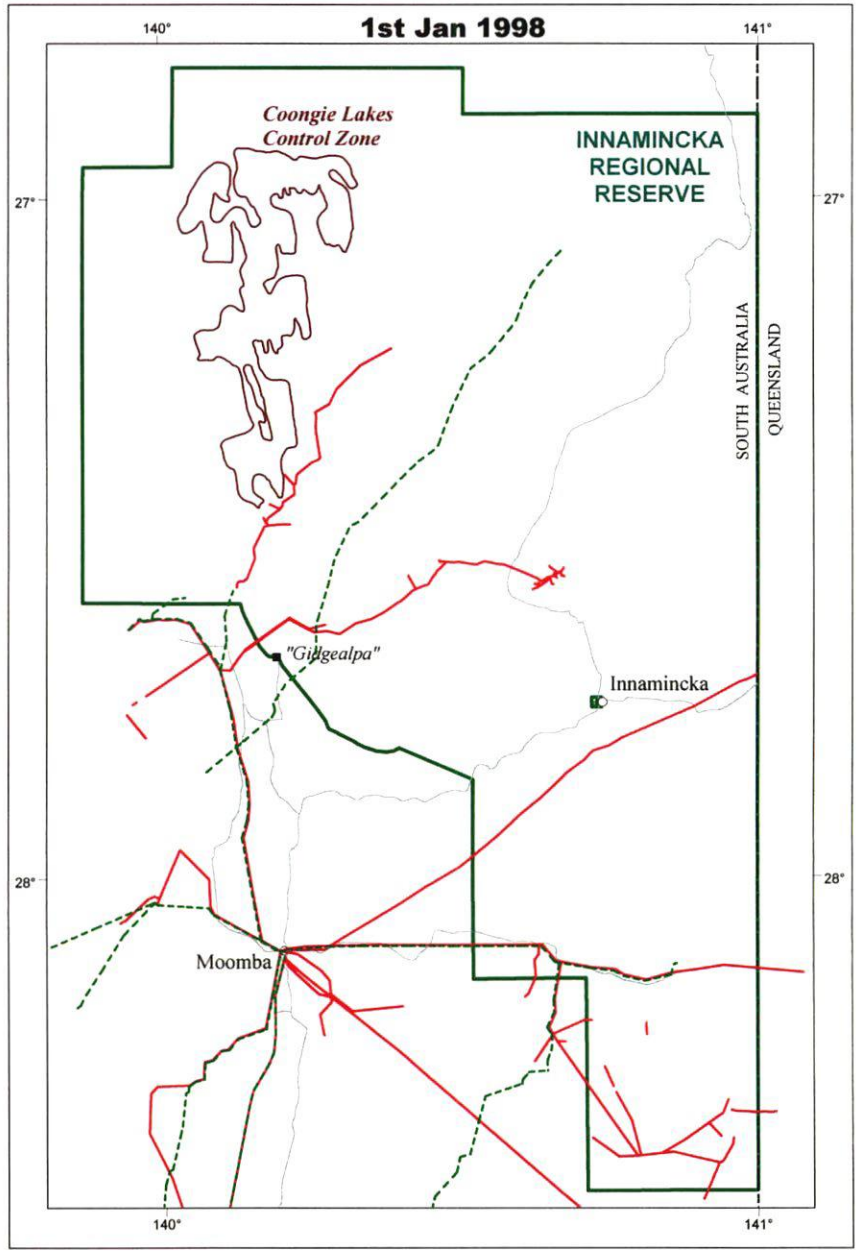
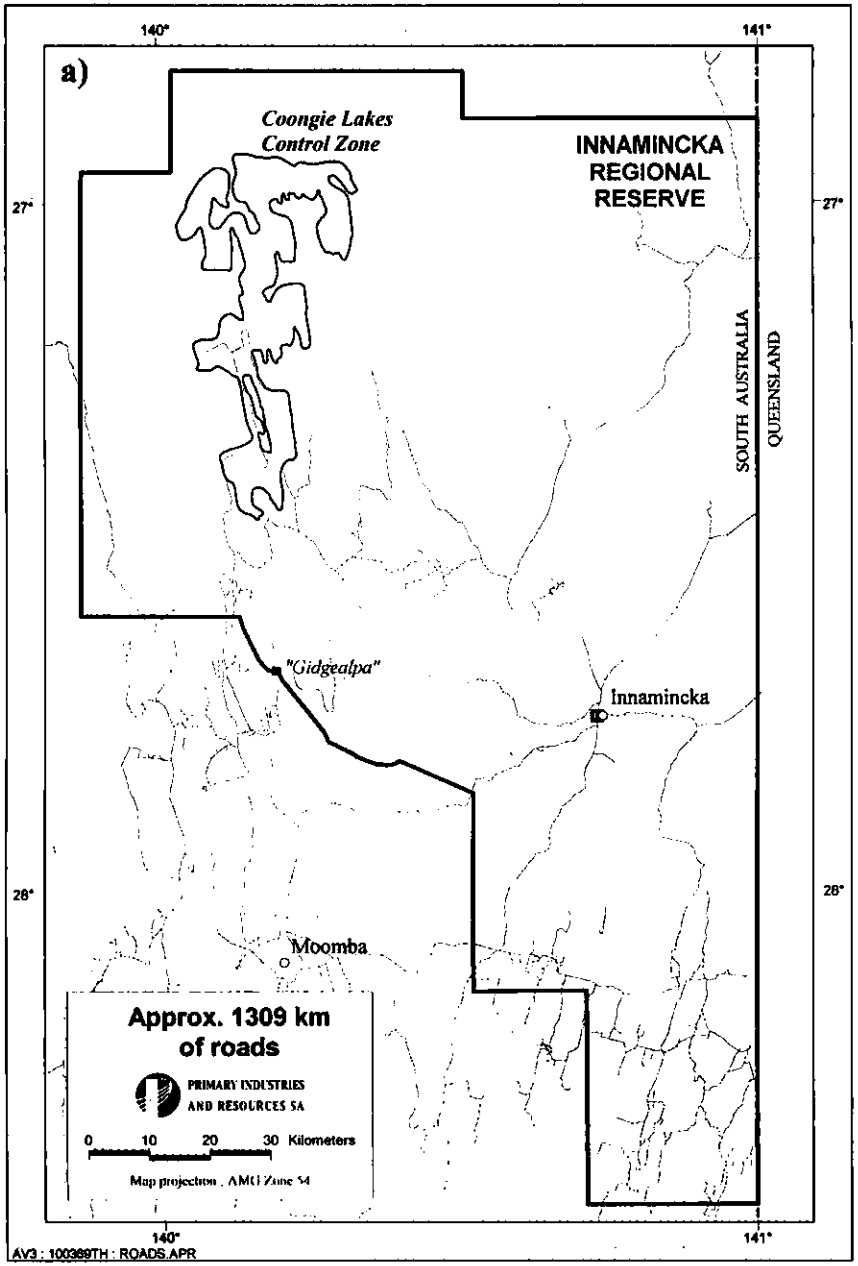


Figure 10 Innamincka Regional Reserve - Roads and Tracks

1st Jan 1989



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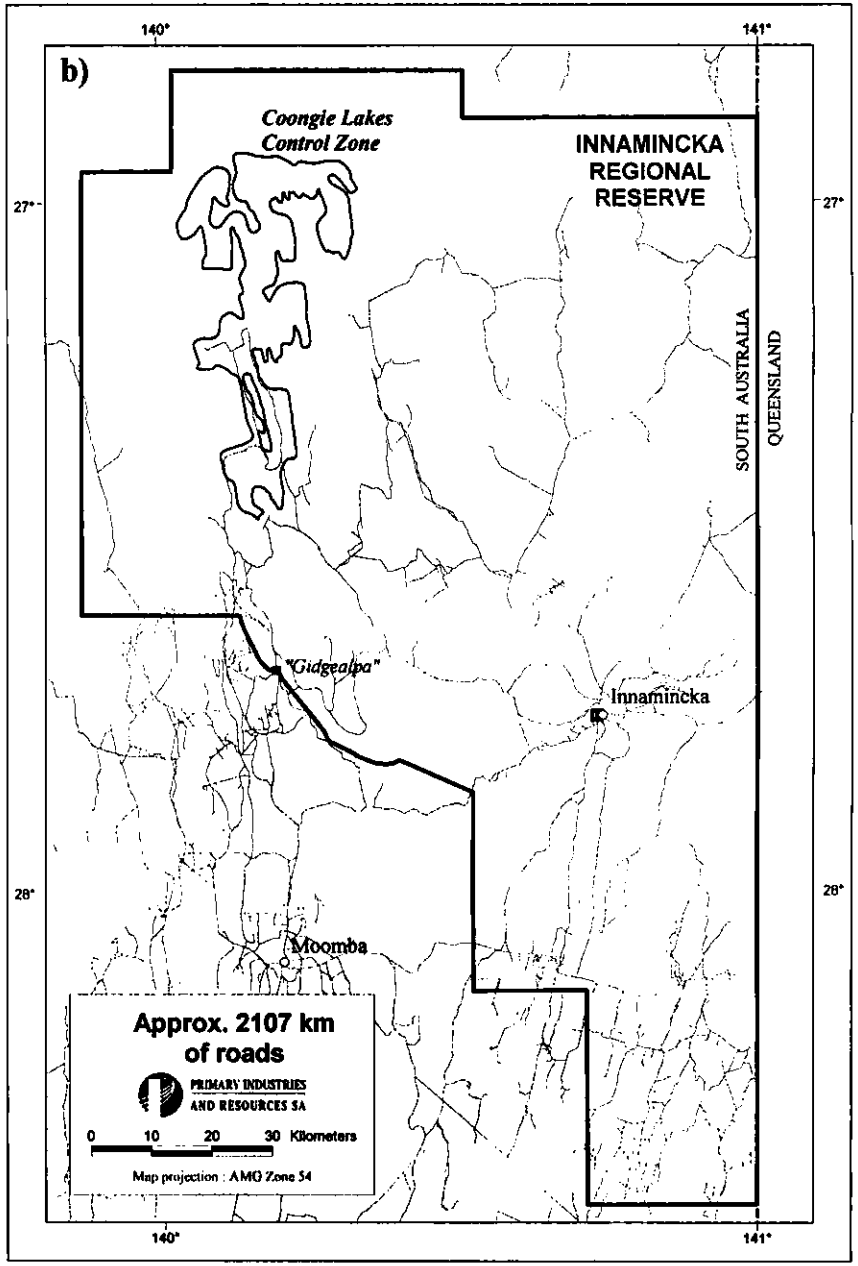
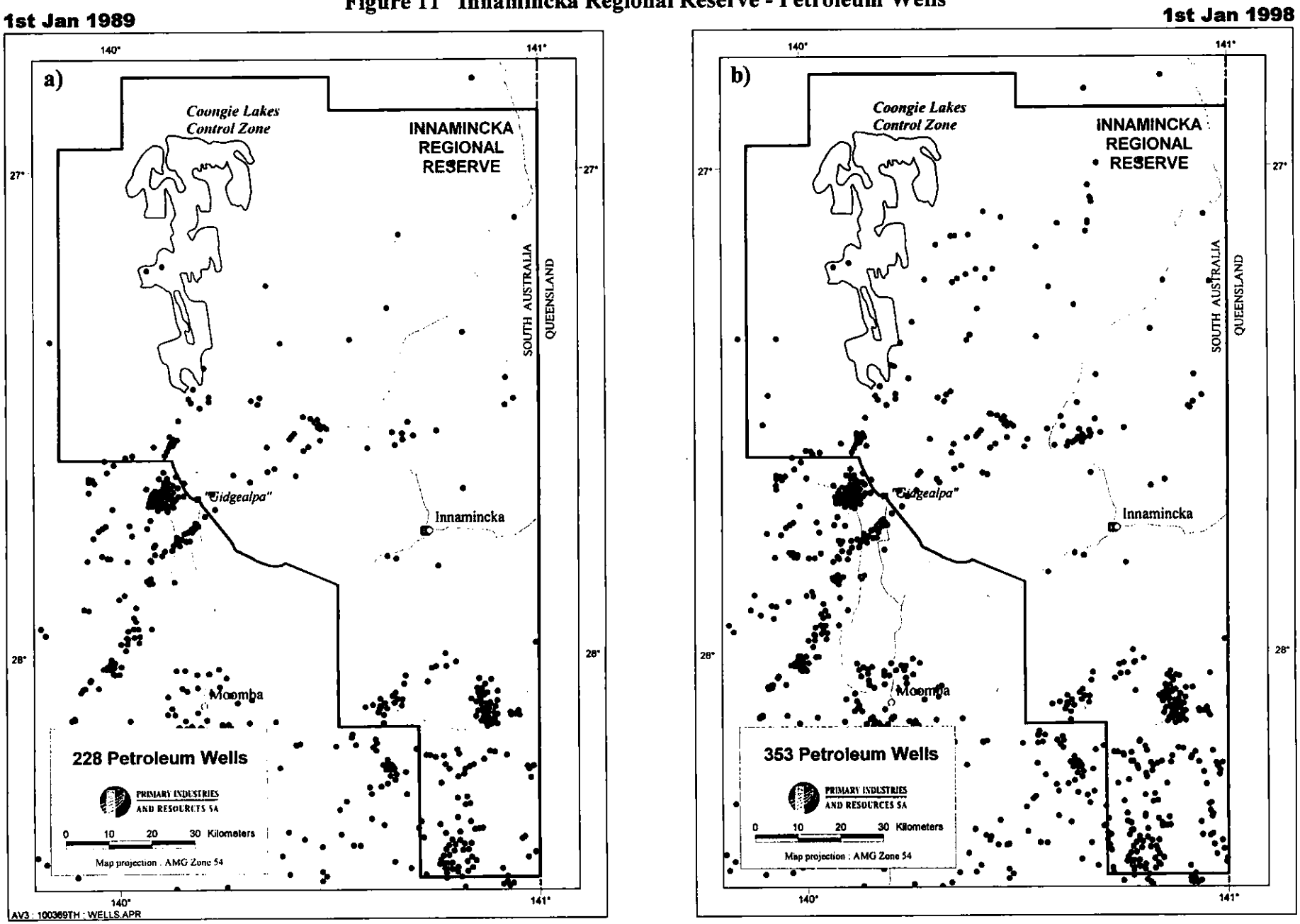


Figure 11 Innamincka Regional Reserve - Petroleum Wells



Tourism

Estimates of visitor numbers to Innamincka show increasing visits fluctuating with seasonal conditions.

In 1985 the number of visitors to Innamincka township was estimated to be 5 000 by the storekeeper at the time (Steel pers. comm. in Freeth 1986). In the year 1986 visitor numbers calculated as a proportion of petrol sales, were estimated to be 15 891, staying 35 124 visitor days. In the ten months from January to October 1987 similar calculations estimated visitor numbers to be 24 460 staying 54 061 visitor days (Gillen in Reid and Gillen 1988).

The doubling of visitor numbers between 1986 and 1987 is attributed to media coverage resulting from environmental research at Coongie Lakes and the proposal to proclaim Innamincka as a Regional Reserve. At the time of the survey 88 of the people present were researchers!

Other visitor surveys identified 243 vehicles and 1 152 visitors during a three week survey during May 1986, 369 visitors in 9 days of survey during September 1990 (Black 1990) and 950 visitors during a six day survey period in April 1992 (Donato 1992). In 1990 visitor numbers were said to be low as recent flood waters had only recently receded, making Coongie Lakes inaccessible; and fuel prices were high at the time due to the crisis in the Middle East (Steel pers. comm. in Black 1990). Over 14 days in October 1995 a 4WD Association campground host at Coongie Lakes was surprised to see just 150 vehicles in the area and only about 50 of these established camp in the area.

The high season for visitors is from Easter to October and peak tourist times the autumn, winter and spring school holidays. During the hot summer months visitor numbers are low. Visitor numbers also fluctuate with seasonal conditions, drought seasons attracting fewer visitors than post flood periods when water levels are high and the birds and fish are plentiful.

Most people are on recreational visits to Innamincka, though there is a significant amount of traffic through the reserve for pastoral, petroleum and Government business. During recreational visits activities and interests identified by the survey, include visiting sites of European history particularly the sites of the Burke and Wills expedition, Aboriginal archaeological sites, art or photography, relaxing and fishing. The survey indicate that nearly all visitors visit the markers of Burke's grave, Wills' grave, Gray's marker, and the dig tree about 15% of respondents traveled to Coongie Lake.

The most popular camping sites are the Town Common and Cullyamurra Waterhole with other sites along Cooper Creek such as Burke's, Wills' and King's Markers and Ski Beach also being popular. Some visitors camp at more than one locality. About 12% of visitors use campsites at Coongie Lakes. The major influence in the selection of campsite is privacy (45%) followed by suitable access (18%); 14% of respondents returned to campsites they had used on a previous visit.

Most visitors stay in the reserve less than one week, however a significant number of visitors stay a fortnight (Black 1990).

A voluntary visitor survey between April 1995 and October 1998 has shown 32% of respondents traveled from Victoria, 28% from New South Wales and 21% from South Australia. Most visitors travel as private or family groups (90%) followed by 6.5% travelling as clubs. The dominant form of transport is the four-wheel-drive vehicle 89%, with 4% of visitors travelling by two-wheel-drive vehicle and a further 3% by bus.

Development

Much effort has been dedicated to changing the image of the area from a last frontier where shooting and fishing were unregulated, to an area where the high conservation significance is respected. Prior to reserve proclamation camping was indiscriminate, rubbish was strewn around, there was damage to significant trees, vehicles pushed into the creek causing bank damage and erosion, and every camp appeared to have a dog, motor boat, generator and chainsaw (Dahl pers. comm. 1998).

Since 1989 visitors have been required to have a Desert Parks Pass (DPP) or camping permit to enter the reserve away from the township of Innamincka. Compliance has been enforced by regular ranger patrols. The DPP track marking system has created a self-guided tour of marked tracks providing ecological information to increase awareness of the diversity of vegetation and develop respect for the area, and to encourage the use of existing tracks and camping areas.

The installation of low line fencing and well-defined windrows along tracks has reduced the amount of track proliferation in the area. Low line fencing has been established at Coongie Lake, Ski Beach, Policeman's Beach, Cullyamurra Waterhole and Burke's Grave camping and day visitor areas.

Toilets have been established at Coongie, Cullyamurra and Burke's camping areas and are under construction at Ski Beach, Policeman's Beach and Town Common camping areas.

The area is patrolled for illegal netting of fish and hunting; guns and hunting are prohibited due to the reserve status, chainsaws are banned in the reserve, and visitors have been encouraged to bring and use gas stoves rather than have large campfires that consume fallen timber.

Over a dozen tour operators offer a range of tour options including four-wheel-drive, bus or fly-in fly-out and tag-along tours. There is also a Cooper Creek cruise tourist operation.

Pastoralism

The Innamincka Pastoral Company, owned and managed by descendants of Sir Sydney Kidman, has held grazing rights at Innamincka since 1904. Although there have been changes to the actual land area held and grazed, the Kidman interests at Innamincka are long established.

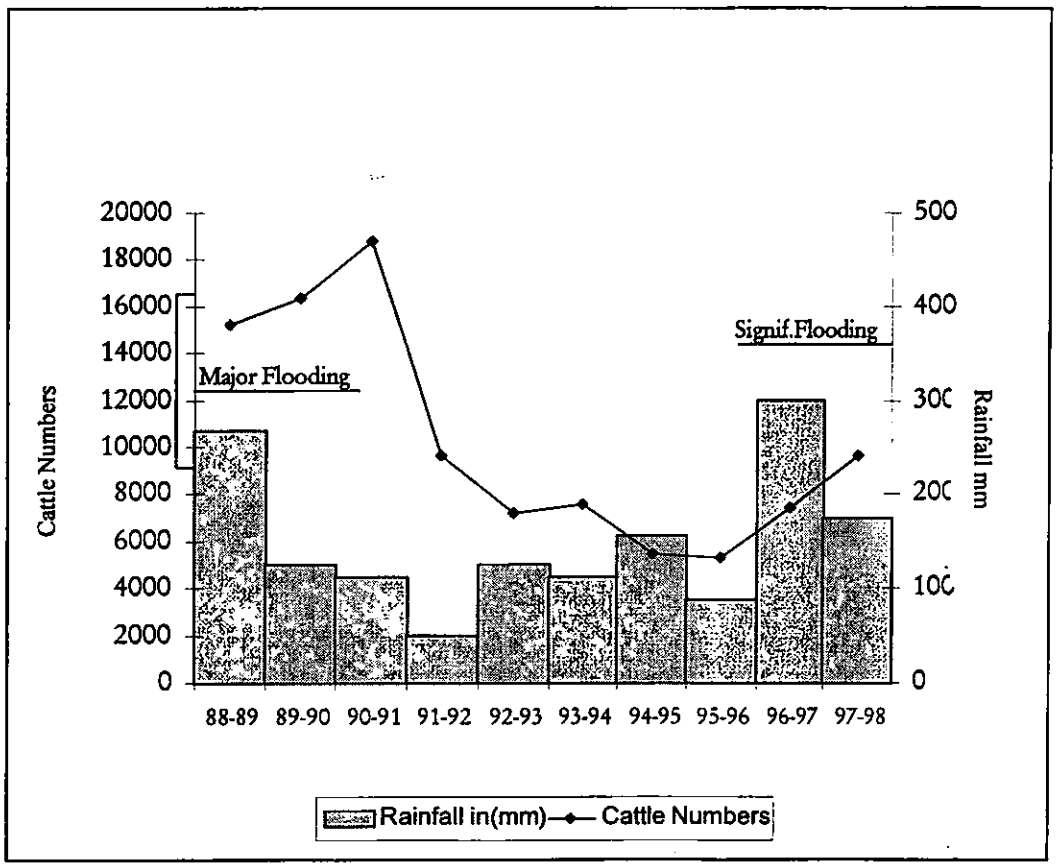
The permanent waterholes in the Cooper were a focus and resting point for droving mobs of cattle for 90 years, until in the early 1960s. On a number of occasions the absence of permanent water along the Strzelecki Track trapped cattle herds at Innamincka. It is said that on at least one occasion, 15 000 head of cattle perished on the Cooper Creek frontages at Innamincka. Such instances caused substantial degradation, some of which are still evident today as large scalded surfaces (Campbell 1994).

A significant proportion of the present day beef production has been exported. The high quality of the floodplain pastures allows the production of premium, chemical free beef, which sells into both the Australian and international premier beef markets. Stock numbers reached 19 000 head in 1991 and were reduced to 7 500 in 1992 (Campbell 1998).

Innamincka and Kidman's remain substantially connected in the pastoral folklore of South Australia, and continue to be important contributors to the regional economy and to the present day management of the Innamincka Regional Reserve (Campbell 1998).

Development

Figure 12 charts cattle numbers and annual rainfall for Innamincka Homestead.



Stock numbers rose from around 14 500 head in 1988 to 19 000 head in 1991 following good seasons and major flood events during that period. In the absence of follow-up rain or further flooding, and the decline in pasture production and quality with the onset of hot weather in late 1991 stock numbers were reduced to 7 500 head by mid-1992 and held at about that level until late 1995. The herd had increased to approximately 10 000 head at the time of the 1997 assessment.

Grazing Intensity

The grazing intensity each area of the reserve experiences is dependent upon how many stock are watered in a particular area for how long and under what climatic circumstance - as well as whether or not the land type is favoured by stock. As this level of understanding and detail is beyond the scope of this review the distribution of pastoral developments and potential grazing intensity as shown in Figure 13 is based upon simple assumptions. The area of the reserve within each land system which is potentially subject to three levels of grazing intensity was estimated by describing grazing zones around each of the permanent or near permanent water points. These water points are equipped subartesian bores, waterholes and pumped troughs receiving water from floods more frequently than 1 year in 5.

The grazing zones are circumscribed by selected radii from these waters:

- potentially high grazing intensity = area within 3 km radius from water
- potentially medium grazing intensity = area between circles of 3km and 8 km radii from water
- potentially low grazing intensity = area beyond that circumscribed by 8 km radius

The distribution of permanent and near-permanent waters places 50% of the reserve under potentially low grazing intensity, 35% under potential medium grazing intensity and the remaining 15% under potentially high grazing intensity. The distribution of potential grazing intensity within each major land system is shown in Table 1.

Refinement of the assumptions by increasing the radii and adding additional waters would alter the areas within each potential grazing intensity class. However due to the linear arrangement of many of the waters, most of these changes are more likely to impact the 'high intensity-medium intensity' interface to a greater extent than the 'medium intensity-low intensity' interface.

Cooper Land System

Within the Cooper land system about 47% of the area is within 8 km of permanent or near-permanent stock waters, and potentially subject to 'medium intensity-high intensity grazing. The remaining 53% is well watered during and after flood events of longer than 1 year in 5 frequency. Here grazing intensity is variable because the greater the flood the more the cattle can spread out in grazing the edges of the floodwaters.

Two developments, the Coongie exclosure and the Cullyamurra exclosure, have excluded cattle from near permanent waters. These are now included in the low grazing intensity category, recognising that these areas were subject to high grazing intensities in the recent past.

The Dune Field Land Systems - Marqualpie, Della, Ketietoonga

The Marqualpie and Della dune fields and sand plains have 51% and 57% respectively developed for potentially 'medium intensity-high intensity' cattle grazing. The Marqualpie land system, although having the higher percentage under potentially low grazing intensity has some areas such as the Marqualpie paddock well developed with waters, and others such as the northern portion of the Coongie paddock undeveloped. In this land system the paddocks provide a more abrupt transition from potentially 'medium intensity-high intensity' grazing to potentially low intensity grazing than occurs in the other two land systems.

Much of the Ketietoonga land system lies within the low intensity zone and would be subject to cattle grazing on an infrequent basis.

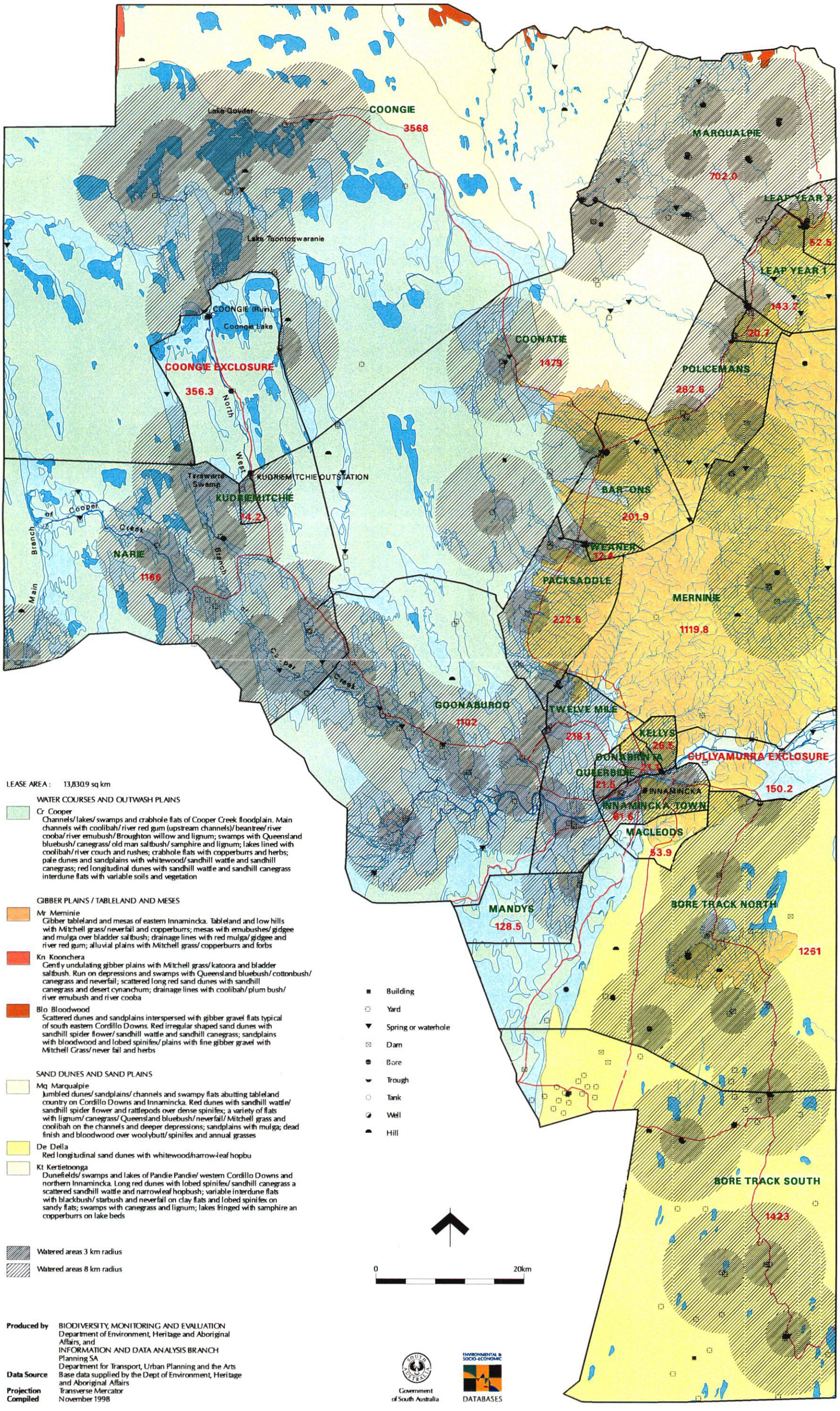
THE STONY LAND SYSTEMS – MERNINIE KOONCHERA AND BLOODWOOD

Merninie land system has 56% of its area developed for potential medium to high intensity grazing. The remaining area is well watered after local rains when gilgais and waterholes are holding water. Koonchera and Bloodwood land systems have minor occurrences in the reserve and are not developed for potentially high to medium grazing intensity.

Table 1 Distribution of Potential Grazing Pressure for Each Land System.

	Potential Grazing Intensity	Area	Percentage Of Land System
Cooper	Low	3614	53
	Medium	2074	30
	High	1156	17
Marqualpie	Low	929	49
	Medium	675	36
	High	290	15
Della	Low	1005	43
	Medium	1070	46
	High	272	11
Kertietoonga	Low	503	80
	Medium	112	18
	High	11	2
Merninie	Low	916	44
	Medium	873	42
	High	300	14
Koonchera	Low	6	100
Bloodwood	Low	17	94
	Medium	1	6
Total Area		13 824	

Figure 13 Innamincka Station Improvements and Grazing Gradients



Property Management Plan

Shortly after the formation of Innamincka as a Regional Reserve, Innamincka Pastoral Company employed a Landcare officer to assist with the development of environmental awareness amongst staff and sustainable management systems for properties for and in the first instance Innamincka Station.

The company prepared a Property Management Plan (PMP) for Innamincka Station in 1994. The PMP aims to help in improving herd quality and output, profit, and pasture conditions on the lease, and to achieve a more comfortable and safer working environment. It acknowledges secondary benefits to the wider community from increased and more stable profits, and from greater biological diversity within the landscape (Campbell 1994).

The most relevant of the company's corporate goals from the PMP (Campbell 1994) for conservation of wildlife and natural and historic features of Innamincka Regional Reserve are:

- to use forage resources in ways which maximise weight gain and calving rates in all seasons, but which ensure the continued productivity for the natural resource base.

A drought decision chart for Innamincka Station has been developed to assist with decision-making with the onset of dry or drought seasons.

- to develop pastoral leases which operate economically and sustainably through adequate development of waters, livestock and land type separation, reduced stress in livestock handling, and comfortable and efficient work environments.

Subdivision of large paddocks such as Coongie, Nari, Coonatie and Callamurra will be needed. This subdivision will be a compromise between the line of easiest or shortest fencing and the desirability of separating distinctly different classes of country.

- to apply and improve pastoral management practices to minimise negative effects on plants, animals and natural processes.

Reducing livestock pressure on the margins of the near permanent freshwater wetlands is undoubtedly the highest conservation priority.

- to recognise that large tracts of pastoral land contain features and provide experiences which visitors seek and value, and where appropriate to grant public access.
- to promote or restrict fire to maintain vegetation diversity and enhance forage quality and quantity.

Campbell (1994) considers that there are no areas on Innamincka where wildfire would be detrimental to the longer term health and productivity of pasture communities, and that the occasional (7-10 year frequency) burn would be advantageous in the Della, and Marqualpie dune systems.

- to improve pasture productivity by controlling or eradicating pest animals and exotic weeds where such actions are economically and practically feasible.

The Spanish flea was released in limited numbers in late 1993 in the hope that the flea would provide a reliable vector for myxomatosis.

A determined effort was recommended to eradicate the remaining populations of donkeys, horses and camels by trapping mustering and shooting. The need for dingo baiting was identified when dingo numbers were high and rabbit numbers were declining or low.

Mexican Poppy has recently been introduced to the region, and the risk of other introductions is high due to the increasing flow of vehicles through the region. The company proposes to maintain a lookout for exotic weeds and to plan and implement control measures in conjunction with NPW staff.

Pastoral Infrastructure

To improve stock management in the Coongie Lakes area the original Coongie paddock was divided east to west through Kudriemitchie Outstation establishing a new southern paddock called Nari Paddock.

New stock waters are Merninie Dam, south of Innamincka No 1 Dam, and Thomson Dam both in Merninie Paddock, and New Bore near Leap Year Bore in Leap Year Two holding paddock.

To improve stock handling a new holding paddock called Mandy's, a dam and trucking facility have been established in the north-east corner of Bore Track North Paddock.

Coongie Lakes & Cullyamurra Waterhole Conservation Exclosures

Coongie paddock had not been stocked for approximately seven years during the 1980s due to the Brucellosis and Tuberculosis Eradication Campaign (BTEC). The paddock was restocked in the early 1990s and destocked in 1994. The paddock was restocked again in the period up to 1997. Ecological surveys of the area identified the ecological significance of the area and the response of vegetation to the reduced grazing pressure. The conservation sector was keen to see continued exclusion of stock from the area.

In 1994 Innamincka Pastoral Company initiated discussions with the South Australian Government proposing the fencing of several lakes at Coongie as well as the important drought refuge of Cullyamurra Waterhole as Restricted Use Units allowing limited stock grazing (after Stafford Smith 1992). After some negotiation the company and the Government entered into a partnership arrangement to fence these areas and manage them as Excised Management Units from which stock grazing would be excluded.

Fencing to exclude cattle from some 45 000 hectares of wetland and associated land types, and provision of alternate stock watering facilities outside these conservation areas began in late 1995 and was completed in early 1996, with stock removed by early 1997 (see Figures 2 and 13).

The area fenced in the Coongie Lakes exclosure (320 km^2) comprises the geographic centre of the Coongie Lakes Control Zone and the Coongie Ramsar Wetland of International Importance reflecting the conservation importance of the area. The area includes Coongie Lake and nearby Lakes Marroocoolcannie and Marroocutchanie, Nawnewauroatawanie Lagoon as well as part of Lake Apachirie. The exclosure also includes approximately 20 kilometres of Northwest Branch channel with several large and persistent waterholes. The wide variety of habitats found within the exclosure reflects the different flooding frequencies and duration of inundation in the different parts of the Cooper floodplain.

Many of the habitats found in the Coongie Lakes exclosure are representative of those found elsewhere in the reserve. These fenced wetlands receive a flow in most years and are therefore considered to be important refugia for both aquatic and terrestrial species, particularly during dry times.

The Cullyamurra Waterhole exclosure (131 km^2) includes approximately fifteen kilometres of Cooper Creek channel and the Cullyamurra Waterhole itself. Cullyamurra waterhole is the largest and most permanent of the Cooper Creek waterholes found in South Australia and is

considered an important refuge for aquatic and terrestrial wildlife, particularly in dry times. A significant proportion of the floodplain country of the exclosure forms part of the Coongie Lakes Ramsar Wetland of International Importance. In addition to significant areas of floodplain country, the exclosure includes two areas of tableland country (Merninie land system) in the northwest and south west of the fenced area.

These two conservation exclosures have been classified as 'Special Interest Areas' under provisions in the Innamincka Plan of Management, and a separate agreement has been signed for their long-term management. The conditions that form part of this Agreement will need to be included in the revision of the Management Plan for Innamincka Regional Reserve.

Reserve Management

National Parks and Wildlife have implemented three major initiatives in the reserve over the last decade. In 1994 the renovated Australian Inland Mission nursing home was re-opened. This building, a ruin since the 1950s was renovated to provide a National Parks and Wildlife office, visitor interpretation centre and ranger accommodation. The renovation was funded by donations from the National Parks Foundation, Australian Geographic and Australian National Parks and Wildlife with matching funding of about $ 320 000 from the State Government.

The State Government's one million dollars Lake Eyre Basin protect program has enabled the implementation of two major initiatives, the development of tourist infrastructure and a conservation fencing program at Coongie Lakes and Cullyamurra Waterhole. These initiatives account for 60% of the LEB protection program funds.

Friends groups and the Parks Volunteer Program have also made substantial contributions to reserve management. The Toyota Four Wheel Drive Club renovated the Kudriemitchie Outstation for use by visitors. Camp ground hosts John Coats and Robin Charlton have provided a presence at Innamincka on behalf of National Parks and Wildlife since April 1991. Ranger staff have located at Innamincka full time since 1995, prior to that rangers were located at Innamincka on a seasonal basis.

3 IMPACTS OF RESOURCE UTILISATION ON WILDLIFE AND NATURAL FEATURES

3.1 Petroleum

Each petroleum operation has a level of environmental impact. Even though these are not viewed as ecologically significant in an overall landscape context, there can be significant local and visual impacts. Community perceptions of the acceptability of such activities and their impacts change over time. At present, the industry is generally keeping impacts to within acceptable standards. As community expectations change, management processes and operational procedures will need to adapt to meet new standards, a process that is planned for.

Impacts on Landscape Features

The impacts of petroleum exploration and production activities to landscape features are

- interruption to the natural landscape by
  - seismic lines
  - roads
  - well sites
  - pipelines
  - satellite processing plant including flares, and
- visual impairment to lands with perceived wilderness qualities.

Seismic Lines

The impacts of seismic operations have been documented over the past ten years. A comprehensive review of these impacts is contained in Moss and Low (1996). These authors conclude that:

- the most obvious impacts of seismic lines is vegetation clearance, but this is potentially of short duration if topsoil is left intact. Interfering with water flows was a problem of pre 1980s methods that lead to erosion on sloping gibber country and to impaired water distribution on flood plains. Adoption of new rolling technology on gibber country and minimal line preparation largely alleviated these problems. The visual impact still has the potential to rank highly in open areas although minimal line preparation techniques and weaving through vegetation help to camouflage the lines
- the major period of seismic exploration in the early 1980s resulted in the significant impact. It is lines from this era that are particularly in need of rehabilitation.

Some of these early 1980s seismic lines have been rehabilitated although further rehabilitation may be required.

With the evolution of environmental management in seismic operations in the past ten years, the impacts of seismic lines are now more visual than ecological (Fatchen and Woodburn, 1997, 1998). There have also been significant developments in operational and planning techniques to minimise visual impacts. These include line weaving and doglegging and offsetting dune crest cuts.

Roads and Well Sites

Primary Industries and Resources SA have carried out regular inspections of well sites and, since 1995, the Goal Attainment Scaling (GAS) criteria (see Appendix C) have been utilised. The two objectives against which the well sites and their access tracks are assessed are:

- minimisation of the visual impacts, and
- revegetation by indigenous species.

Assessments carried out between 1995 and 1998 on abandoned and restored well sites and their access tracks show that visual impacts had been limited to expected or better performance at 90% of sites assessed, and the expected revegetation had occurred at 93% of sites (Table 2).

Table 2 GAS Scores for Abandoned Well Sites

GAS Scores	Minimisation of visual impacts (% of well sites assessed)	Revegetation of indigenous species (% of well sites assessed)
+2: Much more than expected performance	19%	27%
+1: More than expected performance	17%	18%
0: Expected performance	54%	48%
-1: Less than expected performance	6%	6%
-2: Much less than expected performance	4%	1%

For those well sites that scored –2, urgent remedial action was requested and taken by the operator. For those that scored –1, the operator was requested to address the issues by reviewing their operating practices and procedures.

Pipelines

The visual impact of above ground sections of pipeline and the disturbed right-of-way reduces the wilderness quality the reserve. Most of the pipeline in the reserve traverses areas not visited by tourists. Where pipelines do intersect with areas used by tourists the visual impact is reduce by burying the pipeline, dog-legging the pipeline and right-of-way access track and leaving as much vegetation as possible along the access right-of-way.

During construction of pipelines both vegetation and soils are extensively disturbed. Mitigation measures include limiting the width of the right of way, leaving isolated trees and shrubs in place to break line of sight, grading the right of way only where necessary so that soil seed stock remains intact, and stockpiling vegetation cleared from the right of way for replacement following construction.

Satellite Processing Facilities

Satellite production plants consist of large processing plant, extensive pipeline networks, oil storage facilities, flares, staff quarters, and necessary access roads. The visual impact of the processing plants is reduced by locating the facilities away from visitor areas and prohibiting visitor access to the processing facilities.

Another visual impact is the flaring of gases at petroleum processing facilities. Waste gases are burned or flared under normal operating conditions, or during disturbances to facility operations. These flares are dominant landmarks in the reserve, particularly to those flying in the area, or when large amounts of gas are burned during operational disturbances. Flaring activities operate under a licence issued by the Environmental Protection Authority and are monitored and reported in compliance with the conditions of the licence.

Visual impact on land with perceived Wilderness Qualities

A yet to be solved problem is to alleviate the aesthetic impact caused by using the 'mythical', 'remote', 'untouched' lands or wilderness areas of outback Australia (Moss and Low 1996). A casual first inspection would suggest that despite a long history of use, first by Aboriginal people and later by pastoralists the land comprising the reserve was pristine. Development associated with the petroleum and pastoral industries has imposed very obvious signs of human endeavour on to the landscape.

Impacts on Wildlife

The major impacts to wildlife of petroleum exploration and production activities arise from

- disturbance to habitat by seismic operations
- disturbance of fauna
- vegetation damage and clearance
- third party use of seismic lines
- oil spill
- formation water disposal
- waste disposal

Disturbance to Habitat by Seismic Operations

Seismic surveys involve line preparation and seismic recording. Line preparation techniques vary with land form, soil and vegetation type. Over smooth surfaces with sparse vegetation the dozer is 'walked' over the vegetation with blade lifted high, the impact being limited to flattening the vegetation and minimal soil compaction. Preparation involving blading varies in intensity of impacts with soils and vegetation type. In dunefields where traction and surface roughness are problems to seismic recording the blade is used to cut a smooth track. Blading is only rarely used on floodplains. Vibroseis trucks travel along the lines quite rapidly to record the seismic data. They are noisy and heavy (Reid 1998b).

For 2D surveys, less than 0.02% of the land surface is directly impacted while 3D surveys can impact 2 to 5% of the land surface. Fatchen and Woodburn (1997, 1998) raise the question of whether this level of landscape impact is ecologically significant. Reid (1998b) indicates that a figure of 5% of land surface disturbance may be a threshold for landscape-wide significant impact. Fatchen and Woodburn (1997, 1998) conclude that ecological impacts of most seismic operations are not significant. Close attention is being paid to this issue by Primary Industries and Resources South Australia (PIRSA).

However, there are local impacts to the land surface and biota as a result of line preparation and vehicular traffic. These are transient in nature with natural recovery rates dependent on land units, rainfall and preparation methods employed.

Localised environmental impacts (such as visibility, flora and soil impacts) from exploratory activities are expected to recover to within natural variability within the medium term (approximately 8-10 years). Some parts of some lines or well sites may take longer to become invisible. This is particularly relevant to seismic lines prepared prior to 1985 using more destructive techniques.

PIRSA is responsible for environmental audit of petroleum activities. Since 1988 there have been 24 PIRSA inspections within the reserve and, with the introduction of the 1991 Code of Environmental Practice there have been 38 Environmental Audit Reports submitted by Santos. All of these and other programs have been inspected and no major non-compliance issue has arisen.

Over more recent years, Goal Attainment Scaling has been developed by PIRSA and Santos and was used in the audit of the Western Prospects Seismic Survey which was undertaken in 1997/8, partially within the CLCZ (Cockshell et al 1998a). The GAS criteria focus on individual land units within the predominantly wetland system and set more stringent standards of acceptable achievement, in light of the higher environmental, social and cultural sensitivity of the area.

A summary of GAS assessment of seismic lines made between 1994 and 1998 is given in Figure 14 which shows, that of all the sites sampled:

- 13% had no environmental impact
- 21% had little impact
- 52% had impacts which were acceptable
- 11% had impacts which were less than acceptable
- 2% required immediate remedial action to avoid long-term impacts.

Where acceptable criteria were achieved (scores of 0 to +2), the seismic lines are expected to naturally recover from the impact within a time frame acceptable to the community, in most cases this is within 8-10 years. Where GAS scores of -1 were recorded, recovery is likely to take longer, although no permanent damage is expected. Most of the -1 cases related to the non-retrieval of pin flags during the Western Prospects Seismic Survey within the CLCZ. Many of the cases where GAS scores of -2 were recorded related to uphole cuttings being left in a mound higher than 0.5 m. There were no cases where irreversible damage was likely to occur.

Disturbance of Fauna

Direct impacts from petroleum activities to animals are generally restricted to small mammals, reptiles and invertebrates which have small home ranges in which the width of seismic lines or pipeline construction right of way (about 5 m) is significant. Disturbance during seismic recording would be fleeting (Reid 1998b), and disturbance due to pipeline construction will be minimal with some deaths of reptiles and small mammals occurring in open pipeline trenches. To minimise these deaths the time pipeline trenches are open is minimised and limited to about 24 hours.

Fishing and hunting also contributes to fauna disturbance. The operator's Codes of Practice inform the work force which of these activities are illegal. Individual workers do contravene the Codes of Practice, however the magnitude and frequency of such contraventions has not been established (Reid 1998c).

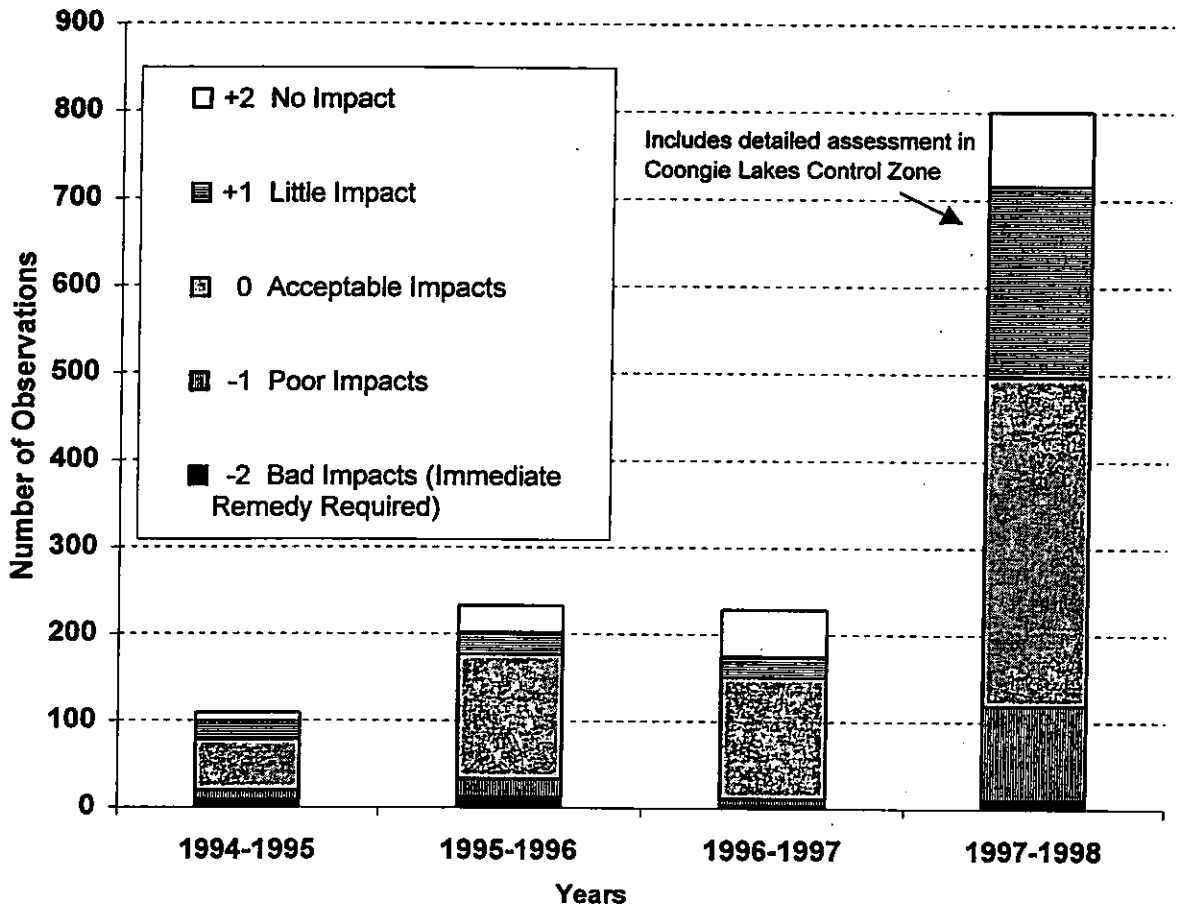


Figure 14 Goal Attainment Scaling for Seismic Operations

Vegetation Damage and Clearance

Floral impacts and recovery rates are more variable, particularly with perennial shrubs and trees. Considerable care is taken to avoid removal of slow growing and long lived species, by sighting seismic lines to avoid thickly vegetated areas and weaving along lines to avoid individual plants. Impacts to soils, soil surface cover and vegetation has also been reduced dramatically by limiting soil disruption and using techniques that reduce blading. These include incorporation of the use of terrain-specific vehicles such as rubber-tracked vehicles, rollers in gibber country, surface trafficking where possible and hand-carrying of equipment particularly in sensitive areas such as the riparian zones of the Coongie Lakes wetlands. Locating production facilities and infrastructure in areas with soils less susceptible to erosion has also ameliorated many impacts.

Installation of extraction and processing facilities and pipelines involves significant local impacts to habitat for the life of the project. Surface installations vary in size from 0.03 sq km for individual well heads and access tracks to 6 – 15 metres width for the length of roads and pipeline right-of-way.

The formed roads within the reserve which service the production facilities also involve local impacts to habitat due to the replacement of the land surface with trafficable clay capping and the extended period of utilisation. Using an average impact width of 30 m, a total surface impact of 63 sq km is involved (0.46% of the reserve).

Moss and Low (1996) conclude that the major impacts of well sites are due to the importing of clay soils to provide a base for drilling rigs, vehicle movement, office and camps. Lack of revegetation of these platforms continues to be a problem due to lack of water retention, seed and suitable soil on the platform with consequent localised minor erosion. Wind blowouts around abandoned well sites in sand dunes is also an impact that requires the establishment of rehabilitation procedures. The clay capping for roads is imported from borrow pits. Borrow pits remain a permanent feature of the landscape, as revegetation of pit walls is slow and where used by stock or feral animals for water, a piosphere of grazing impacts around the borrow pit may occur.

More recent abandonment of well site procedures require that upon completion of operations, active rehabilitation of these sites is undertaken to facilitate recovery to natural conditions. This involves removal of the clay topping and recontouring the site.

Impacts from pipelines relate to access for vehicles and equipment, and ongoing inspection. Much of the 15 m wide pipeline route is used only during pipeline installation, with a vehicle access track for inspection purposes being of a less temporary nature. Recovery of the impacted areas is generally slower than seismic tracks due to the more extensive amount of earthmoving involved and the much greater width. Therefore, a medium term impact on vegetation, land surface and aesthetics is involved, over a total area within the reserve of approximately 5 sq km or less than 0.05%.

Third Party Use of Seismic Lines

Third party use is considered the most serious longer-term threat to the natural values of the reserve arising from seismic programs.

Third party use of seismic lines includes use by livestock, vehicles and placement of infrastructure (eg fencelines, pipelines, roads) once the seismic survey program and auditing are complete. Third party use lessens the likelihood of, and may often prevent, complete recovery of seismic lines, depending on the intensity and type of use (Reid 1998b).

Old seismic lines through the northwestern corner of Tirrawarra swamp have been used for access to lay a stock water pipeline. Cattle are primarily responsible for the lack of recovery of other old seismic lines through the swamp that have not recovered 12-15 years after being cut. The eastern fence for the Coongie Lakes Exclosure utilises an old seismic line which will now not fully recover as an access track follows the fenceline. Visitors to the region often follow seismic lines 'off-road' impacting on their recovery.

Santos has discouraged third party use by tourists by concealing seismic lines at intersections of roads. This approach has been largely successful. During the recent Western Prospects survey lines through lignum swamp were hand cut and are very narrow. Stock access via these lines to these swamps is therefore less likely to occur.

Oil Spill

Incidental spillage of oil from pipelines, wells or plant facilities is a significant potential impact to flora, fauna and soils. This is particularly important in wetland and floodplain areas where there is the potential for extensive spreading of oil by water flow. From 1994 to 1998 there have been approximately 80 incidents involving the accidental release of hydrocarbons (oil spills) and by product formation water to the environment. The cumulative total of these incidents is approximately 159m^3. No spill within the reserve has had a significant environmental impact.

Considerable effort is put into the planning, operational and monitoring phases of production to minimise actual and potential impacts of oil spills. Santos has an Emergency Response Plan which addresses all emergency scenarios such as fire, explosion, aeroplane crash and oil spill response. OSCAR (oil spill containment and recovery) equipment is held at Moomba and Tirrawarra to enable rapid deployment. Oil spill training and response exercises are conducted regularly to ensure staff are familiar with equipment and operational procedures.

Formation Water Disposal

Formation water is a by-product of both gas and oil production. After physical and chemical treatment formation water is disposed of by evaporation and infiltration. There are currently 19 sites within the reserve where produced formation water is disposed of by evaporation. Of these 19 sites, 5 are currently not in use. Water quality is measured on a weekly basis for total oil and grease which is not to exceed 30 ppm in an unlined pit or earthen pond. All treated formation water facilities are also monitored annually with samples collected from the ponds analysed for 81 parameters consistent with those provided in the Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC 1992).

The results of the water disposal monitoring have demonstrated that annually more than 95% of all the biological, physical and chemical components monitored fall below the ANZECC guideline levels. In most cases these are orders of magnitude less. For those components that fall above the guideline levels, the operator has been requested to investigate the cause of this. Preliminary assessments show that the effects of these higher levels are not significant because the contaminants are being confined within designated areas which are either fenced from livestock and native fauna or are isolated from the surrounding environment including aquifers.

Waste Disposal

The Moomba Waste Management Depot is a licensed facility under the Environment Protection Act, 1993 (Licence No. 1259). The depot receives all recyclable metal, cans, batteries etc which are generated by exploration and production activities undertaken anywhere within PEL s 5 and 6. Putrescible wastes associated with permanent camps are disposed of to landfill sites at Dullingari and Bookabourdie within the reserve, and Tirrawarra and Moomba outside the reserve. Solid Waste Returns are completed on a monthly basis and submitted to the EPA.

Conclusions

The audit of Graetz (1990) commended the environmental management of the operators of PEL s 5 and 6 and South Australian Department of Mines and Energy now PIRSA and found that there were no significant environmental problems generated or inherited. A number of modifications to the management processes were recommended along with minor changes to the Codes of Environmental Practice. The author concluded that impacts of the exploration and production activities have been successfully minimised, that the degree of compliance with the Codes was very high and that responsible stewardship of the land was clearly demonstrable. The situation over the last eight years following this report has been to maintain and where necessary improve operating standards.

Studies continue to be undertaken to provide baseline environmental data on petroleum industry impacts and recovery rates. Key aspects that will be studied further in the near future include visibility of seismic lines, rehabilitation of well site pads and oil spills.

3.2 Tourism

The variability of the climate and the frequent flooding of campgrounds on floodplains make the separation of visitor impacts from natural impacts difficult. As resources have not been dedicated to this task there is little quantitative data on visitor impacts over the review period.

Human use of natural areas inevitably leads to changes in condition of those areas. The very conditions that attract recreational use are changed by that use. Changes occur in both the biophysical and social conditions of the area. Soils are compacted, vegetation is disturbed, and the level of social interaction increases as does the potential for conflict between different user groups. The outcome is a phenomenon called recreational succession. As the use of an area increases, resource conditions change until the character of the recreation setting is altered (Prosser 1984).

Tourism has increased at least three fold since the proclamation of the reserve, however visitors to the area are using the area more sensitively than those using the area before its proclamation and the impacts of visitors are much reduced (Dahl pers. comm. 1998). The end result of a decade of visitor management by ranger staff is a more caring attitude and less environmental impact.

Impacts on Landscape Features

Impacts of tourism on landscape features are the establishment of campgrounds and toilets, litter, and track proliferation leading to accelerated erosion, often due to reduced vegetation cover.

Establishment of camp grounds and toilets

The number of visitors to the area and their impact increased to a level where it was obvious and unacceptable. To limit these visitor impacts, designated campgrounds, low line fencing and toilet facilities have been established. These developments have changed the 'wilderness' quality of those camping areas and displaced those visitors that prefer bush camping while attracting visitors that prefer the more structured setting. The Toyota Four Wheel Drive Club has renovated the old Kudriemitchie Outstation as shelter for campers. The outstation also provides a reminder of the isolation and lifestyle of early pastoralists in the region.

Litter

A survey of visitor impacts in 1991 (Page 1992) shows that of 21 camping sites, 8 had visible rubbish consisting of toilet paper, beer bottles and cans and cigarette butts. The 1992 ACF visitor survey (Donato 1992) commented that relatively little rubbish had been left behind in the camping areas. However this may have been due to recent flooding and low visitor numbers. Once again the notable components of rubbish were toilet paper, beer bottles and cans, many of the latter were buried in campfires.

The amount of pollution and litter at camping areas has been greatly reduced by the provision of more ablution facilities at popular camping areas, the promotion of a 'take out what you bring in' approach to rubbish management and the provision of a rubbish dump at Innamincka.

Track Proliferation and Erosion

Track proliferation is a recognised significant impact in and around the major campsites where tracks have extended access, damaged soils and plants and inhibited plant growth and led to sometimes severe gully erosion.

Track proliferation has been much reduced in recent years by the better definition of tracks and campgrounds and the use of low line fencing.

Impacts on Wildlife

Impacts of tourism on wildlife are pollution of waterways, noise disturbance to wildlife, hunting and fishing, and habitat destruction through vegetation clearance particularly, damage to vegetation by vehicles at major campsites, tent site clearance and the collection of firewood including standing dead wood and live vegetation.

Pollution

Pollution of waterways is an undefined impact of tourism. The increasing number of toilets at high use campgrounds is reducing the amount of toilet paper in those areas and the likelihood of pollution of waterways from human effluent. The showers at Innamincka are well used by campers and are likely to reduce the number of people bathing with soap products in waterways and lakes.

Noise Disturbance to Wildlife

Visitors to the area have, in the past broken the solitude and disturbed wildlife by the use of generators, chainsaws, firearms and trail bikes.

Proclamation of the reserve and introduction of the Desert Parks Pass has aimed particularly at changing the culture of (and hence modifying the behaviour of) campers at Innamincka and Coongie Lakes. The high conservation values of the area are promoted through the Desert Parks Pass, interpretive signs and the Parks and Wildlife staff presence.

Since the proclamation of the Regional Reserve the use of equipment which creates excessive noise such as generators and power boats, has been prohibited north of Kudriemitchie Outstation thereby maintaining a more peaceful environment in the Coongie Lakes area.

Hunting and Fishing

Prior to proclamation, the reserve area was used extensively for hunting and fishing. There was a rabbit harvesting enterprise based in the area, and netting of fish although illegal in inland waters and without a permit was unregulated and common.

The Regional Reserve status has reduced the impact on wildlife of hunting and netting. The possession and use of firearms within reserves is prohibited as is the use of nets and more than two rods or handlines. Handlines and rods must be attended and there are limitations on the number of fish that may be taken. The National Parks and Wildlife ranger who is stationed at Innamincka and is a warden under the *Fisheries Act* patrols fishing activities.

The fish catch in the area is thought to be significant. The permanent waterholes of Cooper Creek are important drought refugia for the fish fauna. Fish stock in these refugia recolonise the extensive ephemeral wetland system during floods. There are concerns that the fish catch may reduce the ability of the fish population of drought refugia to restock the wetlands after drought. South Australian Research and Development Institute (SARDI) are conducting a

monitoring program on the fishery of the Cooper Creek area to gain an understanding of the ecology and population dynamics of the fishery, and to determine fishery management needs and strategies (see Appendix C).

Other threats to the integrity and maintenance of the wetland ecosystem attributable to fishers are the abandonment of fishing tackle and the introduction of exotic or fish species as live bait.

Habitat Destruction

Campers in the area have cleared vegetation for tent sites, and depleted habitat by removing dead timber for campfires. Camping areas are now more clearly defined, reducing the likelihood that more area is likely to be cleared for campsites.

Reid and Gillen (1988) indicate that during 1987 visitors camping along the watercourse used the equivalent of 230 mature specimens of coolibah and red gum. During this period it was estimated that visitor numbers were in excess of 24 000. The survey of more recent visitors indicates that some people now bring their own firewood (8%), others use small amounts (5%) and a few use only gas appliances (5%). Four percent of respondents say that they were unable to find firewood. Still, the vast majority of respondents did not answer this question (75%).

Most campers still use a campfire and with over 15 000 visitors, firewood collection and removal by burning must still be a significant impact in the areas where campfires are permitted. Campfires are not permitted north of Kudriemitchie and the use of gas cookers or small campfires is encouraged while large campfires are discouraged at other camping areas.

3.3 Pastoralism

Impacts on Landscape Features

The impacts on landscape features of the pastoral industry are station improvements such as yards, fences, bores and tracks, and stock impacts such as browse lines on shrubs and trees, trampled soils, pugged shorelines, stock induced bank erosion and manure.

Station Improvements

Pastoral improvements impact on the sense of wilderness provided by the landscape. The fences, bores, yards and buildings seen along the main roads through the reserve are evidence that this is a working cattle enterprise. Visitor camping areas are placed so that the visitors are not within sight of stock waters and do not disturb stock. The Cullyamurra and Coongie Conservation exclosures also separate stock from visitor areas.

Stock Impacts

The stock and evidence of their presence are regular reminders that this area is not reserved for conservation and wilderness values alone. In high use areas stock impact on the landscape features of the reserve, however, it is not known whether the presence of stock in the reserve impacts positively of negatively on the enjoyment by visitors of its landscape features.

Impacts on Wildlife

The impacts of pastoral land use on wildlife include:

- selective use by cattle of the wetlands environment
- grazing induced changes to soils and vegetation
- grazing impacts on plants and animals with limited distribution
- stream and waterhole bank erosion and pugging of lake shorelines
- nutrient cycling

Selective Use by Cattle of the Wetlands Environment

Following a receding flood wetlands provide high protein, moist forage for stock. The wetlands and waterholes also provide good quality stock water. It is these same wetland areas that are of high conservation significance, providing a diverse range of riparian, aquatic and mesic flora and fauna.

Stock impacts are greatest close to stock water where grazing and trampling intensity is highest, these impacts reducing with distance away from water. Cattle dependant on a water source will usually graze away from water between 4 and 10 km. Landsberg et al. (1997) in a review of cattle grazing impacts resulting from stock use of waters concluded sites 15 km from water were suitable as ungrazed 'benchmarks'.

Cattle grazing is selective. Stock choose the more palatable plants over the less palatable, until these are removed, then walk further to graze or else select less palatable species. Assessment of grazing impacts on vegetation is based on the grazing-induced condition of the palatable species of plants including:

- their presence or absence (in which case they are referred to as decreaser species)
- the proportion of preferred species to the species that are less palatable and increase in abundance under grazing (increaser species).

The Coongie Lakes, Cooper Creek and waterholes of the reserve have been subjected to these grazing impacts for over 100 years. Rabbit grazing impacts have also been severe and distributed across most land systems as rabbits are not dependent upon watering points. No ungrazed reference area exists to compare with grazed areas and therefore it is not possible to determine the impact on the plant species diversity, density or abundance of grazing impacts. However, it is probable that some species have been significantly disadvantaged by stock and rabbit grazing and that the integrity of the biota of the region has been correspondingly diminished.

The establishment of the Coongie Lakes and Cullyamurra Exclosures should assist with measuring the response vegetation to the absence of cattle. However, as these areas have had a long history of high stock grazing pressure it is unrealistic to expect a reversion to their pre-pastoral condition.

Without a baseline, and given the immense variability in the landscape due to the variety of habitats both spatially and temporally identifying and effecting appropriate stocking rates for wetland areas remains a key issue.

Grazing Induced Changes to Soils and Vegetation

Assessment and monitoring of rangeland condition on Innamincka Station began in 1985. This monitoring of vegetation at marked monitoring sites has provided data by which trends in the stability of soil surfaces and the health and diversity of plant communities can be assessed. In interpreting impacts and causes the different types of country, the plant communities they support and historical grazing impacts are considered (see Appendix C).

Stock numbers were increased from 1984 after the Brucellosis and Tuberculosis Eradication Program. In 1991 they were too high giving rise to vegetation damage and consequent criticism from conservation groups and the Department. Stock numbers were reduced by 1992 and strategies to assist with prevention of this problem recurring were developed including the establishment of additional trucking facilities, the Innamincka Pastoral Company's own monitoring (commenced in 1993) and a greater awareness of the need for more timely adjustments in cattle numbers (Campbell 1998).

Observations made during both the 1995 and 1997 assessments indicate that the current grazing management strategies are facilitating an improving trend in general rangeland condition. However, grazing induced deterioration of rangeland condition was noted at a number of water points. Strategies to address these issues have been developed and implemented.

A summary of the land condition of each land system as assessed in 1997 and its trend against previous pastoral assessments is given below.

Cooper Land System

Regeneration of most overstorey species was found to be both widespread and common throughout most areas surveyed. Coolibah, beantree, Broughton willow, bignonia emubush and whitewood were typically observed throughout the floodplain in mixed-age stands indicating several regeneration events. Scattered juveniles and seedlings of river red gum were noted in the upper reaches of the Main and North West Channels of the Cooper Creek.

A notable observation of the 1997 assessment was the widespread resprouting and suckering of overstorey species apparent in most surveyed areas of the Cooper floodplain. The last two years in particular have seen prolific suckering of whitewood and sour plum. Cattle under high grazing intensity browse both these species. The suckering is attributed to conservative stocking and very low rabbit numbers since the advent of rabbit calicivirus.

Observations indicate that needlewood is regenerating prolifically on sand plains and dune footslopes adjoining the floodplain particularly in Goonaburoo and Twelve-Mile paddocks.

Grazing impact on shrubland communities such as Queensland bluebush was found to be minimal throughout the floodplain areas surveyed. However a decline in density and cover of this species was noted at several locations on the periphery of the floodplain in habitats regarded as marginal for Queensland bluebush. It is considered that this species expanded into these areas following exceptional flooding events and the stands are now contracting. Contemporary grazing levels were assessed to be low at these sites. Queensland bluebush located in the more frequently inundated parts of the floodplain displayed mixed-age stands indicating several regeneration events in recent years. Most of these areas are located within grazing range of water points indicating regeneration is occurring in areas subject to cattle grazing.

Moderate to severe stock grazing impacts were found to be widespread in floodplain country north of Cullyamurra Waterhole. The impacts indicate declining condition since 1985 and include:

- a significant reduction in the cover of perennial species, and heavy grazing of tree and shrub species including hard grazing of coolibah, gray germander and neverfail
- sealing of sandy clay floodplain flats leading to topsoil loss
- areas of moderate to severe active erosion (scalding and drilling)
- heavy grazing of coolibah juveniles and perennial grasses throughout areas surveyed
- reduction in numbers of coolibah juveniles.

A large proportion of this area is now included in the Cullyamurra exclosure. It is considered that active rehabilitation, possibly involving mechanical treatment, will be required to effect significant improvement in this area (Heritage and Biodiversity Division 1998).

Recently heavy grazing of the western and northern surrounds of Tirrawarra Swamp and Tirrawarra Waterhole was reported by Reid (1998b) while auditing seismic lines. The swamp has now filled from recent rain and floodwaters and vegetation has resprouted (Campbell pers comm).

Merninie Land System

Most areas of gibber tableland country assessed were found to be in good condition, typically supporting a dense cover of Mitchell grass and bladder saltbush in mixed-age stands with low levels of grazing impact noted. An exception was gibber tableland country in the vicinity of Thompson's Dam where moderate to high grazing pressure was noted on Mitchell grass and bladder saltbush.

Most stock waters are located on the western footslopes of Merninie land system in the transition zone between gibber tableland country and Cooper land system. These areas are subject to a high degree of natural disturbance, particularly from run-off from the tableland country. Cattle do not favour the dense stone cover of the tableland country to the east and this tends to result in more concentrated grazing on the less resilient footslopes. Grazing has impacted the soils and vegetation in the vicinity of several water points in this zone, including Twelve-Mile Dam and Patchawarra and Barton's Bores. Impacts include a reduction in the cover and density of perennial grass species such as barley Mitchell grass the development of moderate scalding in some areas. Patchawarra Bore has been spelled since 1995 and conservative stocking on Barton's Bore have resulted in an improving trend in these areas since the 1991 assessment with a significant increase in cover and density of Mitchell grass. Mechanical intervention may be required to stabilise some scalded areas.

The Patchawarra Creek floodout scoured by storm run-off in 1995 was found to have recovered well with widespread recruitment of Mitchell grass and other perennial species and stabilised soil surfaces noted. Flooding in Patchawarra Creek has cleaned out sand deposited in Deramookoo Waterhole in 1995 with the waterhole regaining its original depth and permanency (Heritage and Biodiversity Division 1998).

Marqualpie Land System

Overall, Marqualpie land system was assessed to be in good to excellent condition with very low disturbance levels.

Very low levels of grazing impact were noted south of Bloodwood Bore with regeneration of palatable tree species including bloodwood and straggly corkbark noted.

Since 1991 there has been an increase in cover of perennial and annual species west of Boomerang Bore. However recent heavy browsing of cottonbush was noted.

Moderate to high grazing pressure on perennial shrub and grass species had occurred north of Leap Year Dam (Heritage and Biodiversity Division 1998).

Della Land System

Increases in cover and density of plants of perennial grasses such as Mitchell grass and neverfail on interdune flats with heavier soils were recorded. There was also generally good cover on sand dunes with annual and ephemeral species persisting as standing litter.

Prolific suckering of whitewood and sour plum, both regarded to be palatable indicator species, was observed in all stands surveyed. There was however a lack of evidence of significant regeneration within stands of mulga on sand dunes and footslopes, although scattered juvenile mulga was noted in stands between No. 2 Bore and South Tank in Bore Track South Paddock.

In one area, impact from rabbit grazing was noted along with moderate grazing of Queensland bluebush, canegrass and neverfail around perimeter of swamp indicating a local recovery in rabbit populations in these sand dunes (Heritage and Biodiversity Division 1998).

Koonchera Land System

The small area of Koonchera land system in the north west corner of the reserve is remote from any significant stock waters. Following large flood events in this area and when water is available, stock are dispersed widely on the Cooper floodplain.

The gibber plains, sand plains and sand mounds north of Lake Marroopootanie were found to be in excellent condition. The areas traversed supported the range of perennial species, including palatable grass and shrub species, indicative of low long-term disturbance levels.

The widely spaced sand dunes observed were stable typically with a good cover of sandhill canegrass. The persistence of annual and ephemeral cover on sand dunes, a feature of most of the sandy country in the region since the advent of rabbit calicivirus, was evident in Koonchera land system (Heritage and Biodiversity Division 1998).

Grazing Impacts on Plants and Animals with Limited Distribution

There are three tree species with limited distribution that are grazed by cattle. Only mature specimens occur. Cattle and/or rabbits graze seedlings and suckers. There is concern for the long-term survival of these species in the region. The species, their distribution and management are outlined in Table 3.

The marsupial Kowari occurs in the region. The species is rated vulnerable nationally and endangered in South Australia. A key aspect of the habitat of the Kowari is the low, vegetated sand mounds that occur on the gibber plains of the Koonchera and Merninie land systems. Cattle grazing on these relatively fertile, vegetated sandy patches could, if not well managed lead to vegetation loss and erosion of these important habitats. A recovery plan has been prepared for the Kowari (Heritage and Biodiversity Division 1998).

Stream and Waterhole Bank Erosion and Pugging of Lake Shorelines

Cattle use the wetlands edges when available. As water levels recede margins of lakes and other wetlands provide valuable high protein feed for fattening cattle. Stock activity in these areas leads to the development of tracks, erosion gullies on banks, pugging and fouling of waterholes and lake shorelines. The significance of these impacts on wildlife is not documented but will relate to the level of stock use.

Nutrient Cycling

Cattle grazing has changed the way biomass and nutrients are cycled through the environment. The sale of cattle to markets exports the nutrients that went into the growth of the animals. This is a slow removal of nutrients from the system that may or may not be balanced by imports associated with floods, nitrogen fixation and atmospheric inputs from rainfall. Another concern is that cattle redistribute nutrients within the system, tending to concentrate them around and in water in the form of dung and urine.

The long term significance of nutrient cycling within, and export from extensive grazing systems where overall stocking rates are low and environmental perturbations are large, has yet to be determined. However Hook (1997) concluded that export of nutrients in terms of cattle biomass were unimportant in a study at Charters Towers where stocking rates were considerably higher than on the reserve.

Innamincka Pastoral Company match stock numbers, particularly in the northern Lakes area, to the length of shoreline and abundance of fringing pastures as a sustainable management practice. In many years (1989,1990,1991, 1995, 1996, 1997, 1998) the area of flooded country and consequent length of shoreline has been immense, to the point where large areas of riparian vegetation remained untouched by livestock (Campbell 1998).

Table 3 Trees of Limited Distribution

Species	Habitat & Distribution	Comments
Capparis mitchellii Native orange	• occurs on banks of waterholes and larger channels of the Cooper land system; adjacent large creeks of Merninie land system; swales in jumbled dunefields of Marqualpie land system • patchily distributed typically in small stands of a few individuals or often as a single tree, never a common overstorey component	• apart from a small number of juveniles noted in Marqualpie land system, no regeneration of this species recorded on Regional Reserve - as is the case generally in the region • current population consists of adult trees typically with distinct cattle graze line • the banks of waterholes - the preferred habitat for this species in both Cooper and Merninie land system, often exposes this species to impact from cattle • populations should be monitored for affect of low rabbit numbers • exclosure of a number of stands in a range of habitats is recommended
Grevillea striata Beefwood	• occurs on sandy plains of Cooper land system and sandy creeks of western footslopes of Merninie land system • patchily distributed, typically in stands of several individuals, occasionally dominant overstorey species in drainage lines of Merninie land system	• most stands dominated by adult trees with little regeneration noted • juvenile trees typically heavily grazed and damaged by cattle grazing • rabbits readily graze this species, often removing lower branches on juveniles, the effect of low rabbit numbers on the populations of beefwood should be monitored • monitoring of beefwood stands in Coongie Lakes exclosure compared to stands exposed to cattle grazing is recommended
Owenia acidula Sour plum	• occurs on sand plains and dune footslopes of Cooper and Della land systems • patchily distributed, typically in stands of several trees or as single trees	• strong suckering evident in most stands observed in Cooper land system with suckers of a range of sizes indicating successful recruitment over several years including areas regularly grazed by cattle • prolific small suckers in stands found in sandy country (Della land system) coinciding with the crash in rabbit numbers in late 1995 with the advent of Rabbit Calicivirus Disease. • photopoints in Della and Cooper land system will monitor individual stands

3.4 Other Management Issues

Upstream Water Extraction and Land Use

Queensland Government Draft Cooper Creek Water Management Plan

The most significant external threat to the ecological integrity and biodiversity of the Coongie Lakes Wetlands, the major feature of Innamincka Regional Reserve and a wetland of international significance, would be any significant increase in upstream extraction of water from the Cooper Creek and its headwaters.

The Queensland Government Draft Cooper Creek Water Management Plan is the strategy for water allocation for the Cooper Creek Catchment in response to a proposal for water extraction for cotton growing at Currareva near Windorah in SW Queensland (Department of Natural Resources 1998a & b).

The South Australian Government provided a submission to this proposal expressing concern about the potential impacts to the near natural and variable flows of the Cooper system that would result from the implementation of the increased rates of water abstraction and diversion proposed in the Draft Water Management Plan. While these wetlands are in South Australia they are dependent on water flows from Queensland. Extraction of water on the scale proposed would lead to changes that could have detrimental impacts on the health and integrity of Cooper Creek and Coongie Lakes system and its internationally important conservation values.

The South Australian Government submission to the Queensland Government on their draft Cooper Creek Water Management Plan recommends (among other things) that:

- no additional water be allocated from the Cooper Creek pending completion of negotiations on the Lake Eyre Basin Agreement
- a high level of commitment is accorded to negotiations for the cross-border Agreement to provide a framework for managing cross-border water resource issues.
- Water resource planning and management in Cooper Creek be based on an integrated catchment approach, recognising cross-jurisdictional issues

These recommendations are consistent with protecting the ecological character of the wetlands of the reserve.

Currareva Cotton Proposal Issues and Outcomes

The South Australian Government along with environmental groups, pastoralists and tourism interests opposed the earlier move to extract large volumes of water from the Cooper Creek system for cotton growing near Currareva. These groups believe that such large-scale extractions of water for cotton growing in particular had the potential to have a devastating effect on the ecosystem of Cooper Creek and Coongie Lakes wetlands.

The South Australian Government's response to the Currareva cotton proposal resulted in the development of a Heads of Agreement between South Australian and Queensland.

Heads of Agreement

In May 1997 the Minister for Environment and Natural Resources South Australia, the Minister of Natural Resources Queensland, the Minister of Environment Queensland with support from Commonwealth Minister for the Environment entered into a Heads of Agreement which details the intention of the signatories to develop an Agreement which will include:

- a statement of objectives
- an institutional structure that will provide for high level interaction and exchange between the respective Governments, community involvement and scientific and technical input, and
- provisions for the development and adoption or endorsement, monitoring and evaluation of management plans or policies for flow regimes which reflect current, near natural and variable flows in the river systems, land and water management, catchment management strategies and research and monitoring
- the encouragement and promotion of research and monitoring to assist in informed decision making for the basin.

Lake Eyre Basin Catchment Management Committee

In May 1995 the Far North Consultative Committee for the Department of Environment and Natural Resources organised a workshop in Birdsville to discuss catchment management for the Cooper Creek and Diamantina River and the formation of a Working Group.

At this meeting the Lake Eyre Basin (LEB) Catchment Management Steering Group was formed to prepare an information paper on the present management and resources of the Basin and to consult the community and interested groups on options for management. To meet these objectives the South Australian, Queensland and Commonwealth Governments jointly funded a project officer.

This Group held a subsequent meeting in November 1997 in Birdsville at which participants from the local community, Government agencies and interest groups agreed to establish catchment management processes in the Lake Eyre Basin and agreed on a structure for implementation. The result of this has been the establishment of a Lake Eyre Basin Coordinating Group (LEB CG), and catchment committees for the Cooper Creek and Diamantina River catchments. The role of the LEB CG includes:

- promote ecological and economic sustainability
- develop a strategic vision
- integrate priorities for action plans and funding
- manage a communication strategy for the basin
- provide a communication channel with Government
- apply social justice principles so that diverse views are respected and considered.

The LEB CG and Catchment Committees have the support of the community, interest groups and the South Australian, Queensland and Commonwealth Governments. This structure is in a position to play a pivotal role in catchment management and strategic planning for resource use and impacts which may affect the conservation and sustainable management of Cooper Creek and Coongie Lakes Wetlands in the future.

Coongie Lakes Wetlands Ramsar Listing and Management Plan

The Coongie Lakes wetlands and the Cooper Creek and its flood plains in South Australia were listed as the Coongie Lakes Wetlands under the *Convention on Wetlands of International*

Importance Especially as Waterfowl Habitat (the Ramsar Convention) in June 1987. The broad objectives of this convention are to ensure the conservation and wise use of wetlands of international importance.

The Commonwealth is committed to formulate and implement planning so as to promote conservation of Ramsar listed sites. The South Australian Government, with assistance from the Commonwealth is developing a management plan for the Coongie Lakes Wetlands that will coordinate management between the various owners, occupiers and user groups.

Feral Animals

Rabbits, feral pigs, feral horses and donkeys are on occasions significant to substantial pests within the reserve.

The overwhelming impact of rabbits has been much commented on within the reserve especially on dunes associated with the Cooper floodplain and the within the Della land system. Rabbits have contributed significantly to the total grazing pressure of the region over the last century. Present day rabbit numbers are generally low due to the rabbit calicivirus disease (RCD) outbreaks in late 1995. Nevertheless significant rabbit populations are surviving in areas adjacent to the permanent fresh water in the Coongie delta area and have since recolonised many of the dunes in the area (Campbell 1998, Heritage and Biodiversity Division 1998).

Increasing understanding of rabbit calicivirus epidemiology and the impact of RCD on rabbit populations is demonstrating that virus epizootics are most likely to occur in the spring aided by blowflies and bush flies as vectors to spread the virus between rabbits. Also rabbit numbers in the arid and semi-arid regions of Australia, although subject to fluctuation, are being maintained at levels 70% to 80% below those pre RCD Best pers. comm.).

A marked increase in the cover and persistence of vegetation on sandy country and widespread regeneration of trees and shrubs was noted during the 1997 assessment. This regeneration is largely attributed to reduced rabbit grazing since the introduction of RCD.

Innamincka Pastoral Company and State agency staff have made releases of the Spanish Rabbit Flea to provide vectors to spread both the myxoma virus and the rabbit calicivirus. Physical forms of rabbit control such as warren ripping are generally impracticable in the area and would be inappropriate in the dune systems (Campbell 1998).

Feral donkeys are found at low densities throughout Merninie land system. Near the boundary of Merninie and Cooper land systems to the north of Cullyamurra Waterhole their numbers appear higher. Donkeys can have significant impact on tree and shrub species such as bladder saltbush and red mulga.

Feral horses (brumbies) are not easily constrained by fences, and through breeding and migration their numbers sometimes total several hundred. Kidman's control both brumbies and donkeys through contract mustering and the shooting of any unmusterable stock (Campbell 1998).

Feral pigs have been present in parts of the Cooper floodplain for some time. However their numbers and distribution appear to have increased in response to recent flood events. The feral pig population is concentrated in the dense lignum of Tirrawarra Swamp, where pugging of channel margins has been observed. Natural mortality during the next dry season and dingo predation will reduce numbers however control by 1080 baiting and shooting from helicopter is planned (Heritage and Biodiversity Division 1998, Campbell 1998).

Weeds

Exotic or naturalised plant species probably comprise less than 10% of the known 500 species of vascular plants in the reserve. Mexican poppy and couch grass are apparent recent introductions and have spread from popular camping spots in the Cooper frontages. In 1995 the athel pines were removed from the Innamincka station complex since they were known to have caused major problems in other arid zone watercourses. No formal weed control occurs within the reserve (Campbell 1998).

Fire

Fire is a naturally occurring event in the sand dunes and sand plains of Marqualpie land systems which are dominated by lobed spinifex. This part of the reserve has experienced excellent seasons over the last few years and fuel loads are high.

The development of a fire management plan for Marqualpie land system is a high priority. It is noted that Marqualpie land system contains habitats very similar to those found in Yulara, Central Australia and the fire management strategies developed there in recent years may form the basis for a program at Innamincka. The program would be aimed at maintaining habitats for wildlife and reducing the risk of a widespread wildfire.

4 IMPACTS OF RESOURCE UTILISATION ON CULTURAL FEATURES

4.1 Aboriginal Culture

Petroleum

Impacts on Aboriginal heritage by Santos' petroleum exploration and production activities are minimal and continue to be minimised by planning, survey and avoidance of identified sites.

Williams (1987) recommended that petroleum installations be sited well away from lake margins and river channels. At the time of the recommendation there was no State Aboriginal heritage legislation to offer protection of archaeological relics. Williams noted the sympathetic approach of Santos and commented that the preservation of the archaeological record of the area relied on the continuation of Santos' sympathetic attitude and site management policies.

Since Williams made her recommendations the Aboriginal Heritage Act 1988 has been proclaimed and provides mechanisms for the protection of archaeological relics and sites.

For developments which require a Declaration of Environmental Factors (DEF) an archaeological survey is conducted by an archaeologist and Aboriginal consultant nominated by the local Aboriginal community or committee. All identified Aboriginal sites are avoided. Archaeological survey during the Western Prospects seismic Survey (Coongie Lakes area) identified 123 Aboriginal sites. All of these were avoided by seismic activities. Archaeological survey prior to the construction of pipelines identified a further 64 sites visible on the soil surface, all of which were avoided. During pipeline construction avoidance strategies include the narrowing of the right of way and erection of protective fencing. In one case the pipeline was re-routed away from a site involving a 50 m offset of the pipeline. Sites not visible on the surface had the potential for damage by pipeline construction although none were discovered during construction.

Santos staff and their contractors inspect petroleum exploration and production activities that do not require a DEF (such as construction of roads, well sites and drill pads). Staff and contractors receive theoretical and practical training in the recognition of Aboriginal sites, objects and remains. They are also trained in procedures to follow for project planning and site recording and reporting. Posters and handbooks reinforce these procedures and training. Sites identified are avoided. Locations of all archaeological sites found during inspections are recorded. The records are provided to the Division of State Aboriginal Affairs. In this way knowledge of the distribution and type of sites throughout the reserve is being accumulated.

Archaeologists and anthropologists working in the area have indicated concern at the ad hoc nature of data collection in the region. While a considerable amount of information is being recorded during site clearance work, there is a need for this information to be drawn together and considered within a regional perspective. This would enable the impact development has on the cultural record to be assessed. Unless the results of clearance work are considered within the broader cultural context there is a risk that despite the legislative protection, the cultural record will become incrementally diminished and sites will remain as isolated islands in a developed landscape (Nicholson 1998a). The implementation of the Site Conservation Strategy on a regional basis may address this concern (Nicholson 1998a).

Tourism

The impacts of tourism on the conservation of archaeological sites has not been monitored or assessed. Many Aboriginal campsites are centred on water sources, for example Coongie Lake, Kudriemitchie, Minki, Tilcha and Cullyamurra waterholes. These areas have been, and continue to be favoured camping sites for visitors to the area.

Damage can be intentional or unintentional. Williams observed severe damage to all her research sites over a few years (Williams 1987). People dig up sites, drive through them, camp on top of them and collect artifacts from them. Little of archaeological value remains in these areas.

To limit the damage to archaeological sites by visitors, Dr Williams recommended that visitor access be restricted to all parts of the system other than the south-east side of Coongie Lake and the eastern bank of the North-west Branch of Cooper Creek. Within these areas Dr Williams recommended further restrictions to avoid archaeologically sensitive areas and to prevent visitor access along seismic lines and petroleum and pastoral tracks. She also suggested that an education and interpretive program be introduced and that camping areas be defined. These recommendations were all implemented with the establishment of the reserve.

Pastoralism

Impacts to Aboriginal heritage by pastoral activities and stock have not been quantified. However, the Division of State Aboriginal Affairs indicates that the main cause of damage to sites recorded on the Register of Aboriginal Sites and Objects is stock trampling. Documented examples of damage to sites in other pastoral areas, indicates that continued presence of stock in areas containing sites should be considered to be detrimental to the conservation of those sites. Stock trampling can accelerate erosion in and around sites, disrupting the stratigraphic record, scattering material, damaging stone arrangements and crushing Aboriginal remains (Williams 1987, Nicholson pers. comm., Lance pers. comm.).

In 1995 the then Department for Aboriginal Affairs inspected some of the recorded sites on the reserve and commended the actions of staff of the Innamincka Pastoral Company in respecting and conserving these sites

The cooperation between Innamincka Pastoral Company and the Department for Environment, Heritage and Aboriginal Affairs in establishing cattle exclusion zones has provided protection for some significant sites. An opportunity is now available to assess the impact of stock on sites outside the exclusion zone. Current archaeological survey work at Coongie Lakes has revealed an almost continuous band of occupation sites along the lakeshores from Kudriemitchie Waterhole to Lake Goyder, and at many waterholes in the greater reserve area. Since cattle activity is focused on natural sources of water, the conservation of archaeological remains and stock activity are in conflict, with a number of known significant sites under threat of stock trampling. There is a need for further work to identify and protect cultural and archaeological sites outside the cattle exclusion zones. Until this is done, cattle management will not be compatible with the conservation of the Aboriginal heritage features of the reserve.

Pastoral activities such as fencing and dam construction which may result in disturbance to land should involve consultation and survey by the Aboriginal community to establish the significance of that area to Aboriginal people. Any sites identified should be avoided and reported to the Division of State Aboriginal Affairs.

Other

Rabbits

Rabbits have disturbed some known sites. The reduction in rabbit numbers over recent years will have reduced site disturbance by rabbits. There may well be cases where active control of rabbits should be considered.

Infrastructure

The Strzelecki Track from the Della road to Innamincka was realigned and built in 1995-96. An archaeologist, Aboriginal consultants, State Aboriginal Affairs staff and an ecologist surveyed the proposed alignments. The archaeological and ecological survey identified a route that avoided all but one identifiable archaeological site. One site of low scientific and Aboriginal significance was close to the road alignment and may have been impacted to some extent. However deviation of the road alignment to avoid this site would have impacted other more sensitive sites.

4.2 Non-Aboriginal Culture

Increased public interest in the reserve has lead to the rebuilding of the Australian Inland Mission nursing home. Part of the funding for the renovation was raised by Australian Geographic from individuals and corporate sponsors.

The building now provides facilities and interpretation for visitors with office and accommodation for the NPW ranger.

The pastoral industry has been associated with the area for over 120 years. The stories of hardship and endurance, conflict and sorrow are part of the cultural heritage of the region and Australia.

The Innamincka picnic race meeting is a popular bush culture and community event attracting tourists and locals and providing a local business opportunity.

In the past, firewood collection was indiscriminate and significant marker trees of the Burke and Wills expedition were damaged. Currently there appears to be no damage to non-Aboriginal cultural items of the reserve caused by any of the land uses.

5 IMPACTS OR POTENTIAL IMPACTS OF RESOURCE UTILISATION ON THE ECONOMY OF THE STATE

Note: For further details on this section see Attachment 1

5.1 Petroleum

Over the review period, oil and gas exploration and production has contributed over $2.6 billion to the State's Gross State Product. This expenditure has created net incomes for South Australians of over $1.4 billion and supported over 4 080 jobs per annum.

Table 4 illustrates this economic impact for South Australia.

The measures of economic activity used are employment, wage and salary income, and value-added. Value-added represents the difference between the value of the goods produced and the cost of materials and supplies used in producing them (ie the net value). Output of one firm often becomes the input of another in the production of a final product. Reporting the impact on output therefore involves considerable double counting. The stated value-added figures contained in this study overcome the double counting problem as they represent the sum of the value added to a product at each stage of production.

The direct impact is the impact in terms of employment and incomes of local residents within the production itself, and in direct suppliers/services to the production. The total impact includes the indirect or flow-on effect as the expenditure circulates within the economy.

Table 4 Estimation of the Economic Impact, 1988 to 1997

	Employment per annum	Income ($'000)	Value-added ($'000)
Direct Impact	1 012	573 174	1 775 734
Indirect Impact	3 068	870 312	846 880
Total Impact	**4 080**	**1 443 486**	**2 622 615**

Note: Totals may not tally due to rounding.

Future Prospects

There are two aspects with respect to the future prospects for the petroleum activity within the reserve. Firstly, the life of the wells which are currently in use, and secondly the potential finds for the future.

The Stakeholder Working Group reports in their submission to this review that there is an expectation that significant additional resources remain to be found in the region. With considerable expenditure on exploration and new technologies and geoscientific understanding of the area, the likelihood of significant discoveries is high.

It is estimated that undiscovered reserves of 80 to 1 550 peta joules of Sales Gas and 1 150 to 9 500 megalitres of oil may occur within the reserve. It is forecast that the oil and gas production from the area will remain high until at least the year 2005.

Because oil is sold onto the world market the future prospects for this commodity are positive but unclear. ABARE (1998) explained the recent fall in the world price of oil to US$12.70 a barrel as the result of OPEC supplies rising faster than demand. A significant cause of the

difference between supply and demand has been weaker world economic growth particularly in Japan and East Asia.

In response to the lower prices some of the higher-cost producers have cut back their production. In addition, ten OPEC members and six major non-OPEC producers have also agreed to restrain their output, possibly throughout the second half of 1998.

Nevertheless, an improvement in world economic growth and consequent increased consumption of oil is expected to cause world oil prices to increase to US$17.50 a barrel in 1999. ABARE expects oil prices to remain firm in the medium term, but has not forecast oil prices beyond the year 2003. It is possible that the negative impact of the downturn in Asia will be prolonged and that the firming of oil prices will be delayed.

To estimate the potential impact of production in the reserve on the South Australian economy for the next ten-year period the estimated value of gas contracts has been used. This assessment only takes account of the extraction from existing resources in the reserve. That is, the potential for new discoveries has not been included. These estimates can therefore be considered lower bounds, as the market demand is much higher than the present supply and, as noted above, the probability of future finds is good.

Future revenue was estimated for known gas resources as $1.1 billion.

Using industry standard multipliers, Table 5 illustrates the economic impact of the above expenditure for South Australia.

Table 5. Estimation of the Economic Impact for the next Ten-year Period

	Employment per annum	Income ($'000)	Value-added ($'000)
Direct Impact	366	207 285	642 187
Indirect Impact	1 110	314 745	306 271
Total Impact	**1 476**	**522 031**	**948 458**

Note: Totals may not tally due to rounding.

Extracting the existing gas resources in the reserve over the following ten-year period is expected to contribute around $950 million to the State's Gross State Product. This output may create net incomes for South Australians of approximately $522 million and create around 1 475 jobs per annum.

5.2 Tourism

Most visitors to the reserve are self-sufficient and their spending is, in the main, limited to fuel and supplies. A total visitor number to Innamincka of 15 000 per annum has been adopted for this study and it has been assumed that visitor expenditure on fuel and supplies remained constant.

Innamincka has one tourism business, Cooper Creek Cruises. This operation has been operating for over four years and employs one person (owner/operator). The cruises operate between April and October of each year and over the four-year period the operator estimates that there has been a 10 per cent increase in business. In 1997 over 1 900 tourists undertook the tour. The expenditure profile outlined below takes accounts of this reported growth.

Businesses in the town that would benefit from tourism to the area are the Innamincka Trading Post and Innamincka Hotel, as well as the grader operator and the tyre and windscreen repair business.

The owner of the Innamincka Hotel currently employees four full time equivalent persons and reported that over the eight years that he has been proprietor, his bed nights have increased three fold. This dramatic increase in visitor nights has been included in the expenditure profile below.

In establishing the benefits of tourism to the State it is important to distinguish between intrastate, interstate and international tourists. Advice from people in the region has suggested that very high proportions (80 %) of visitors are from interstate or overseas. The number of visitors to the region has therefore been discounted to remove the intrastate component.

Using industry standard multipliers, Table 6 illustrates the economic impact of expenditure, as discussed above, for South Australia.

Table 6 Estimation of the Economic Impact for the Ten-year Period

	Employment per annum	Income ($'000)	Value-added ($'000)
Direct Impact	13	2 605	4 310
Indirect Impact	18	4 931	5 117
Total Impact	31	7 536	9 428

Note: Totals may not tally due to rounding.

Over the ten years of the Innamincka Regional Reserve, tourism has contributed over $9.4 million to the State's Gross State Product. This expenditure has supported net incomes for South Australians of approximately $7.5 million and underpinned over 31 jobs per annum.

Future Prospects

The State government is targeting an increase in tourism in the next few years. The recent State Budget included a doubling of the tourism marketing budget.

Although the reported visitor numbers of up to 30 000 appears high, current evidence supports that tourism in the area is on the increase. With the increasing appeal of the product the region offers and government's increased commitment to tourism, it does appear likely that the increase will continue. Therefore the net value of tourism to the State Economy over the next 10 years is likely to be in the order of $15m to $18m.

5.3 Pastoralism

The total expenditure for Innamincka Station in 1995-96 dollars between 1987-88 to 1996-97 is estimated to be nearly $7.6 million.

On the basis of the expenditure profile provided by Innamincka Pastoral Company the expenditures were distributed to industries (or categories) in which they would have their impact. To estimate the effects of the wages and salaries (and therefore consumption), on-costs have not been included[1] and the $2.2 million has been discounted by 25 % to account for the leakage from the South Australian economy due to personal income tax collections[2] and savings. The remaining $1.7 million has been distributed across 57 industry sectors on the basis of household consumption shares.

The Input-Output tables are based on basic prices. That is, transport costs and retail mark ups are not included in the value of goods associated with each industry. These services are sourced by each industry from the Trade and Transport related industries. The retail and wholesale mark ups associated with the purchases of some of the expenditure items has been estimated at 30 per cent and attributed to the Trade industry.

The expenditure was also adjusted to reflect the source. For example Kidman's reported that only 15 per cent of their cattle were purchased from South Australia. The value of cattle purchases was discounted accordingly.

The industry distribution of expenditure used in the assessment therefore includes that which would have occurred as a result of the Station's activities and that which would have occurred as a result of the consumption expenditure resulting from the wages paid to the Station's employees.

Using industry standard multipliers, Table 7 illustrates the economic impact of the expenditure discussed above for South Australia.

Table 7 Estimation of the Economic Impact of Pastoralism over the Ten-Year Period

	Employment per annum	Income ($'000)	Value-added ($'000)
Direct Impact	6	1 521	1 745
Indirect Impact	7	1 829	1 600
Total Impact	12	3 351	3 345

Note: Totals may not tally due to rounding.

Over the ten years of the Regional Reserve, Innamincka Station has contributed over $3.3 million to the State's Gross State Product. This expenditure has created net incomes for South Australians of approximately $3.3 million and created around 12 jobs per annum.

1 Note that on-costs, in the main, are transfers to Government (WorkCover, Payroll Tax etc), although part is superannuation that will raise future consumption. No account has been taken of this future benefit.

2 Note that it is likely that at least part of the leakage (to both Governments) will return to the community in some form of benefits (and therefore raise disposable income). However, due to the uncertainty of the value and type of this return it is best to remain conservative and exclude an estimate from the analysis.

Future Prospects

The future *value* of pastoralism on Innamincka Station will depend on several factors. These include:

- world beef prices;
- the carrying capacity of the land; and
- seasonal variation.

Bailey, Barrett, Rodriguez and Toyne (1998) forecast that in real terms the saleyard price for beef will increase slightly until 1999-2001 and then level out in 2001-02. Over the medium term ABARE projects that Australian saleyard prices will increase in real terms by about 3 per cent from 1997-1998 prices to reach 180c/kg in 2002-03. Estimates of expected saleyard prices over the longer term were not provided.

Assuming that previous average stocking rates are maintained, future seasonal patterns are similar to those experienced over the last ten years and beef prices are relatively unchanged it is suggested that the contribution of the station to gross State product over the next-ten years should be at least as good as the previous ten year period. However, there is a measure of uncertainty attached to each of these assumptions.

5.4 Conclusion

The economic assessment of the utilisation of natural resources within the Innamincka Regional Reserve was confined to the impact on South Australia's economy as stipulated in the Act. However, it became obvious during this study that the impacts on Australia's economy are greater than those on the South Australian economy, because petroleum is exported from the State, a significant portion of the tourists are from interstate and overseas and cattle dealings are not confined to South Australia. Therefore the economic impacts calculated in this study are conservative due to use of conservative assumptions and the confinement to the South Australian economy.

The contribution of the petroleum industry to the State's economy is over 2 600 million dollars while the contributions of tourism and pastoralism are in the low millions of dollars. Future prospects for petroleum suggest a decrease in production, but still contributing around one thousand million dollars. Growth should occur in the tourism sector, while pastoralism should maintain its present level of contribution.

6 SUBMISSIONS TO THE REVIEW PROCESS

6.1 Submissions Received

Submissions for the review of the reserve were received from the following groups and individuals:

Nature Conservation Society of South Australia Inc
Conservation Council of South Australia
South Australian Ornithological Association
Australian Conservation Foundation
The Wilderness Society
Adelaide Bush Walkers Inc.
Julian Reid
Julian Reid and Jim Puckridge
South Australian Association of Four Wheel Drive Clubs - Natural Resources Advisory Unit
Mr G C Thompson
Department of Transport
Outback Areas Community Development Trust
Marree Soil Conservation Board
S. Kidman and Co (Innamincka Pastoral Company)
Petroleum Exploration and Production Innamincka Regional Reserve Stakeholder Working Group - a joint report from PIRSA and Santos
Division of State Aboriginal Affairs
Goolburri Aboriginal Corporation
Tourism Resource Group - a joint report of SA Tourism Commission, Flinders Ranges and Outback South Australia Tourism, National Parks and Wildlife and South Australian Association of 4WD Clubs.
DEHAA Biodiversity and Evaluation Program - Report on Pastoral Lease Assessment

These submissions are filed in Docket 25 7/2102 within the Department of Environment, Heritage and Aboriginal Affairs.

6.2 Issues Raised in Submissions

Regional Reserves - the multiple land use concept

There has been considerable discussion during the development of the Regional Reserve classification and since proclamation of the Innamincka Regional Reserve of the benefits and flaws of the multiple land use concept, its implementation and management.

There is concern that the process and agreements which established the reserve were not transparent and many submissions argue *that a full description of the model needs to be presented including details of the commercial land use agreements.*

Several submissions expressed the opinion about the Regional Reserve category:

- *that the category operates against the best interests of conservation by:*
  - *artificially inflating the area of the State which is reserved for conservation purposes*
  - *putting conservation a poor third to the interests of the economically beneficial resource use industries: petroleum and pastoralism*

- *weakening the State's argument for commitment to the conservation of the wetlands in which we need the cooperation of the Queensland Government to prevent further water diversion and the introduction to the near natural system of agricultural fertilisers and chemicals*
- *being managed as a 'low cost' conservation option when in reality the integration and supervision of the exploitative land uses requires more, not less involvement of Department of Environment, Heritage and Aboriginal Affairs staff.*

An alternate view has been expressed by one of the resource use partners at the reserve:

Negative comments on the Regional Reserve stem more from marked differences in people's value systems than from any hard data on land use. At one end of the value system is the argument that a 'hands off' approach will preserve all species and enhance the spiritual values of natural settings. The contrasting view is that nature is inherently variable and unstable; no particular species are guaranteed to survive, and that wise use, so long as it preserves the critical functioning of the system, is a sensible endeavour of mankind,

and adds:

in effect the reserve was proclaimed to provide jointly for nature conservation, recreation, and the existing legal uses of resources. If there is a single major goal for Regional Reserve it is to pioneer and '....establish management strategies that successfully integrate the different uses for which the reserve has been proclaimed'.

Review Process

It was argued in several submissions that the review process needed to be transparent, provide for community input and include a contingency valuation.

Contingency Valuation has been recommended to assess proposed petroleum industry operations within the CLCZ.

The impacts of resource exploitation on other values need proper analysis eg. consideration of long term environmental costs, the contribution of tourism, and there needs to be realism rather than speculation concerning projected profit figures from various extractive industries.

There are significant threats of compromise for short-term economic gains that may jeopardise long term values. Therefore, there should be a comparison of short-term economic gains as against long term gains through conservation.

Reserve Status /Conservation Objectives

Several submissions strongly advocated that at least a portion of the reserve should be zoned for conservation as sole purpose. This was expressed in a number of ways:

- *The Coongie Lakes Control Zone has features that ought to be recognised and conserved under an IUCN category 1 reserve ie National Park.*
- *Some areas of the reserve, particularly the CLCZ need to be zoned as core conservation areas from which pastoral and petroleum activities are excluded or, dedicate these areas of the reserve as a higher conservation order reserve such as Conservation Park or National Park.*
- *Regional reserves are not included in the CARRS program, and it is strongly proposed that 10-15% of the Lower Cooper Wetlands bioregion needs to be conserved under the CARRS program to ensure genuine ecological sustainability.*

Monitoring

Monitoring is seen as an essential tool in determining the effectiveness of Regional Reserves in meeting conservation objectives and the impacts of land utilisation on those objectives. The following comments were made about monitoring needs and opportunities:

- *Monitoring is essential to maintaining natural values of the area and must be independent and include random audits.*
- *Long term and systematic monitoring is needed, because the philosophy of Regional Reserves is compromised if no figures or evidence is available to assess whether this form of management is effective, eg. Is the area better managed than previously? Has degradation ceased? Has condition improved and so on.*
- *There is a lack of quantitative studies on the impacts of pastoralism on the native biota. Given the potential for conflict between the two land uses, conservation and pastoralism, this lack is a serious flaw in the last ten years of management of the reserve. With fencing of some areas there is now an opportunity to do comparative studies. However, these must have expert and independent planning input and implementation as well as the involvement and co-operation of Kidman Pastoral Co.*
- *Studies are needed of impacts of gas and petroleum industry on aquatic wildlife and wetlands in the reserve (such as Embarka Swamp on Gidgealpa Station[3]). There is a need for quantitative post-impact studies. These should include a widening of the 'wildlife' criteria to include hydrology, erosion/depositional changes, bioaccumulation of pollutants as well as more general plant and animal studies. This is a significant opportunity for research and is especially important due to plans for the potential development of mining prospects at Coongie and Tirrawarra Swamp.*
- *Studies of the respective impacts of the pastoral, tourism, and petroleum industries are needed. These should seek to compare each with the other, as well as investigating the impacts of each industry individually and cumulatively. This information could then be used to determine which industry/ies are more, or less, appropriate in particular areas.*
- *The issues to be studied are complex, as the spacio-temporal variability of the system (climate, landscape, flora, and fauna responses) is highly complex, and identifying contemporary and continuing impacts from historical legacies of over-grazing episodes would be difficult.*

Aboriginal Cultural Heritage

The Goolburri Land Council (a body that represents some Yandruwandha traditional owners in Queensland) provided a submission which expressed concern about:

- *damage to sites, or about a general change in the landscape and its relationship to people. Custodianship of country is still a matter that instills concern when traditional owners discuss developments in their region*
- *the impacts of seismic survey, while not great in any one location are widespread and significantly modify the landscape. Pastoral activities also impact on the cultural heritage*
- *considering the legal and practical implications of Native Title rights that may exits in respect of the resources of the reserve, including use rights hunting/fishing as well as maintenance of natural features or habitats such as wetland areas.*

[3] although Gidgealpa Station is not within the Regional Reserve, it is within the larger Wetlands of International Importance (edit note).

Consultation with Aboriginal people of the region (Nicholson 1998 a&b) raised the following issues:

Access.

Public access to the Lakes is restricted to Lake Coongie, and access to the northern lakes is not provided. Aboriginal community members requested access on cultural grounds to these areas to visit spiritually important sites, to pass on knowledge of places and sites.

Older community members feel cautious about visiting areas for cultural reasons because for much of their lives this access has not been permitted or has been discouraged. Specific consideration to the needs of the local Aboriginal community with regard to access is required.

Access from the Birdsville track to Innamincka has also been requested. Aboriginal people with links to this area live in Birdsville and SW Queensland and opportunities to visit the area would be increased if access via the Walkers Crossing track was available to the community.

Decision Making

An appropriate structure for consultation with the Aboriginal community is required for the Regional Reserve. The North - East Aboriginal Land Corporation (NELAC) has been involved in the past and the status of this organisation needs to be clarified. Native Title Claimant groups need also to be consulted. Aboriginal Legal Rights Movement (ALRM) which may also provide an appropriate forum may establish a Native Title Working Group.

Problems have been identified with the current process of development related site assessment. Community consultation on such assessments needs to cater for the broad spread of members of the Community by establishing contacts with key individuals and groups and for the need for communal decision making.

Petroleum

The submissions from the conservation sector showed concern and disappointment that the delineation and agreements regarding CLCZ did not provide sufficient protection for this internationally significant wetland area from seismic exploration.

The control Zone concept is vital for the protection of key areas, but obviously isn't working adequately at present as the Santos Western Prospects survey in the wetlands area was approved. The special care provisions in the Declaration of Environmental Factors and supplement really only define best practice procedures that should pertain to any arid area.

Visitor Experience

The changes to the visitor clientele and activities brought about by the proclamation of the reserve under the *National Parks and Wildlife Act* has not been without its critics. Many local businesses were threatened by, and very critical of the changes. But over the ten years since proclamation most of the issues have been resolved.

One outstanding remaining conflict remains. Four-Wheel-Drive Clubs regularly and consistently raise arguments for access to more of the reserve. A submission to this review was received from the South Australian Association of Four-Wheel-Drive Clubs (SAAFWDC). This submission makes a number of points:

- *that while the pastoral and petroleum uses of the reserve extract large amounts of product from the reserve, tourism does not involve the taking of resources, although there is some utilisation of resources such as firewood and fish*
- *in terms of impact, assuming that there are approximately 350 km of roads and tracks accessible to visitors within the reserve and allowing a 1 km corridor of impact to that length, vehicle based access is limited to just 2.5% of the 13 818 km^2 of the reserve. This is compared to the 100% access granted to the pastoral and petroleum industries*
- *that tourism is 'value for money', and will prove to be a valuable, low impact user of the reserve now and in the future. The 4WD tourist has much to offer the State in terms of income from Desert Parks Passes, fuel, and local purchases at Innamincka. The areas proximity to the eastern States ensures that it attracts money to the State of SA. The value of the 4WD traveler is that the income from this sector will continue, it is not exhaustible*
- *that given the value of tourism to the State and its demonstrated limited impact on the environment compared with the other permitted resource utilisers that the imbalances in involvement in management of the reserve and visitor access to a greater area within the reserve be addressed.*

The tourism working group raised the issue of the impacts of the various land uses on tourism. In their submission, it was indicated that:

- *the pastoral and petroleum land uses not only impact on the environment but also on the quality of the tourism experience*
- *in the case of cattle grazing the denudation of the landscape had affected the quality of the tourism experience. The land has become progressively and uncharacteristically barren and unattractive (ACF 1992).* It is worth noting that this comment relates to the period in which stock numbers were too high.
- *in the case of petroleum activities the major impact involves the creation of 'roads' in the form of seismic lines that are sometimes used by third parties (such as visitors or for pastoral purposes) slowing their regeneration.*

Pastoralism

Many submissions focussed on the apparent incompatibility of conservation and a cattle enterprise.

The submission to the review from one of the resource users argues that:

There has always been vigorous debate over multiple use and the success of the Regional Reserve concept. Much of the debate stems from the perception that nature conservation is the principal objective within a Regional Reserve.

That respondent put the view that:

Nature conservation is a co-habiting and equal objective along with wise use of the natural resources. There are provisions for nature conservation to prevail as the prime objective in selected areas. The gazettal of Regional Reserve provides a formal mechanism for Government to commit resources to conservation management, but it equally recognises prior legal rights to land use. Although nature conservation is the prime intent of the National Parks and Wildlife Act, the gazettal of Regional Reserve does not automatically convey nature conservation as the prime intent for all lands within the reserve.

This is supported with the legal advice that:

The interests of conservation on the one hand and utilisation on the other appear to be on an equal footing under Section 34A of the Act. There is nothing in the Act to suggest otherwise and the Parliamentary Debates support the view that Parliament intended that the two interests be equally balanced. (AGD 2956-98).

This submission continues in support of the pastoral industry to argue that the acceptability of pastoralism in a reserve is about meeting community expectations and perceptions:

The question is really whether it is socially acceptable and which values carry weight in the setting of government policy. Two American authors (Heintschmidt and Walker 1997) suggest that plant species composition (diversity) does not impact society's acceptance of grazing nearly as much as amount of standing biomass, ground cover, number of faecal pats, and water quality. Social acceptance of grazing at Innamincka will therefore be maximised by excluding cattle from popular camping areas, and through timely adjustments of stock numbers in the face of declining seasons. The exclosure comparisons of samples of grazed and ungrazed land types may also inform visitors and raise acceptance of grazing as being compatible with other uses. Hosting visits which demonstrate the practical workings and lifestyle on a remote cattle station may offer commercial and public relations opportunities. However the introduction of such a program into a corporate beef operation would present a range of business and human resource challenges. Any debate over the future of grazing at Innamincka is essentially one of value difference. Pastoralism has been demonstrated to be economically beneficial, economically viable and ecologically sustainable

Submissions from the conservation sector disagree with the view that pastoralism is ecologically sustainable and argue that pastoralism is not economically viable when the natural resource values of the region are taken into the benefit cost analysis:

The SA Government lacks power to implement adequate protection of the most ecologically important areas within the reserve due to the nature of the deal struck with Kidmans when the reserve was originally set up. In particular, the Government can't act to achieve a proper spatial separation of conflicting land uses eg. pastoralism and nature conservation, unless Kidman's consent to major administrative changes as a gesture of goodwill.

There is a lack of quantitative studies on the impacts of pastoralism on the native biota. This lack is a serious problem. With fencing of some areas there is now an opportunity to do comparative studies. However, these must have expert and independent planning input and implementation as well as the involvement and co-operation of Kidmans.

Socio-economic cost benefit analysis, some points to be considered:

- *the value of pastoral production is very small compared to value of hydrocarbon industry*
- *grazing is only viable due to periodic flows down the Cooper and is thus in conflict with the conservation values of the area which are also dependent on these flows*
- *grazing impacts are extensive, affecting virtually all of the landscape, whereas hydrocarbon industry impacts are more restricted and localised. Profits and returns from the hydrocarbon industry are much greater than from pastoralism*
- *mitigating against land degradation caused by pastoralism is a high-risk activity in arid areas with exceptional biotic and climatically driven variability and low economic returns. Degradation can happen quickly but recovery is slow. Pastoralism is not compatible with formal nature conservation and should be excluded from key areas such as the CLCZ. The success of pastoralism in the area is dependent on flows down the Cooper, which also give Coongie its unique conservation value, ie. the two are in direct conflict*
- *Kidmans should release figures on annual herd sizes on a paddock by paddock basis (minimum and maximum annually), and turn-off figures as numbers of livestock by class and market value.*

Pastoral leases in the Ramsar area and CLCZ wetland should have publicly available management plans compatible with Coongie Lakes Wetlands Ramsar plan.

7 DISCUSSION

Innamincka Regional Reserve was the first Regional Reserve to be proclaimed. The need for management structures and resources to ensure the maintenance of the ecological integrity of the wetlands of the reserve was the motivating objectives for the development of the regional reserve classification and its implementation at Innamincka.

The Coongie Lakes and Cooper Creek wetlands of the region are recognised as internationally important and are listed under the Ramsar Convention.

The resources of the reserve have significant ecological, intrinsic and economic value to the community. The utilisation of the resources of the reserve poses threats to the maintenance of its natural and historic values and these threats need to be managed and minimised. The utilisation of resources includes extraction by the petroleum industry, tourism, pastoralism and extraction of water by upstream domestic and agricultural users. Spatial and temporal separation of activities is often necessary to ensure areas of particular importance are not disturbed. The success of the regional reserve concept of multiple land use in a conservation context depends on balancing and respecting the needs of the various values and uses of the area.

Table 8 summarises Resource Utilisation Impacts.

7.1 Petroleum

Over the period 1988 to 1998 oil and gas exploration and production has contributed over $2 600 million to the State's Gross State Product. This expenditure has created net incomes for South Australians of over $ 1.4 billion and created over 4 080 jobs per annum.

Petroleum activities have been assessed as having a high though temporary impact on the landscape features of the reserve and a low impact on its wildlife and cultural features.

Over the last ten years they have generally avoided disturbing areas of high cultural or biological significance. The major impacts are: temporary modification of the landscape in the course of seismic operations; longer term modification of the landscape for developments such as roads and production facilities; third party use and continued disturbance of seismic lines and the risk of pollution to the wetlands by oil or chemical spill.

To ensure that impacts on the landscape, wildlife and cultural features of the reserve are reduced or at least maintained at their current levels it will be necessary to ensure that future Petroleum Exploration and Production Licence holders adhere to the objectives for operations developed by PIRSA and use appropriate technologies. Methods are being developed to further reduce the visual impact and third party use of seismic lines. It is also recommended that a better understanding of the impact of oil in this environment be developed so that appropriate ameliorative measures for management of oil contamination may be developed.

The estimated economic impact of oil and gas exploration and production from the reserve area in the next ten years is about $950 million and 1 475 jobs per annum.

Table 8 Summary of Resource Utilisation Impacts at Innamincka Regional Reserve

	Landscape Features	Wildlife Features	Aboriginal Cultural Features	Non-aboriginal cultural features	Contribution to Economy of State 1988-1998	Forecast Contribution to Economy of State 1998 – 2008
Petroleum	HIGH IMPACT The overall impact of petroleum exploration and production activities is considered to be relatively high on a temporary basis. The major impacts are: temporary modification of the landscape in the course of seismic operations, and less temporary modification by roads, well sites, pipelines and satellite processing plant.	LOW IMPACT The overall impact on wildlife features of the reserve through destruction and disturbance of habitat, vegetation, soils and animals and pollution of exploration and production processes and facilities is considered relatively low. Impacts are confined to specific sites and are not selective.	LOW IMPACT The impact of petroleum activities on the Aboriginal cultural features of the reserve is considered relatively low. Petroleum activities avoid sites of cultural significance. However Aboriginal people are concerned about the impact of seismic operations on the cultural landscape.	LOW IMPACT Petroleum activities avoid sites of cultural significance.	$ 2 600 million	$ 950 million
Tourism	MODERATE IMPACT The overall impact of visitor facilities such as campgrounds, toilets and low line fencing on the landscape features and wilderness like quality of the reserve is considered relatively moderate. The impacts are restricted to a few nodes at key wetland areas and to a minor extent along access routes.	LOW IMPACT The overall impact on wildlife features of the reserve through destruction and disturbance of habitat, vegetation, soils and animals and pollution of visitors and their activities is considered low. Impacts are confined to relatively small areas.	LOW - MODERATE IMPACT The impact of visitor activities on the Aboriginal cultural features of the reserve is considered moderate. In the past the collection of artifacts has impacted on the cultural features of the reserve in some locations, however awareness of the inappropriateness of this behaviour is increasing	LOW IMPACT Visitor activities have not impacted on sites of non-aboriginal significance over the last ten years.	$ 9.4 million	$ 15-$18 million

Pastoralism	MODERATE IMPACT The overall impact of the cattle enterprise developments such as fences, wells, yards and stock on the landscape features and wilderness-like quality of the reserve is considered relatively moderate.	HIGH IMPACT The overall impact on wildlife features of the reserve through destruction and disturbance of habitat, vegetation, soils and animals and pollution of pastoral enterprise is considered high. Stock grazing impacts are selective both spatially and at species level. Grazing impacts across the whole of the reserve although intensity varies	HIGH IMPACT The impact of pastoral activities and stock on the Aboriginal cultural features of the reserve is considered high Waterholes and lakes are the focus of stock activity and are areas of high archaeological value.	LOW IMPACT Pastoral activities avoid sites of cultural significance. Pastoral enterprise is part of the non-aboriginal cultural landscape.	$ 3.3 million	ca $ 3.3 million
Water Extraction	HIGH IMPACT The impact of the proposed increases in water extraction for domestic and agricultural purposes by upstream users in Queensland will substantially alter the flow regimes of the Cooper system. These changes will alter the landscape of the reserve.	HIGH IMPACT The biology of the wetlands of the reserve is dependent on the fluctuations in flow regime. Alteration of the variety of peak and volume of floods will have a significant impact on the ecology and biology of the reserve.	MODERATE IMPACT Changing the flow regimes may alter the location and extent of water bodies. This will affect the cultural landscape of the wetlands.	LOW IMPACT The pastoral and exploration history of the area is linked to the water bodies of the area. Changes to these water bodies will affect the enjoyment of the heritage of the area.		
Feral and Pest Animals	MODERATE IMPACT The overall impact of feral animals such as pigs, brumbies, donkeys and rabbits on the landscape features and wilderness-like quality of the reserve is considered relatively moderate.	HIGH IMPACT The overall impact on wildlife features of the reserve through destruction and disturbance of habitat, vegetation, soils and animals of feral and pest animal populations are considered high. Pigs impact the wetland areas, rabbits the sandy areas, and donkeys and horses the gibber areas.	MODERATE IMPACT The impact of feral animals on the Aboriginal cultural features of the reserve is considered moderate and in some locations it may be high. Feral and pest animals trample and burrow areas of high archaeological value.	LOW IMPACT No impact from feral animals is evident.		

7.2 Tourism

Over the last decade tourism has contributed over $9.4 million to the State's Gross State product. This expenditure has supported net incomes for South Australians of approximately $7.5 million, including over 31 jobs per annum.

The development of visitor facilities and visitor impacts have been assessed as having a moderate impact on the reserves landscape features, low impact on the wildlife and ecology of the reserve and a low to moderate impact on the Aboriginal cultural features of the reserve.

Human use of natural areas inevitably leads to changes in condition of those areas. As the use of an area increases resource conditions change until the character of the recreation setting is altered.

The provision of visitor facilities such as toilets and camp grounds, visitor management structures such as low line fencing and sign-posting, litter and the proliferation of tracks by off road vehicle use impact on the wilderness quality of the landscape in localised areas.

Visitor impacts on wildlife are considered low and include the taking of fish, clearance of vegetation around campsites and for firewood and pollution of waterholes with small amounts of soap and other products. These impacts are limited to localised areas.

The collection of Aboriginal artifacts and disturbance of Aboriginal sites by visitors is likely to amount to a moderate impact on the Aboriginal cultural features of the reserve, although impacts on Aboriginal relics and sites has not been surveyed or monitored.

Increasing interest by visitors in non-Aboriginal heritage of the reserve encouraged the rebuilding of the Australian Inland Mission nursing home at Innamincka. Funds were donated by the public and matched by the Government for this renovation and the building now houses the Park Ranger, NPW office and visitor interpretation display.

The net value of tourism over the next ten-year period is likely to grow and it is estimated that it will be in the order of $15 to $18 million.

7.3 Pastoralism

Over the ten years of the reserve Innamincka Pastoral Company operations at Innamincka Station have contributed over $3.3 million to the State's Gross State Product. This expenditure had created net incomes for South Australians of approximately $3.3 million and created around 12 jobs per annum.

The Innamincka Regional Reserve area has been utilised for pastoral purposes for over a century. Early pastoral activities are known to have lead to widespread vegetation and habitat damage. The contemporary pastoral management practices are more responsive to seasonal conditions and an improvement in the rangeland condition has been recorded.

The impact of pastoral operations on the landscape features of the reserve is considered moderate, impacts on the wildlife features are considered high and impacts on the Aboriginal cultural features are likely to be high.

The presence of pastoralism in the area is evidenced by station improvements such as fences, windmills and yards and, the off road use of vehicles for stock management. These structures and off road vehicle use impact on the wilderness features of the landscape. The pastoral industry is also a significant part of the cultural heritage of the region and Australia.

Impacts to wildlife are difficult to quantify due to the highly variable nature of the climatic and flooding regimes of the region. Research indicates that the selective nature of cattle grazing and the preference of cattle for wetland environments will lead to alterations in plant community composition and diversity and thence to altered habitats. The distribution of stock water places more than half the reserve area within range of high to moderate stock grazing pressure, and these are focussed on the wetlands of the reserve. To ensure the maintenance of the biodiversity values of these very significant wetlands stock management within these areas needs to be closely monitored reviewed and where necessary modified. The recent fencing of the Coongie Lakes and Cullyamurra exclosures has enabled stock to be removed from these two highly significant wetlands areas. Nevertheless the implications for the biological integrity of the greater reserve area of continued pastoral production is gradual alteration of biological diversity and integrity of wildlife.

Aboriginal sites, relics and mythology focus on the natural waterbodies of the region. The preference of cattle for these environments and their use of natural waterbodies mean that the trampling and grazing by stock impact areas of high archaeological and cultural significance. These impacts have not been extensively surveyed at Innamincka but an assessment of some sites in 1995 commended Innamincka pastoral Company in respecting and conserving these sites. Research in other areas however indicates that the potential for of stock impacts on Aboriginal cultural heritage is high.

The contribution of the Station to GSP over the next ten years should be at least as good as the previous ten-year period. This forecast is based on the assumptions that previous average stocking rates are maintained, future seasonal patterns are similar to those experienced over the last 10 years and that beef prices are relatively unchanged.

7.4 Water Extraction

The chief concern with regard to the maintenance of the integrity of the wetlands of the reserve is the upstream extraction of water from the Cooper Creek and its catchment in Queensland. Significant amounts of water are withdrawn from the system in Queensland for domestic and agricultural purposes. The Queensland Government has proposed a Cooper Creek Water Management Plan that would allow a further increase in withdrawals of water from the system. This proposed increase in water extraction poses a significant threat to the health and integrity of these wetlands of international importance.

The South Australian Government has commented on the Queensland Government's Cooper Creek Water Plan, has entered into a Heads of Agreement with the Queensland and Commonwealth Governments and has supported the establishment of the Lake Eyre Basin Coordinating Committee and the Cooper Creek Catchment Committee. The intention of the SA Government's involvement in these fora is to promote the development of whole-of-catchment management strategies that will sustain these unique wetlands.

The South Australian Government submission to the Queensland Government on their draft Cooper Creek Water Management Plan recommends (among other things) that:

- no additional water be allocated from the Cooper Creek pending completion of negotiations on the Lake Eyre Basin Agreement
- a high level of commitment is accorded to negotiations for the cross-border Agreement to provide a framework for managing cross-border water resource issues.
- Water resource planning and management in Cooper Creek be based on an integrated catchment approach, recognising cross-jurisdictional issues

These recommendations are consistent with protecting the ecological character of the wetlands of the reserve.

7.5 Feral and Pest Animals

Rabbits, feral pigs, horses and donkeys are on occasions significant pests within the reserve. Feral animals contribute to changes in vegetation diversity and abundance and changes in native animal habitat.

The impacts of feral animals on the reserve's landscape features are considered to be moderate. Impacts on the wildlife features are considered high while impacts on Aboriginal cultural heritage are considered moderate. The impacts on wildlife features relate to selective grazing behaviour and disturbance of vegetation and soils. The trampling of feral animals also has a moderate impact on archaeological features of the reserve. Rabbit populations have been reduced by 70-80% since the introduction of Rabbit Calicivirus Disease. Mustering and shooting is used to control populations of pigs, donkeys and horses.

7.6 Community Perceptions

It is important to recognise that the Regional Reserve classification has not had the support of the conservation organisations of South Australia. Conservation representatives consistently argue that the Regional Reserve concept is flawed, that it artificially inflates the area of the State set aside for conservation purposes, that it puts conservation a poor third behind the resource use interests, petroleum and pastoralism and, that it weakens the State's position over negotiations regarding Cooper Creek water flows.

On the other hand the Regional Reserve classification has provided a framework to protect a significant area of natural habitat while allowing use of the natural resources of the area to continue. The framework has enabled the development of partnerships between Government and principal land users.

7.7 Management Structures

The Innamincka Working Group is an informal communication network between the three primary land managers. This group has been a successful medium for communicating most on ground works. It has not however provided a fully integrated land use management team. The group needs include managers responsible for pastoral lease assessment and Aboriginal cultural needs.

The Coongie Lakes Control Zone Management Group was established to oversee petroleum exploration and production activities within the CLCZ. An extensive seismic exploration program in the CLCZ in late 1997 was highly regulated and audited and included a community consultation phase. The involvement of the CLCZ MG in the oversight of this seismic survey achieved positive outcomes, which met both community and environmental concerns.

The Far North Consultative Committee has provided an adequate forum for communication between the land managers of the reserve and other stakeholders such 4WD clubs, the local community, the Marree Soil Conservation Board, Arid Areas Water Resources Committee and Lake Eyre Basin Catchment Management. Conservation interests tend to express their concerns direct with the Department for Environment, Heritage and Aboriginal Affairs.

The management plan for Innamincka Regional Reserve was gazetted in 1993. Although this review has not included a formal evaluation of the management plan most objectives for management have been met. In the process of this review it has become evident that the exiting management plan does not provide clear goals and objectives for management of the reserve. This plan ought to be reviewed in the near future and the review needs to include an evaluation of progress towards the objectives of the management plan and, establish clear objectives for conservation and visitor management. Future plans should also include an action plan that enables easy evaluation of progress towards, or review of, objectives.

To date data gathering has been focussed on the biological diversity of the wetlands in particular and pastoral lease assessment. Monitoring for other purposes has been hindered by the lack of clear objectives. The development of clear objectives for conservation and visitor management would assist in establishing targeted monitoring programs and to evaluate the achievement of the objectives.

8 RECOMMENDATIONS

8.1 Reserve Status under the Act

It is the finding of this review that overall, the proclamation of Innamincka Regional Reserve has resulted in positive environmental and economic outcomes. The benefits of reserve status has included improved environmental management, while the multiple-use management regime has provided opportunities to generate significant wealth for the State.

> **It is therefore recommended that the Innamincka Regional Reserve remain a Regional Reserve as classified under the National Parks and Wildlife Act at least until the next review within the next ten years.**

While there is some public concern that the wetlands of the area are not adequately protected under the regional reserve classification, the findings of this review are that generally the conservation of wildlife, natural and historic features of the reserve has improved since its proclamation in 1988.

Improved land management effort is demonstrated by the environmentally sensitive approach to recent seismic activities in the reserve, the establishment of the Coongie and Cullyamurra Exclosure Paddocks which exclude cattle, the placement of a National Parks and Wildlife ranger at Innamincka and the provision of visitor facilities within the reserve. Overall, grazing management has improved but there is continuing locally high impact in areas of environmental importance.

The contribution of the petroleum industry to the economy of the State over the last decade is estimated to be about $2.6 billion, the contribution of tourism $9.4 million and pastoralism $3.3 million. Over the next ten years it is estimated that while the petroleum industry's contribution will fall to about $950 million, the contribution of tourism will perhaps double and that of pastoralism will remain about the same.

The benefits to the State's economy through opportunities provided by the Regional Reserve classification are significant, but over the next ten years this may change and the benefit-cost of the integration of conservation with land uses that utilise the natural resources of the reserve may also change. Therefore, the status of Innamincka Regional Reserve will therefore be reviewed again within the next ten years.

8.2 Future Management of Innamincka Regional Reserve

Management Plan

It is recommended that the Management Plan for Innamincka Regional Reserve be revised in the near future and that the revision provides:

- ecological and wildlife conservation objectives and priorities for the reserve, with associated monitoring requirements and performance measures
- a structure, terms of reference and formal reporting mechanism for an integrated reserve management group comprising representatives from:
  - petroleum industry
  - petroleum industry regulators
  - pastoral lessee
  - pastoral lease assessment officer
  - National Parks and Wildlife South Australia.
  - Aboriginal community
- a clear process for the next review pursuant to section 34A to be applied within the next ten years.

Petroleum

Petroleum activities in the Coongie Lakes Control Zone (CLCZ) have been highly regulated, and impacts on the environment have been significantly reduced since the early 1980s. In February 1999 Petroleum Exploration Licenses 5 and 6 will expire. The current arrangements for the management of petroleum operations in the Coongie Lakes Control Zone are through an Agreement with the current licence holders.

> **It is recommended** that at least the same level of regulation be applied to any future petroleum licence holders in the reserve to ensure the current level of protection of wildlife, landscape and Aboriginal heritage features is maintained.

The Coongie Lakes Control Zone boundary and management group was established in the late 1980s. Ecological knowledge and understanding of the area has advanced and it is considered timely that a review of the boundary and management arrangements be undertaken.

> **It is recommended** that a review of the boundaries of the CLCZ be undertaken to establish whether the current Zone includes adequate representation of wetland areas of significant ecological importance and provides adequate protection to those wetlands.

Tourism

A draft development plan for the management of visitors and the development of visitor infrastructure within Innamincka Regional Reserve was prepared in 1996.

> **It is recommended** that the visitor Infrastructure Developments Plan for the reserve be reviewed to ensure that infrastructure development and visitor management prescriptions proposed in the draft development plan adequately provide for visitor needs and protect the landscape, wildlife, and cultural features of the reserve.

Pastoralism

It is acknowledged that the Coongie Lakes and Cullyamurra Exclosure paddocks permanently exclude cattle grazing from some prime wetland areas. However while the petroleum industry activities are highly regulated to ensure the protection of wetlands features especially the CLCZ, stock impacts on wetlands features still open to pastoral use are of concern.

> **It is recommended** that early discussions be held with the pastoral lessee to review stock management practices with the objective of managing stock impacts on wetland areas.

The establishment of an integrated reserve management group, which includes departmental pastoral management expertise, will largely address this concern.

Water Extraction

Intergovernmental agreements and community catchment committees have been established to develop strategies for sustainable catchment management.

> **It is recommended** that the South Australian Government maintain its commitment to the maintenance of water flows and duration to meet environmental requirements.

8.3 Data Requirements and Analytical Frameworks for Future Reviews

The establishment of clear objectives for management of the reserve will enable targeted monitoring programs to be established. Targeted monitoring programs will provide appropriate information for futures reviews of the reserve.

This review has used existing data, which in some instances is inadequate for the purposes of the review.

It is **recommended** that to improve the accuracy and accountability of future reviews data be collected on the following:

- visitor numbers, and visitor travel profile
- conservation values of the reserve
- resources dedicated to the management of the reserve including share of administration costs, specific projects, research activity, rescue and policing.

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10 APPENDICES

10.1 Appendix A Interpretation of the Provisions of Section 34A of the Act

In undertaking the review, it has been necessary to ensure that the requirements of the Act are properly addressed. To facilitate this process, an interpretative analysis of section 34A was conducted and is provided below. This analysis has been used to guide the conduct of the review. It is also useful in guiding readers of the report.

For the purposes of section 34A (5)(a)(i) and (ii), *natural resources* are considered to be:

- native vegetation which is utilised by pastoral stock for feed
- petroleum and any mineralisation that require the process of recovery to be undertaken by operations that take place within the boundaries of the reserve
- native vegetation which is utilised by pastoral stock for feed
- landscapes and natural features including native vegetation, native animals, birds, insects and other small fauna that are of recreational and educational value to visitors to the reserve and which are accessible to visitors in accordance with the management plan for the park, and
- surface and sub surface water recovered from within the boundaries of the reserve.

For the purposes of section 34A (5)(a)(i) and (ii), *utilisation of natural resources* is taken to mean:

- recovery (petroleum), mining, grazing (pastoralism), environmental appreciation and recreation activity (tourism) and water recovery and use (general) and includes the infrastructure necessary to facilitate such utilisation
- recovery and utilisation of water prior to its inflow to the reserve and

where such utilisation is consistent with the specific objective in the Act in relation to the management of regional reserves, that is to say 'to permit the utilisation of natural resources while conserving wildlife and the natural or historic features of the land'. (Section 37j)

For the purposes of section 34A (5)(a)(i), i.e. in the context of conservation, *impact of utilisation* is taken to mean:

- the effects upon the condition of the wildlife and natural features of the reserve and the management strategies that are considered necessary and adequate to sustainably conserve the wildlife and natural features of the reserve, and
- the effect upon the approach taken to managing the wildlife and natural features of the reserve as a response to a regime that provides for land uses other than those characteristic of other classifications of reserve under the Act.

For the purposes of Section 34A (5)(a)(i), *conservation of natural and historical features of the reserve* is to have such a meaning as to be consistent with the relevant objectives for managing reserves as set out in Section 37 of the Act, the relevant objectives being:

(a) the preservation and management of wildlife

(b) the preservation of historic sites, objects and structures of historic or scientific interest within reserves

(c) the preservation of features of geographical, natural or scenic interest

and where such preservation is undertaken in accordance with other objectives of the Act as set out in paragraphs (d) to (g) which address the deleterious impact of weeds and exotic plants, vermin and exotic animals, diseases of animals and vegetation and bush fires and other hazards.

For the purposes of Section 34A (5)(a)(ii), ie in the context of the economy of the State, *impact of utilisation* is taken to mean:

- the contribution of utilisation to the economy of the State in dollar terms, and
- any offsets to benefits that might be occasioned by one form of utilisation as a result of another.

For the purposes of section 34A (5)(a)(iii), *the future status under this Act of the land constituting the reserve* is taken to mean the classification of the reserve under Part 3, Divisions 1 - 4 and 4A of the Act, the classifications available being National Park (Division 1), Conservation Park (Division 2), Game Reserve (Division 3), Recreation Park (Division 4) and Regional Reserve (Division 4A).

Further, for the purposes of section 34A (5)(a)(iii), *recommendations as to the future status of the reserve* are taken to relate to recommendations made in consideration of:

- the original intent of the reserve classification in providing for the management of the reserve for the purposes of conserving wildlife and natural features and utilising natural resources, and
- any factors that as a result of the review, significantly appear to work against the purpose of the Regional Reserve classification in providing direction for, and facilitating the management of, the reserve.

While the Act, at section 34A, does not provide for the framing of recommendations regarding the ongoing management of the reserve, section 38 of the Act does provide for the preparation and periodic review of reserve management plans.

During the conduct of the review, issues emerged that will need to be addressed in the ongoing management of the reserve. Some of these issues relate to the scope and quality of baseline data upon which critical analysis of management should rely and which will be essential for the conduct of future section 34A reviews. Other issues relate directly to the standards and aspects of management that need to be addressed on an ongoing basis.

Recommendations for management, therefore, while not a requirement in the context of the section 34A report, are nonetheless included in this report for the purposes of foreshadowing those issues that will be need to be addressed in reviewing the plan of management for this reserve.

10.2 Appendix B

Table 1. A list of vascular plants

Recorded from site records for Innamincka Regional Reserve in the South Australian Biodiversity Database October 1995 download. Introduced species are marked with an asterisk

FERNS AND ALLIES	
Azollaceae	
Azolla filiculoides	Pacific azolla
Marsileaceae	
Marsilea drummondii	common nardoo
Marsilea hirsuta	short- fruit nardoo
Ophioglossaceae	
Ophioglossum polyphyllum	large adder's-tongue
DICOTYLEDONS	
Aizoaceae	
Glinus lotoides	hairy carpet-weed
Gunniopsis quadrifida	Sturt's pigface
Mollugo cerviana	wire-stem chickweed
Tetragonia tetragonioides	New Zealand spinach
Trianthema triquetra	red spinach
Zaleya galericulata	hogweed
Acanthaceae	
Dipteracanthus australasicus ssp. glabratus	no common name
Rostellularia adscendens ssp. adscendens	var. red trumpet
Amaranthaceae	
Alternanthera angustifolia	narrow-leaf joyweed
Alternanthera denticulata	lesser joyweed
Alternanthera nodiflora	common joyweed
Amaranthus grandiflorus	large-flower amaranth
Amaranthus mitchellii	Boggabri weed
Ptilotus latifolius var. latifolius	tangled mulla mulla
Ptilotus macrocephalus	feather-heads
Ptilotus nobilis	var. yellow-tails
Ptilotus obovatus var. obovatus	silver mulla mulla
Ptilotus polystachyus var. polystachyus	long-tails
Ptilotus sessilifolius var. sessilifolius	crimson-tails
Asclepiadaceae	
Cynanchum floribundum	desert cynanchum
Sarcostemma viminale ssp. australe	caustic bush
Boraginaceae	
Halgania cyanea	rough blue-flower"
**Heliotropium curassavicum*	smooth heliotrope
Heliotropium filaginoides	no common name
**Heliotropium supinum*	creeping heliotrope
Heliotropium tenuifolium	bushy heliotrope
Omphalolappula concava	burr stickseed
Plagiobothrys plurisepaleus	white rochelia
Trichodesma zeylanicum	camel bush
Campanulaceae	
Wahlenbergia gracilis	sprawling bluebell
Wahlenbergia tumidifructa	swollen-fruit bluebell
Capparaceae	
Capparis mitchellii	native orange
Caryophyllaceae	
Polycarpaea arida	no common name
Chenopodiaceae	
Atriplex acutibractea ssp.	pointed saltbush
Atriplex angulata	fan saltbush
Atriplex crassipes var. crassipes	no common name
Atriplex elachophylla	no common name
Atriplex fissivalvis	gibber saltbush
Atriplex eardleyae	Eardley's saltbush
Atriplex holocarpa	pop saltbush
Atriplex intermedia	no common name
Atriplex leptocarpa	slender-fruit saltbush
Atriplex limbata	spreading saltbush
Atriplex lindleyi	baldoo
Atriplex lobativalvis	no common name
Atriplex muelleri	Mueller's saltbush
Atriplex nummularia ssp. nummularia	old-man saltbush
Atriplex pseudocampanulata	spreading saltbush
Atriplex quinii	kidney-fruit saltbush
Atriplex spongiosa	pop saltbush
Atriplex stipitata	bitter saltbush
Atriplex sturtii	no common name
Atriplex velutinella	sandhill saltbush
Atriplex vesicaria ssp. Calcicola	bladder saltbush
Chenopodium auricomum	golden goosefoot
Chenopodium cristatum	crested goosefoot
Chenopodium desertorum ssp. desertorum	frosted goosefoot
Chenopodium gaudichaudianum	scrambling goosefoot
Chenopodium nitrariaceum	nitre goosefoot
Dissocarpus paradoxus	ball bindyi
Einadia nutans ssp. Eremaea	dryland climbing saltbush
Enchylaena tomentosa var. glabra	smooth ruby saltbush
Enchylaena tomentosa var. tomentosa	ruby saltbush

Halosarcia indica ssp. Leiostachya	brown-head samphire
Maireana aphylla	cotton-bush
Maireana astrotricha	low bluebush
Maireana coronata	crown fissure-plant
Maireana eriantha	wolly bluebush
Maireana georgei	satiny bluebush
Maireana integra	entire-wing bluebush
Maireana microcarpa	swamp bluebush
Maireana pyramidata	black bluebush
Maireana radiata	radiate bluebush
Maireana schistocarpa	split-fruit bluebush
Maireana villosa	silky bluebush
Malacocera albolanata	woolly soft-horns
Neobassia proceriflora	desert glasswort
Osteocarpum acropterum var. acropterum	tuberculate bonefruit
Osteocarpum dipterocarpum	two-wing bonefruit
Osteocarpum pentapterum	five-wing bonefruit
Rhagodia spinescens	spiny saltbush
Salsola kali	prickly saltwort
Sclerolaena bicornis	goathead bindyi
Sclerolaena brachyptera	short-wing bindyi
Sclerolaena calcarata	redburr bindyi
Sclerolaena constricta	no common name
Sclerolaena convexula	tall bindyi
Sclerolaena cuneata	tangled bindyi
Sclerolaena decurrens	green bindyi
Sclerolaena diacantha	grey bindyi
Sclerolaena eriacantha	silky bindyi
Sclerolaena holtiana	grey bindyi
Sclerolaena intricata	tangled bindyi
Sclerolaena lanicuspis	spinach bindyi
Sclerolaena longicuspis	long-spine poverty-bush
Sclerolaena muricata var. muricata	black roly-poly
Sclerolaena parallelicuspis	western bindyi
Sclerolaena parviflora	small-flower bindyi
Sclerolaena patenticuspis	spear-fruit bindyi
Sclerolaena uniflora	grey bindyi
Sclerolaena ventricosa	salt bindyi
Sclerostegia medullosa	no common name
Chloanthaceae	
Dicrastylis lewellinii	purple sand-sage
Compositae	
Actinobole uliginosum	flannel cudweed
Brachycome ciliaris var. ciliaris	variable daisy
Calocephalus platycephalus	western beauty-heads
Calotis ancyrocarpa	anchor burr-daisy
Calotis erinacea	tangled burr-daisy
Calotis hispidula	hairy burr-daisy
Calotis latiuscula	leafy burr-daisy
Calotis multicaulis	woolly-headed burr-daisy
Calotis plumulifera	woolly-headed burr-daisy
Calotis porphyroglossa	channel burr-daisy
Centipeda cunninghamii	common sneezeweed
Centipeda minima	spreading sneezeweed
Centipeda thespidioides	desert sneezeweed
**Chrysocephalum apiculatum*	common everlasting
Chrysocephalum eremaeum	sand button-bush
Chrysocephalum pterochaetum	shrub everlasting
Chrysocephalum semicalvum ssp. semicalvum	scented button-bush
Craspedia chrysantha	golden billy-buttons
Dichromochlamys dentatifolius	no common name
Dimorphocoma minutula	no common name
Epaltes australis	spreading nut-heads
Epaltes cunninghamii	tall nut-heads
**Gnaphalium polycaulon*	Indian cudweed
Gnephosis arachnoidea	spidery button-flower
Gnephosis eriocarpa	native camomile
Gnephosis tenuissima	dwarf golden-tip
Gratwickia monochaeta	no common name
Hyalosperma semisterile	orange sunray
Ixiochlamys nana	small fuzzweed
Ixiolaena brevicompta	plains plover-daisy
Isiolaena chloroleuca	pale plover-daisy
Ixiolaena leptolepis	narrow plover-daisy
Ixiolaena tomentosa	wooly plover-daisy
Millotia greevesii ssp. greevesii var. greevesii	creeping millotia
Minuria cunninghamii	bush minuria
Minuria denticulata	woolly minuria
Minuria integerrima	smooth minuria
Minuria leptophylla	minnie daisy
Minuria rigida	no common name
Myriocephalus rudallii	small poached-egg daisy
Othonna gregorii	fleshy groundsel
Pluchea dunlopii	pink-plains bush
Podolepis capillaris	wiry podolepis
Polycalymma stuartii	poached-egg daisy
Pseudognaphalium luteoalbum	Jersey cudweed
Pterocaulon sphacelatum	apple-bush
Rhodanthe floribunda	white paper-daisy
Rhodanthe microglossa	clusteres sunray
Rhodanthe moschata	musk daisy
Rhodanthe stricta	slender everlasting
Rhodanthe uniflora	woolly sunray
Rutidosis helichrysoides	grey wrinklewort
Schoenia ramosissima	dainty everlasting
Senecio cunninghamii var. cunninghamii	shrubby groundsel
Senecio cunninghamii var. serratus	shrubby groundsel
Senecio glossanthus	annual groundsel
Senecio lautus	variable groundsel
Senecio runcinifolius	thistle-leaf groundsel
**Sonchus oleraceus*	common sow-thistle
Streptoglossa adscendens	desert daisy
Tricanthodium skreserveophorum	woolly yellow-heads
Vittadinia eremaea	desert New Holland daisy
Convolvulaceae	
Convolvulus erubescens	Australian bindweed
Convolvuluc remotus	grassy bindweed
Cressa cretica	rosinweed
Evolvulus alsinoides var. decumbens	tropical speedwell
Evolvulus alsinoides var. villosicalyx	no common name
Ipomoea muelleri	native morning glory

Ipomoea polymorpha	silky cow-vine
Ipomoea racemigera	inland bell-vine
Crassulaceae	
Crassula colorata var. acuminata	dense crassula
Crassula sieberiana ssp. tetramera	Australian stonecrop
Cruciferae	
Arabidella eremigena	priddiwalkatji
Arabidella glaucescens	no common name
Blennodia canescens	native stock
Blennodia pterosperma	wild stock
**Brassica tournefortii*	wild turnip
Harmsiodoxa blennodioides	hairypod cress
Harmsiodoxa brevipes var. brevipes	short cress
Harmsiodoxa puberula	scented cress
Lepidium muelleri-ferdinandi	Mueller's peppercress
Lepidium oxytrichum	green peppercress
Lepidium papillosum	warty peppercress
Lepidium phlebopetalum	veined peppercress
Phlegmatospermum sp	native cress
Stenopetalum lineare	narrow thread-petal
Stenopetalum nutans	stinking thread-petal
Cucurbitaceae	
Citrullus lanatus	bitter melon
Cucumis melo	Ulcardo melon
Mukia maderaspatana	snake vine
Mukia micrantha	desert cucumber
Elatinaceae	
Bergia ammannioides	jerry water-fire
Bergia trimera	three-part water-fire
Euphorbiaceae	
Adriana hookeri	mallee bitter-bush
Euphorbia drummondii	caustic weed
Euphorbia parvicaruncula	rough-seeded spurge
Euphorbia tannensis ssp. eremophila	desert spurge
Euphorbia wheeleri	Wheeler's spurge
Phyllanthus fuernrohrii	sand spurge
Phyllanthus lacunarius	lagoon spurge
Sauropus trachyspermus	slender spurge
Frankeniaceae	
Frankenia cupularis	no common name
Frankenia foliosa	leafy sea-heath
Frankenia serpyllifolia	thyme sea-heath
Gentianaceae	
**Centaurium spicatum*	spike centaury
Geraniaceae	
Erodium angustilobum	no common name
**Erodium aureum*	no common name
Erodium crinitum	blue heron's-bill
Erodium cygnorum ssp. cygnorum	blue heron's-bill
Erodium cygnorum ssp. glandulosum	clammy heron's-bill
Goodeniaceae	
Goodenia cycloptera	serrated goodenia
Goodenia fascicularis	silky goodenia
Goodenia havilandii	hill goodenia
Goodenia lunata	stiff goodenia
Goodenia pinnatifida	cut-leaf goodenia
Lechenaultia divaricata	tangled lechenaultia
Scaevola aemula	fairy fanflower
Scaevola depauperata	skeleton fanflower
Scaevola parvibarbata	small-beard fanflower
Scaevola spinescens	spiny fanflower
Haloragaceae	
Haloragis aspera	rough raspwort
Haloragis glauca forma sclopetifera	grey raspwort
Haloragis gossei	no common name
Myriophyllum verrucosum	red milfoil
Labiatae	
Mentha australis	river mint
Teucrium racemosum	grey germander
Leguminosae	
Acacia aneura	mulga
Acacia cambagei	gidgee
Acacia coriacea	wirewood
Acacia cyperophylla	red mulga
Acacia dictyophleba	net-veined wattle
Acacia farnesiana	sweet acacia
Acacia ligulata	umbrella bush
Acacia ligulata	umbrella bush
Acacia murrayana	colony wattle
Acacia oswaldii	umbrella wattle
Acacia ramulosa	horse mulga
Acacia salicina	willow wattle
Acacia stenophylla	river cooba
Acacia tenuissima	slender wattle
Acacia tetragonophylla	dead finish
Acacia victoriae ssp.	elegant wattle
Acacia victoriae ssp. victoriae	elegant wattle
Aeschynomene indica	budda pea
Cullen australasicum verbine	scurf-pea
Cullen cinereum	hoary scurf-pea
Cullen graveolens	native lucerne
Cullen pallidum	woolly scurf-pea
Crotalaria cunninghamii	birdflower rattlepod
Crotalaria eremaea ssp	*loose-flowered rattlepod
Crotalaria eremaea ssp. eremaea	downy loose-flowered rattlepod
Crotalaria smithiana	yellow rattlepod
Glycine canescens	silky glycine
Glycine clandestina ssp.	twining glycine
Indigofera leucotricha	white indigo
Indigofera linifolia	flax-leaf indigo
Indigofera linnaei	Birdsville indigo
Indigofera psammophila	desert indigo
Isotropis wheeleri	Wheeler's lamb-poison
Lotus cruentus	red-flower lotus
Lysiphyllum gilvum	bauhinia
**Medicago polymorpha var. polymorpha*	burr-medic
Neptunia dimorphantha	no common name
Senna artemisioides nothossp.	Artemisioides silver senna

Senna artemisioides nothossp.	Coriacea desert senna
Senna artemisioides nothossp.	Sturtii grey desert senna
Senna artemisioides ssp. filifolia	fine-leaf desert senna
Senna artemisioides ssp. helmsii	blunt-leaf desert senna
Senna artemisioides ssp. oligophylla	limestone cassia
Senna artemisioides ssp. petiolaris	flat-stalk senna
Senna artemisioides ssp. zygophylla	desert senna
Senna pleurocarpa var. pleurocarpa	stripe-pod senna
Sesbania cannabina var. cannabina	yellow pea-bush
Swainsona affinis	small-leaf Swainson-pea
Swainsona campylantha	no common name
Swainsona laxa	no common name
Swainsona oroboides	variable swainson-pea
Swainsona phacoides ssp. phacoides	dwarf swainson-pea
Tephrosia sphaerospora	mulga trefoil
Tephrosia supina	no common name
Trigonella suavissima	sweet fenugreek
Loranthaceae	
Amyema maidenii ssp. maidenii	pale-leaf mistletoe
Amyema miquelii	box mistletoe
Amyema preissii	wire-leaf mistletoe
Amyema quandang var. quandang	grey mistletoe
Diplatia grandibractea	coolibah mistletoe
Lysiana exocarpi ssp. exocarpi	harlequin mistletoe
Lysiana subfalcata	northern mistletoe
Lythraceae	
Ammannia multiflora	jerry-jerry
Malvaceae	
Abutilon cryptopetalum	hill lantern-bush
Abutilonfraseri	dwarf lantern-bush
Abutilon halophilum	plains lantern-bush
Abutilon leucopetalum	desert lantern-bush
Abutilon malvaefolium	scrambling lantern-bush
Abutilon otocarpum	desert lantern-bush
Hibiscus brachysiphonus	low hibiscus
Hibiscus krichauffianus	velvet-leaf hibiscus
Lavatera plebeia	Australian hollyhock
Malvastrum americanum	malvastrum
Sida ammophila	sand sida
Sida argillacea	no common name
Sida cunninghamii	ridge sida
Sida fibulifera	pin sida
Sida filiformis	fine sida
Sida goniocarpa	angled sida
Sida intricata	twiggy sida
Sida petrophila	rock sida
Sida rohlenae	shrub sida
Sida trichopoda	high sida
Meliaceae	
Owenia acidula	sour plum
Myoporaceae	
Eremophila bignoniiflora	bignonia emubush
Eremophila dalyana	no common name
Eremophila duttonii	harlequin emubush
Eremophila freelingii	rock fuchsia-bush
Eremophila latrobei ssp. glabra	crimson emubush
Eremophila longifolia	weeping emubush
Eremophila macdonnellii	Macdonnell's emubush
Eremophila maculata var. maculata	spotted emubush
Eremophila obovata var. obovata	no common name
Myrtaceae	
Eucalyptus camaldulensis var. obtusa	northern river red gum
Eucalyptus coolibah ssp. arida	coolibah
Eucalyptus centralis	bloodwood
Eucalyptus opaca	no common name
Eucalyptus terminalis	long-fruit bloodwood
Nyctaginaceae	
Boerhavia coccinea	wituka
Boerhavia dominii	tar-vine
Boerhavia schomburgkiana	Schomburgk's tar-vine
Onagraceae	
**Ludwigia peploides ssp. montevidensis*	water primrose
Ludwigia peploides ssp. peploides	no common name
Pedaliaceae	
Josephinia eugeniae	Josephina burr
Pittosporaceae	
Pittosporum phylliraeoides var. microcarpa	native apricot
Plantaginaceae	
Plantago drummondii	dark plantain
Plantago varia	variable plantain
Polygalaceae	
Polygala isingii	Central Australian milkwort
Polygonaceae	
Muehlenbeckia florulenta	lignum
Polygonum plebeium	small knotweed
Rumex crystallinus	shiny dock
Portulacaceae	
Calandrinia balonensis	broad-leaf parakeelya
Calandrinia disperma	two-seed purslane
Calandrinia eremaea	dryland purslane
Calandrinia ptychosperma	creeping parakeelya
Calandrinia pumila	tiny purslane
Calandrinia stagnensis	no common name
Portulaca intraterranea	buttercup purslane
Portulaca oleracea	common purslane
Proteaceae	
Grevillea juncifolia	honeysuckle grevillea

Grevillea stenobotrya	rattlepod grevillea*
Grevillea striata	beefwood*
Hakea eyreana	fork-leaf corkwood
Hakea leucoptera	silver needlewood
Ranunculaceae	
**Myosurus minimus var. australis*	mousetail
Rubiaceae	
Asperula gemella	twin-leaf bedstraw
Dentella pulvinata	no common name
Synaptantha tillaeacea	no common name
Santalaceae	
Santalum lanceolatum	plumbush
Sapindaceae	
Atalaya hemiglauca	whitewood
Dodonaea viscosa ssp.	sticky hop-bush
Dodonaea viscosa ssp. angustissima	narrow-leaf hop-bush
Scrophulariaceae	
Mimulus repens	creeping monkey-flower
Stemodia florulenta	bluerod
Stemodia glabella	bluerod
Solanaceae	
**Datura leichardtii*	native thorn-apple
Nicotiana velutina	velvet tobacco
Solanum ellipticum	velvet potato-bush
Solanum esuriale	quena
**Solanum nigrum*	black-berry nightshade
Solanum oligacanthum	desert nightshade
Sterculiaceae	
Gilesia biniflora	western tar-vine
Keraudrenia integrifolia	common firebush
Melhania oblongifolia	velvet hibiscus
Rulingia loxophylla	no common name
Thymelaeaceae	
Pimelea simplex ssp.	desert riceflower
Pimelea trichostachya	spiked riceflower
Umbelliferae	
Daucus glochidiatus	native carro*
Eryngium supinum	little devil
Trachymene glaucifolia	blue parsnip
Verbenaceae	
**Verbena officinalis*	common verbena
Zygophyllaceae	
Tribulus eichlerianus	villous caltrop
Tribulus hystrix	no common name
Tribulus occidentalis	perennial caltrop
**Tribulus terrestris*	caltrop
Zygophyllum ammophilum	sand twinleaf
Zygophyllum ammophilum	sand twinleaf
Zygophyllum apiculatum	pointed twinleaf
Zygophyllum howittii	clasping twinleaf
Zygophyllum humillimum	small-fruit twinleaf

MONOCOTYLEDONS

Amaryllidaceae	
Crinum flaccidum	Murray Lily
Cyperaceae	
Cyperus exaltatus	splendid flat-sedge
Cyperus gymnocaulos	spiny flat-sedge
Cyperus pygmaeus	pygmy flat-sedge
Eleocharis pallens	pale spike-rush
Fimbristylis dichotoma	common fringe-rush
Fimbristylis velata	veiled fringe-rush
Gramineae	
Agrostis avenacea var. perennis	perennial blown-grass
Amphipogon caricinus var. caricinus	long grey-beard grass
Aristida anthoxanthoides	yellow threeawn
Aristida contorta	curly wire-grass
Aristida holathera var. holathera	tall kerosene grass
Aristida inaequiglumis	no common name
Aristida latifolia	feathertop wiregrass
Astrebla lappacea	wheat Mitchell-grass
Astrebla pectinata	barley Mitchell-grass
Brachyachne ciliaris	hairy native couch
**Cenchris ciliaris*	buffel grass
Chloris pectinata	comb windmill grass
Chrysopogon fallax	golden-beard grass
Cymbopogon obtectus	silky-head lemon-grass
**Cynodon dactylon*	couch
Dactyloctenium radulans	button-grass
Dichanthium sericeum ssp. humilius	annual silky blue-grass
Digitaria brownii	cotton panic-grass
Digitaria coenicola	spider grass
Diplachne fusca	brown beetle-grass
Echinochloa inundata	channel millet
Enneapogon avenaceus	common bottle-washers
Enneapogon cylindricus	jointed bottle-washers
Enneapogon nigricans	black-head grass
Enneapogon polyphyllus	leafy bottle-washers
Enteropogon acicularis	umbrella grass
Enteropogon ramosus	umbrella grass
Eragrostis australasica	cane-grass
Eragrostis basedowii	neat love-grass
Eragrostis dielsii var. dielsii	mulka
Eragrostis eriopoda	woollybutt
Eragrostis laniflora	hairy-flower woollybutt
Eragrostis leptocarpa	drooping love-grass
Eragrostis parviflora	weeping love-grass
Eragrostis setifolia	bristly love-grass
**.Eragrostis tenellula*	delicate love-grass
Eragrostis xerophila	knotty-butt neverfail
Eriachne aristidea	three-awn wanderrie
Eriachne mucronata	three-awn wanderrie
Eriochloa australiensis	Australian cupgrass
Eriochloa pseudoacrotricha	perennial cupgrass
Eulalia aurea	sugar grass
Iseilema eremaeum	no common name
Iseilema vaginiflorum	red Flinders-grass
Leptochloa digitata	umbrella cane-grass
Neurachne munroi	window mulga-grass

Panicum decompositum var. decompositum	native millet
**Panicum schinzi*	sweet panic
Paractaenum novae-hollandiae ssp. reversum	barbed-wire grass
Paractaenum refractum	bristle-brush grass
**Setaria verticillata*	whorled pigeon-grass
Sporobolus actinocladus	ray grass
Sporobolis caroli	yakka grass
Sporobolus mitchellii	rat's-tail couch
Sporobolus virginicus var.	no common name
Themeda triandra.	kangaroo grass
Tragus australianus	bur grass
Triodia basedowii	lobed spinifex
Tripogon loliiformis	five-minute grass
Triraphis mollis	purple plume grass
Urochloa praetervisa	large arm-grass
Zygochloa paradoxa	sandhill cane-grass
Juncaginaceae	
Triglochin calcitrapum	spurred arrowgrass
Liliaceae	
Bulbine alata	winged bulbine-lily
Bulbine semibarbata	small leek-lily
Corynotheca sp.	sand lily

Table 2. A list of mammals, birds, reptiles and amphibians

Recorded from site records for Innamincka Regional Reserve in the South Australian Biodiversity Database October 1995 download. Additional bird species have been added from a list for the reserve supplied by Mr Julian Reid dated March 1998. Introduced species are marked with an asterisk

MAMMALS

Bovidae	
**Bos taurus*	Cattle
Canidae	
Canis lupus	Dingo
Dasyuridae	
Ningaui ridei	Wongai Ningaui
Planigale gilesi	Paucident Planigale
Planigale tenuirostris	Narrow-nosed Planigale
Sminthopsis crassicaudata	Fat-tailed Dunnart
Sminthopsis macroura	Stripe-faced Dunnart
Emballonuridae	
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat
Equidae	
**Equus caballus*	Horse
Felidae	
**Felis catus*	Cat
Leporidae	
**Oryctolagus cuniculus*	(European) Rabbit
Macropodidae	
Macropus rufus	Red Kangaroo
Molossidae	
Mormopterus planiceps	Little Mastiff-Bat
Tadarida australis	White-striped Mastiff-Bat
Muridae	
Hydromys chrysogaster	Water Rat
Leggadina forresti	Forrest's Mouse
**Mus domesticus*	House Mouse
Notomys alexis	Spinifex Hopping-mouse
Notomys fuscus	Dusky Hopping-mouse
Pseudomys hermannsburgensis	Sandy Inland Mouse
Rattus villosissimus	Long-haired Rat
Suidae	
**Sus scrofa*	Pig
Tachyglossidae	
Tachyglossus aculeatus	Short-beaked Echidna
Vespertilionidae	
Chalinolobus gouldii	Gould's Wattled Bat
Nyctophilus geoffroyi	Lesser Long-eared Bat
Scotorepens greyii	Little Broad-nosed Bat

BIRDS

Accipitridae	
Accipiter cresservehocephalus	Collared Sparrowhawk
Accipiter fasciatus	Brown Goshawk
Aquila audax	Wedge-tailed Eagle
Circus approximans	Swamp Harrier
Circus assimilis	Spotted Harrier
Elanus axillaris	Black-shouldered Kite
Elanus scriptus	Letter-winged Kite
Haliaeetus leucogaster	White-bellied Sea-eagle
Haliastur sphenurus	Whistling Eagle
Hamirostra melanosternon	Black-breasted Buzzard
Hieraaetus morphnoides	Little Eagle
Lophoictinia isura	Square-tailed Kite
Milvus migrans	Black Kite
Aegothelidae	
Aegotheles cristatus	Australian Owlet-nightjar
Alaudidae	
Mirafra javanica	Singing Bushlark
Alcedinidae	
Halcyon sancta	Sacred Kingfisher
Todiramphus pyrrhopygia	Red-backed Kingfisher
Anatidae	
Anas castanea	Chestnut Teal
Anas clypeata	Northern Shoveller
Anas gracilis	Australasian Grey Teal
Anas rhyncotis	Australasian Shoveller
Anas superciliosa	Pacific Black Duck
Anseranus semipalmata	Magpie Goose
Aythya australis	Hardhead
Biziura lobata	Musk Duck
Chenonetta jubata	Wood Duck
Cygnus atratus	Black Swan
Malacorhynchus membranaceus	Pink-eared Duck
Oxyura australis	Blue-billed Duck
Stictonetta naevosa	Freckled Duck
Tadorna tadornoides	Mountain Duck
Anhingidae	
Anhinga melanogaster	Darter
Apodidae	
Apus pacificus	Fork-tailed Swift
Ardeidae	
Ardea alba	Great Egret
Ardea garzetta	Little Egret
Ardea ibis	Cattle Egret
Ardea intermedia	Intermediate Egret

Ardea novaehollandiae	White-faced Heron
Ardea pacifica	Pacific Heron
Nycticorax caledonicus	Nankeen Night Heron
Casuariidae	
Dromaius novaehollandiae	Emu
Charadriidae	
Charadrius australis	Inland Dotteral
Charadrius ruficapillus	Red-capped Dotterel
Charadrius veredus	Oriental Plover
Cladorhynchus leucocephalus	Banded Stilt
Elseyornis melanops	Black-fronted Dotterel
Erythrogonys cinctus	Red-kneed Dotteral
Himantopus leucocephalus	White-headed Stilt
Pluvialis fulva	Eastern Golden Pl;over
Vanellus miles	Masked Plover and Spur-winged
Vanellus tricolor	Banded Plover
Climacteridae	
Climacteris picumnus	Brown Treecreeper
Columbidae	
**Columba livia*	Feral Pigeon
Geopelia cuneata	Diamond Dove
Geopelia placida	Peaceful Dove
Ocyphaps lophotes	Crested Pigeon
Phaps chalcoptera	Common Bronzewing
Phaps histrionica	Flock Pigeon
Coraciidae	
Eurystomus orientalis	Dollarbird
Corvidae	
Artamus cinereus	Black-faced Woodswallow
Artamus cyanopterus	Dusky Woodswallow
Artamus leucorhynchus	White-breasted Woodswallow
Artamus personatus	Masked Woodswallow
Artamus superciliosus	White-browed Woodswallow
Cinclosoma cinnamomeum	Cinnamon Quailthrush
Colluricincla harmonica	Grey Shrikethrush
Coracina maxima	Ground Cuckooshrike
Coracina novaehollandiae	Black-faced Cuckooshrike
Corvus bennetti	Little Crow
Corvus coronoides	Australian Raven
Cracticus torquatus	Grey Butcherbird
Grallina cyanoleuca	Magpie-lark
Gymnorhina tibicen	Australian Magpie
Lalage sueurii	White-winged Triller
Myiagra inquieta	Restless Flycatcher
Oreoica gutturalis	Crested Bellbird
Pachycephala rufiventris	Rufous Whistler
Psophodes cristatus	Chreserveuping Wedgebill
Rhipidura fuliginosa	Grey Fantail
Rhipidura leucophrys	Willie Wagtail
Cuculidae	
Cacomantis flabelliformis	Fan-tailed Cuckoo
Cuculus pallidus	Pallid Cuckoo
Chrysococcyx basalis	Horsfield's Bronze Cuckoo
Chrysococcyx osculans	Black-eared Cuckoo
Scythrops novaehollandiae	Channel-billed Cuckoo
Dendrocygnidae	
Dendrocygna eytoni	Plumed Whitling-duck
Eopsaltriidae	
Petroica goodenovii	Red-capped Robin
Melanodryas cucculata	Hooded Robin
Microeca fascinans	Jacky Winter
Eurostopodidae	
Eurostopodus argus	Spotted Nightjar
Falconidae	
Falco berigora	Brown Hawk
Falco cenchroides	Nankeen Kestrel
Falco hypoleucos	Grey Falcon
Falco longipennis	Little Falcon
Falco peregrinus	Peregrine Falcon
Falco subniger	Black Falcon
Glareolidae	
Glareola maldivarum	Oriental Pratincole
Stiltia isabella	Australian Pratincole
Gruidae	
Grus rubicundus	Brolga
Hirundinidae	
Cheramoeca leucosternum	White-backed Swallow
Hirundo ariel	Fairy Martin
Hirundo neoxena	Welcome Swallow
Hirundo nigricans	Tree Martin
Hirundo rustica	Barn Swallow
Laridae	
Chlidonias hybridus	Whiskered (Marsh) Tern
Chlidonias leucopterus	White-winged Tern
Larus novaehollandiae	Silver Gull
Sterna caspia	Caspian Tern
Sterna nilotica	Gull-billed Tern
Maluridae	
Amytornis goyderi	Eyrean Grasswren
Malurus lamberti	Variegated Wren
Malurus leucopterus	White-winged Wren
Meliphagidae	
Acanthagenys rufogularis	Spiny-cheeked Honeyeater
Ashbyia lovensis	Gibberbird
Certionyx niger	Black Honeyeater
Certionyx variegatus	Pied Honeyeater
Conopophila whitei	Grey Honeyeater
Epthianura aurifrons	Orange Chat
Epthianura tricolor	Crimson Chat
Manorina flavigula	Yellow-throated Miner
Melithreptus gularis	Black-chinned Honeyeater
Lichenostomus penicillatus	White-plumed Honeyeater
Lichenostomus virescens	Singing Honeyeater
Phylidonyris albifrons	White-fronted Honeyeater

Meropidae	
Merops ornatus	Rainbow Bird
Nectariniidae	
Dicaeum hirundinaceum	Mistletoe Bird
Otididae	
Ardeotis australis	Australian Bustard
Pardalotidae	
Acanthiza chrysorrhoa	Yellow-rumped Thornbill
Acanthiza uropygialis	Chestnut-rumped Thornbill
Aphelocephala leucopsis	Southern Whiteface
Aphelocephala nigricincta	Banded Whiteface
Calamanthus campestris	Rufous Calamanthus
Pardalotus rubricatus	Red-browed Pardalote
Pardalotus striatus	Striated Pardalote
Smicrornis brevirostris	Weebill
Passeridae	
Anthus novaeseelandiae	Richard's Pipit
Oriolus saggitatus	Olive-backed Oriole
**Passer domesticus domesticus*	House Sparrow
Poephila guttata	Zebra Finch
**Sturnus vulgaris*	Common Starling
Pelecanidae	
Pelecanus conspicillatus	Australian Pelican
Pedionomidae	
Pedionomus torquatus	Plains Wanderer
Phalacrocoracidae	
Phalacrocorax carbo	Great (Black) Cormorant
Phalacrocorax melanoleucos	Little Pied Cormorant
Phalacrocorax sulcirostris	Little Black Cormorant
Phalacrocorax varius	Pied Cormorant
Phasianidae	
Coturnix pectoralis	Stubble Quail
Podargidae	
Podargus strigoides	Tawny Frogmouth
Podicipedidae	
Podiceps cristatus	Great Crested Grebe
Poliocephalus poliocephalus	Hoary-headed Grebe
Tachybaptus novaehollandiae	Australasian Grebe
Pomatostomidae	
Pomatostomus ruficeps	Chestnut-crowned Babbler
Psittacidae	
Aprosmictus erythropterus	Red-winged Parrot
Barnardius zonarius	Ring-necked Parrot
Calyptorhynchus banksii	Red-tailed Black0cockatoo
Cacatua leadbeateri	Pink Cockatoo
Cacatua roseicapilla	Galah
Cacatua sanguinea	Little Corella
Melopsittacus undulatus	Budgerigar
Neophema bourkii	Bourke's Parrot
Neophema chrysostoma	Blue-winged Parrot
Northiella haematogaster	Bluebonnet
Nymphicus hollandicus	Cockatiel
Pezoporus occidentalis	Night Parrot
Psephotus haematonotus	Red-rumped Parrot
Recurvirostridae	
Recurvirostra novaehollandiae	Red-necked Avocet
Rallidae	
Fulica atra	Coot
Gallinula tenebrosa	Dusky Moorhen
Gallinula ventralis	Black-tailed Native-hen
Gallirallus phillippensis	Buff-banded Rail
Porphyrio porphyrio	Purple Swamphen
Porzana fluminea	Australian Crake
Porzana pusilla	Baillon's Crake
Porzana tabuensis	Spotless Crake
Scolopacidae	
Actitis hypoleucos	Common Sandpiper
Calidris acuminata	Sharp-tailed Sandpiper
Calidris ferruginea	Curlew Sandpiper
Calidris melanotos	Pectoral Sandpiper
Calidris ruficollis	Red-necked Stint
Calidris subminuta	Long-toed Stint
Galinago hardwickii	Latham's Snipe
Limosa limosa	Black-tailed Godwit
Numenius phaeopus	Whimbrel
Rostratula benghalensis	Painted Snipe
Tringa flavipes	Lesser Yellowlegs
Tringa glareola	Wood Sandpiper
Tringa nebularia	Common Greenshank
Tringa stagnatilis	Marsh Sandpiper
Strigidae	
Ninox novaeseelandiae	Southern Boobook
Ninox connivens	Barking Owl
Sylviidae	
Acrocephalus stentoreus	Clamorous Reedwarbler
Cincloramphus cruralis	Brown Songlark
Cincloramphus mathewsi	Rufous Songlark
Megalurus gramineus	Little Grassbird
Threskiornithidae	
Platalea flavipes	Yellow-billed Spoonbill
Platalea regia	Royal Spoonbill
Plegadis falcinellus	Glossy Ibis
Threskiornis aethiopicus	Sacred Ibis
Threskiornis spinicollis	Straw-necked Ibis
Turnicidae	
Turnix velox	Little Button-quail
Tytonidae	
Tyto alba	Barn Owl
Tyto novaehollandiae	Masked Owl

REPTILES

Agamidae

Amphibolurus gilberti	Gilbert's Dragon
Ctenophorus fordi	Mallee Dragon
Ctenophorus isolepis	Military Dragon
Ctenophorus nuchalis	Central Netted Dragon
Ctenophorus pictus	Painted Dragon
Diporiphora winneckei	Canegrass Dragon
Pogona vitticeps	Central Bearded Dragon
Tympanocryptis intima	Smooth-snouted Earless Dragon
Tympanocryptis lineata	Five-lined Earless Dragon
Tympanocryptis tetraporophora	Centralian Earless Dragon

Boidae

Antaresia stimsoni	Stimson's Python
Aspidites ramsayi	Woma

Chelidae

Emydura sp	Cooper Creek Turtle(undescribed)

Elapidae

Furina diadema	Red-naped Snake
Oxyuranus microlepidotus	Inland Taipan
Pseudechis australis	Mulga Snake
Pseudonaja modesta	Five-ringed Snake
Pseudonaja nuchalis	Western Brown Snake
Simoselaps fasciolatus	Narrow-banded Snake
Suta suta	Curl Snake

Gekkonidae

Diplodactylus byrnei	Pink-blotched Gecko
Diplodactylus conspicillatus	Fat-tailed Gecko
Diplodactylus damaeus	Beaded Gecko
Diplodactylus stenodactylus	Sandplain Gecko
Diplodactylus tessellatus	Tessellated Gecko
Gehyra purpurascens	Purple Dtella
Gehyra variegata	Tree Dtella
Heteronotia binoei	Bynoe's Gecko
Nephrurus levis	Smooth Knob-tailed Gecko
Rhynchoedura ornata	Beaked Gecko
Strophurus ciliaris	Northern Spiny-tailed Gecko
Strophurus elderi	Jewelled Gecko
Strophurus intermedius	Southern Spiny-tailed Gecko

Pygopodidae

Delma butleri	Spinifex Snake-lizard
Delma haroldi	no common name
Delma tincta	Black-necked Snake-lizard
Lialis burtonis	Burton's Legless Lizard
Pygopus nigriceps	Black-headed Scaly-foot

Scincidae

Cryptoblepharus plagiocephalus	Desert Wall Skink
Ctenotus ariadnae	Pin-striped Ctenotus
Ctenotus brachyonyx	Brown Ctenotus
Ctenotus brooksi	Sandhill Ctenotus
Ctenotus helenae	Dusky Ctenotus
Ctenotus leae	Centralian Coppertail
Ctenotus leonhardii	Common Desert Ctenotus
Ctenotus pantherinus	Leopard Skink
Ctenotus regius	Eastern Desert Ctenotus
Ctenotus robustus	Eastern Striped Skink
Ctenotus schomburgkii	Sandplain Ctenotus
Ctenotus strauchii	Short-legged Ctenotus
Egernia inornata	Desert Skink
Egernia stokesii	Gidgee Skink
Eremiascincus fasciolatus	Narrow-banded Sandswimmer
Eremiascincus richardsonii	Broad-banded Sandswimmer
Lerista labialis	Eastern Two-toed Slider
Lerista xanthura	Yellow-tailed Slider
Menetia greyii	Dwarf Skink
Morethia adelaidensis	Adelaide Snake-eye
Morethia boulengeri	Common Snake-eye
Tiliqua multifasciata	Centralian Bluetongue Lizard

Typhlopidae

Ramphotyphlops bituberculatus	Rough-nosed Blind Snake
Ramphotyphlops endoterus	Centralian Blind Snake

Varanidae

Varanus eremius	Desert Pygmy Goanna
Varanus gouldii	Sand Goanna
Varanus tristis	Black-headed Goanna

AMPHIBIANS

Hylidae

Cyclorana platycephala	Water-holding Frog
Cyclorana cultripes	no common name
Litoria caerulea	Green Tree Frog
Litoria latopalmata	Gunther's or Broad-palmed Frog
Litoria rubella	Red Tree Frog

Leptodactylidae

Crinia deserticola	Desert Froglet
Limnodynastes spenceri	no common name
Limnodynastes tasmaniensis	Marbled Frog
Neobatrachus centralis	Trilling Frog
Uperoleia sp.	no common name

Table 3. A list of Fish

Recorded from Cooper Creek, Innamincka Regional Reserve (Puckridge, 1997)

Clupeidae	
Nematolosa erebi	Bony Bream
Retropinnidae	
Retropinna semoni	Australian Smelt
Plotosidae	
Neosilurus hyrtlii	Hyrtl's Tandan
Neosilurus argenteus	Silver Tandan
Neosilurus sp.	Cooper Creek Tandan
Antherinidae	
Craterocephalus eyresii	Lake Eyre Hardyhead
Melanotaeniidae	
Melanotaenia splendida tatei	Desert Rainbowfish
Ambassidae	
Ambassis mulleri	Mueller's Glassfish
Percicthyidae	
Macquaria sp.	Callop
Terapontidae	
Bidyanus welchi	Welch's Grunter
Leiopotherapon unicolor	Spangled Perch
Scortum barcoo	Barcoo Grunter
Scortum hillii	Leathery Grunter (Doubtful Record)
Gobiidae	
Hypseleotris sp.	Western Carp Gudgeon
Cyprinidae	
**Carrasssius argenteus*	Goldfish
Poeciliidae	
**Gambusia holbrooki*	Eastern Gambusia

10.3 Appendix C Biological and Archaeological Assessment and Survey

Biological Survey

The first biological survey data for the area now known as Innamincka Regional Reserve occurred in 1845 when Captain Charles Sturt's expedition passed along Cooper Creek. It was on this expedition that John McDouall Stuart collected, in the vicinity of Lake Goyder, the first specimen of the Night Parrot. Sturt brought back over 100 species of plant and many geological and faunal specimens which included a pair of grey falcon (Moorehead pp 22 and 23). Biological observations and specimens from the region were also collected by the exploration teams lead by Gregory, Howitt, McKinlay, and Andrews on Lewis' expedition of 1874 -75. In September and October 1916 the South Australian Museum staged an expedition to the Strzelecki and Cooper Creeks (Waite 1917). In 1924 J. B Cleland made collections in the Cooper Creek and Cordillo Downs region and J.M. Black identified these plants, and recorded 253 species for the north-east region. During the 1930s, Finlayson made extensive mammal collections.

These early collections were followed by a shift in emphasis from a taxonomic approach to botanical research to an ecological approach which identified plant communities and their relationships to their physical environments. Studies using this approach include Specht (1972), SA Pastoral Board (1973), Lewis (in Foale 1975) Laut et al (1977) and Mollenmans et al (1984) (see Gillen and Drewien 1993).

In more recent times there have been several biological survey expeditions to the region. In 1975 a biological survey of the north-east region was conducted by the Nature Conservation Society of SA (Foale 1975). This expedition described land forms (Twidale), vegetation associations (Lewis), made 783 plant collections (Jessop), made observations of birds and their ecology, during which 131 bird species were recorded (Cox), and observed 6 species of mammal and several bats.

In 1984 a Biological Survey of the Cooper Creek Environmental Association (Mollenmans et al 1984) gathered information in a systematic way representing a sample of the range of biological variation in the area. During the survey 50 vegetation and vertebrate quadrats were sampled within the (now) Innamincka Regional Reserve. The report to this survey describes the great variety of habitats in the region, and identifies 60 wetland habitats. It also provides detailed annotated comments on the wildlife of the region

In 1986 the Land Assessments Branch of the then Department of Lands prepared a Rangeland Assessment Manual for the Innamincka Pastoral Lease which describes land systems and establishes a long term land condition and trend monitoring program for pastoral land management. The assessment also discusses other major management concerns in that area. The land systems mapped by the Land Assessments Branch (since called Pastoral Management Branch and now part of the Biodiversity Monitoring and Evaluation group) is still used today for identification of habitats, land condition assessment and biological monitoring.

This approach was built upon in the mapping and description of the Coongie Lakes Control Zone Terrain-Vegetation Land Units (Barratt 1988). This vegetation association mapping was jointly funded by SA DEP, DME and Santos for the purpose of delineating the Coongie Lakes Control Zone (CLCZ) within the reserve. The terrain units identified sensitivity to impacts for each of 23 terrain - vegetation land units identified within the CLCZ.

In the last decade DEHAA has coordinated seven biological surveys in the region which have contributed to the biological and ecological understanding of the ecology of the reserve.

1 *The Coongie Lakes Study*

This study established 30 vegetation and vertebrate quadrats with field sampling extending to 14 periods from December 1986 to December 1990 (Reid and Gillen 1988). This report still provides the most useful background, description and assessment of the biology of the region.

The Coongie Lakes Study was instigated by a $55 000 donation from Dick Smith's Australian Geographic Pty Ltd through the National Parks Foundation of SA to the (then) Department for Environment and Planning. Further financial support from Santos, ANPWS States Assistance Scheme, NPWSA Wildlife Conservation Fund, and Mrs Begg through her daughter Mrs Barbara Hardy enabled the study to be extended for several years. A separate Special Research Grant from the Dept Architecture of the University of Adelaide enabled the visitor survey included this report, to be conducted.

The amateur organisation, Scientific Expedition Group, conducted a scientific expedition to the region in 1988 during which aquatic and terrestrial ecology was observed and reported using the sites and techniques established for the Coongie Lakes Study, and revegetation of seismic lines was assessed (SEG 1988). This survey contributed to the data set for the region.

The Coongie Lakes Study data and observations was further assessed and reported on in relation to the impact on flooding on the district's terrestrial biota in 1992 (Reid 1992).

These more recent reports provide a baseline against which assessment of activities in the last decade could be made.

2 *The Della and Marqualpie Land Systems Faunal Monitoring Programme*

During the period 1988 - 1990 Gillen and Reid established 70 monitoring sites in the dune land systems Della and Marqualpie. The purpose of this research funded by Santos was to:-

- identify biologically significant species, communities, habitats and geographical areas
- provide base-line environmental data for impact assessment the education of personnel and contribution to environmental management and rehabilitation
- recommend appropriate management practices for the amelioration of environmental impacts upon the biota of the region arising from Santos' operations within the Cooper Basin.

3 *A Vegetation Survey of Kanowana Wetlands - Cooper Creek*

This vegetation survey was conducted in response to the listing of the Coongie Lakes Wetlands under the *Convention on Wetlands of International Importance Especially as Waterfowl Habitat* in July 1987. It was a co-operative project between the ANPWS and NPW SA to undertake a site based survey and inventory to assess, classify and map the vegetation of the area thus creating baseline data for future monitoring and contributing to an understanding of the wetland system. Additionally the project was to be treated as a pilot study, developing approaches and techniques for vegetation survey and mapping in other desert wetland systems. The survey, conducted in 1991 and 1992 established 173 botanical survey sites 55 of which are located on the reserve. The survey resulted in the identification and detailed mapping of 14 floristic associations and, identification of 157 plant species.

4 *The Rare Rodents Project*

The rare rodents project (1992) was funded by the Endangered Species Program of Environment Australia. The objectives of the survey in this area were to find specimens of two rare rodents; the Plains Rat and the Dusky Hopping Mouse. Sites where these species had previously been recorded were revisited and extensively surveyed, including 10 sites in the reserve. Neither species was relocated during this survey. In summary there has been no record of the Plains Rat

east of Lake Eyre since 1974 despite reasonable trapping effort. The Dusky Hopping mouse is presumed to occur, though rare, in the southern portion of the reserve. This species is more common further south (Brandle pers. comm. 1998).

5 *The Moomba to Sydney Pipeline Trench Survey*

In 1995, the South Australian section of the Moomba to Sydney gas pipeline was buried and a 40 km section of open trench to the east of the Regional Reserve were systematically checked for mammals and reptiles which had fallen in. A detailed report of the results of this study is available (Armstrong, 1995), which records 7 mammal and 16 reptile species.

6 *The Stony Deserts Biological Survey*

The primary aim of the Biological Survey of South Australia is to systematically and consistently sample a representative range of the ecological habitats to be found in South Australia. This information is collected to enhance with scientific data integrated land management and the conservation of South Australia's biological diversity.

Within the reserve 35 sites were sampled in 1996 for vegetation with a sub-set covering vertebrates.

The specific objectives of the Stony Deserts Biological Survey were:

- to collate existing information about the flora, fauna and physical features of stony deserts in South Australia
- to survey the flora and fauna at selected sample sites throughout the stony desert biome and describe the physical characteristics of these sites
- to achieve a fauna sampling coverage equivalent to about 30 sites per 1 : 250 000 map sheet
- to systematically survey the vertebrate fauna - the mammals, birds, reptiles and frogs - at each site using standard survey methods developed for the Biological Survey of South Australia
- to sample the terrestrial invertebrates of the stony deserts using standard micro- and macro- pitfall trapping techniques. to establish a stony deserts biological survey database
- to provide distribution maps for stony desert flora and fauna species, using GIS technology
- to analyse the stony desert biological survey database to produce maps of the distributions of plant and animal communities
- to identify characteristic species, communities and habitats of the stony desert biome
- to identify threats to the region's biological diversity, and
- to summarise all findings in a final report including recommendations for appropriate management strategies to achieve the goals of biodiversity conservation and ecological sustainability (Brandle in prep).

7 *The Cuttapirrie to Moorari Gas Pipeline Trench Survey*

As part of the Pachawarra East Development, a second gas pipeline was constructed from Cuttapirrie to Moorari in 1998. This pipeline trench was also systematically monitored for mammals and reptiles with 8 mammal, 28 reptile and 2 frog species being recorded (Owens 1998).

Data from both pipeline trench surveys have been added to the OPPORTUNE database of the Biological Survey of South Australia. The OPPORTUNE database records opportunistic sitings from reliable sources, but specimens are not required. Representative specimens from the trench surveys were added to the collections of the South Australian Museum.

8 Cooper Floodplain Study (not complete)

Funded by the National Estate Grant Program this study by J. Reid and J. Puckridge (in prep) will :

- analyse five years of ecological observations on the terrestrial and aquatic components of the Cooper Creek Region in the Coongie Lakes, Strzelecki Desert area, S;
- describe the distribution and dynamics of aquatic and terrestrial vertebrate communities in relation to system driving, key landscape, climatic and hydrological processes;
- describe a monitoring program to protect National Estate values including rare and threatened species, and
- document a new National Estate Site.

There are several other biological surveys which have been conducted in the reserve. These are discussed below. There have been other studies done by interested persons and Post Graduate Students which are not discussed here.

Waterbird Surveys

A summary of the waterbird species and abundance has been prepared for the Coongie Lakes Wetlands (Ramsar) Management Plan.

Much of the data has been collected by Julian Reid as part of his ongoing involvement in biological survey and monitoring of the area and reported in the Coongie Lakes Study, Terrestrial Monitoring Coongie Lakes After Flood, and Monitoring bird populations of the Coongie Lakes, Innamincka Regional Reserve (in prep) funded by the Reserves Advisory Committee) and the Cooper Floodplain Study (Reid and Puckridge in prep).

Waterbird surveys were conducted as part of the vegetation of the Kanowana Wetlands (see above), when 47 species of water birds and their abundance were recorded at 19 wetland sites 10 of which are on the reserve.

Janet Holmes reported her ornithological findings in the Australian and New Zealand Scientific Expedition Group's Expedition Strzelecki Report 1990, and the Scientific Expedition Group during Expedition Coongie Lakes also collected data in 1988.

Monitoring and Assessing Pastoral Grazing Impacts

Biodiversity Monitoring and Evaluation Program of DEHAA (formerly Pastoral Management Branch DENR and Land Assessment Branch Dept of Lands) has undertaken the assessment and monitoring of range condition on Innamincka Regional Reserve since its inception and on Innamincka Station prior to proclamation in 1988.

The techniques and approach employed in the assessment and monitoring of range condition for Innamincka Regional Reserve are comparable with the State's Pastoral Lease assessment program as required by the Innamincka Regional Reserve Management Plan. However, as the principal management aim for the Regional Reserve is the maintenance of biodiversity in a multiple use environment, there are some significant differences. These include a greater focus on the grazing as it relates to wildlife conservation issues such as threatened species and wetland management. Parts of the Regional Reserve have been the subject of biological survey and research providing a greater level of information than typically available for Pastoral Leases. The vegetation monitoring program for the reserve is far more extensive than the average Pastoral Lease with over eighty photopoints and ten exclosures installed.

The assessment and monitoring program for Innamincka began in 1983 when several assessment photopoints were installed. The first assessment of what was then Innamincka Pastoral Lease was undertaken and in 1985 (Dept. Lands, 1986). Since the creation of the Regional Reserve,

full assessments have been undertaken in 1991 and 1997, with a partial assessment carried out in 1995.

The techniques and approach applied to the assessment and monitoring program for the Regional Reserve are outlined in this chapter and limitations with the approach are identified.

Have cattle had a detrimental impact on the natural resources at Innamincka? This critical question is most difficult to answer. It is well known in these arid environments that the huge seasonal fluctuations in vegetation quantity and quality overwhelm any measurable disturbances or selective herbivory associated with cattle grazing. At Innamincka the total forage utilisation is also a combination of rabbit and cattle grazing with substantial spatial and temporal variations in both. Objective attempts at separating cattle impacts from those of rabbits and from the vagaries of season are time consuming and expensive to apply. In experimental terms the treatments (levels and timing of grazing, amount and timing of rainfall and flood inundation) are uncontrolled and largely unmeasured. Interpreting data collected at fixed monitoring sites is therefore based on subjective ratings or assumptions about both pasture growing conditions and use (Campbell 1998).

Permanent vegetation monitoring sites have been established to track trends in the stability of the soil surfaces, and in the vigour and diversity of the plant communities. Most sites are located in areas where cattle grazing is known to occur. Kidmans aim for a stable or improving trend in ecological condition, when considered over a run of seasons, as a good measure of ecological sustainability. Certainly resilience in soil and vegetation, the base natural resources, does not necessarily imply the persistence or stability of all species, but is a necessary precursor and a reasonable surrogate (Campbell 1998).

Further to the grazed monitoring sites, some ungrazed sites are also monitored at considerable distance from stock water where grazing pressures are expected to be negligible. Some sites have also been established within exclosures built to exclude cattle or rabbits or both.

Water Quality Monitoring

As part of the Biological Health Monitoring Program, Cooper Creek at Cullyamurra waterhole has been monitored by the Environment Protection Authority (EPA) for ambient and biological attributes. The Cooper Creek was one of 15 rivers monitored and selected as a high priority reference site.

Hydrological Monitoring, and Modelling

Water levels are monitored at the Cullyamurra Waterhole gauging station and the data set dates to February 1973. This data is used to calculate flows in Cooper Creek. In association with gauging station maintenance and data down loading some basic water quality data has also collected, including for example dissolved oxygen, salinity, pH, and occasional intermediate and composite water quality sampling for chemical analysis. Daily flow heights using depth indicators at the Innamincka causeway have also been collected during floods. Water resources monitoring is likely to be privatised in the next few years. This data may not meet needs analysis criteria, for continued monitoring.

Research to determine the relationship between flow regimes of Cooper Creek and flooding patterns of the Cooper Creek flood plains and Coongie Lakes Wetlands is being conducted by Justin Costello. This modelling of flooding patterns will be combined with work undertaken by Jim Puckridge to model biological responses to flooding. This hydrological modelling will also be useful for determining impacts of upstream abstraction of flows, and to provide advance warning to oil and gas producers and pastoral managers of likely flood extent and duration.

Fishery Research and Monitoring

The South Australian Research and Development Institute (SARDI) and formerly the Dept. of Fisheries have focussed its research effort in the region on:

- determining the species diversity (genetic status) of the fish stock
- identifying drought refuges for fish in the region
- determining habitat preference and requirements of fish species
- developing methodologies for measuring fish abundance and composition as an ongoing index of resource health, and
- developing an understanding of post flood dynamics of waterhole fish stocks (Pierce 1993).

Archaeological and Anthropological Survey

Most of the work incorporating archaeological or anthropological research was undertaken before gazettal of Innamincka Regional Reserve. These projects were undertaken through the National Estate Grants Program. The majority of the sites in the Register of Aboriginal Sites and Objects were recorded in 1982. They were then nominated and accepted onto the Register of the National Estate.

In 1986, Vlad Potezny of the Aboriginal Heritage Branch, Dr Luise Hercus and Professor Isabel McBryde recorded myth sites in an exercise partly funded by the Aboriginal Heritage Branch. The Aboriginal Heritage Branch later became part of DOSAA.

Dr Liz Williams undertook fieldwork at Coongie Lakes in 1987 and provided a submission to NPW SA on the management and protection of archaeological sites in the Coongie Lakes region.

Dr Williams provided the following recommendations:

- stock damage to be reduced by revegetation of eroded areas
- site identification programmes to be undertaken when development was proposed
- archaeologically sensitive areas be identified through survey work and access to sensitive areas should be restricted, and
- establishment of camp grounds and implementation of an education program for visitors.

Some of these recommendations have been addressed through the gazettal and management of the area as a Regional Reserve, and through the Aboriginal Heritage Act 1988. However the recommendation that more survey work needs to be undertaken is still valid.

In 1988 Neale Draper, Roger Leubbers and Tom Power carried out some archaeological survey work at Coongie Lakes, however the sites were inadequately recorded and the project was not completed. None of these sites has been registered.

Currently, Professor Keith McConnochie of University of SA is working on a Coongie Lakes Archaeological Survey.

DoSAA holds the following reports for surveys on the Innamincka Regional Reserve between 1988 and 1998. Most of these surveys were undertaken in response to development proposals for roads or for petroleum exploration or production applications and works. The reports are listed in chronological order.

Hamm Giles *1988 A Reconnaissance Investigation Of The Archaeological Potential Of The Strzelecki To Limestone Creek Pipeline Route.* Report To Social And Ecological Assessment.

Mckellar Hazel 1992 *Report On The History Of Aboriginal People In The Innamincka Area With Special Reference To Planned Pipeline Construction Between Cooper Creek And Moomba.*

Schell Petra 1992 *Archaeological Reconnaissance in the Cooper Creek Region South Australia* ANZSES. This study was largely outside thereserve.

Lance Allan 1995 *An Archaeological Survey Of The Strzelecki Track Realignment Between Innamincka And Della South Australia.* A Report to the South Australian Department Of Transport.

Nicholson Annie 1995 *Moomba To Sydney Ethane Pipeline Aboriginal Site Survey - Moomba To The South Australian Border.* Report to East Australia Pipeline Limited.

Social And Ecological Assessment Pty Ltd 1995 *Keleary To Merrimelia Pipeline Declaration Of Environmental Factors.* Report to Santos.

Lance Allan 1997 *The Strzelecki Track Realignment - Innamincka To Della Route Revision At Innamincka - South Australia.*

Petroleum Exploration and Production Impact Assessment and Monitoring

Prior to 1985 there were few standards of environmental management available, or used, to minimise environmental impacts, other than utilising more easily accessible routes for logistical reasons. Commensurately, there was little environmental monitoring or assessment. In 1984, the first Code of Environmental Practice for seismic and drilling operations within PELs 5&6 was developed by Delhi Petroleum, Santos and SADME (now PIRSA). This Code was prescriptive in nature, contained many clauses which were subjective in interpretation, and were based on the environmental knowledge of the day. Regular revisions of this Code were undertaken (eg Santos 1991) as knowledge of environmental impacts recovery rates and techniques accrued. The aim of such Codes was to minimise the impacts to the natural and cultural resources of the region.

Since 1984, there has been regular field inspections of petroleum operations by PIRSA inspectors and assessment of compliance with the Codes of Environmental Practice. In 1988, at the time the reserve was gazetted, assessment was normally undertaken with a checklist approach. Any issues of non-compliance or likelihood of long term impact was identified and remedied by the operator. Such remediation included either physical rehabilitation of specific sites or changes in work practices to avoid or reduce the recurrence of potential impacts.

Audits of environmental impacts and recovery rates from petroleum operations, as well as the effectiveness of the Codes of Environmental Practice have been undertaken by ecological specialists such as Graetz (1990), Moss and Low (1996) and Fatchen and Woodburn (1997, 1998). Most of these audits have been Cooper Basin wide, although they focus on the reserve due to the range of landforms in the area and environmental sensitivity of many of them (eg gibber plains and wetlands). These scientific studies have been utilised to:

- identify levels of impacts from each petroleum operation
- identify impacts/operations likely to lead to long term damage
- validate or modify the standards set in the Codes of Environmental Practice for each operation
- identify areas requiring active rehabilitation (where not already identified in the Codes)
- provide scientific baseline data for evaluation of environmental performance and standards, and
- increase the environmental awareness of the industry and its regulators.

These audits, along with specific scientific studies by DEHAA, Delhi Petroleum and others (eg SEA 1988a, b, 1989, Gillen and Drewien 1993, Reid and Gillen 1988, Stoll 1989) as well as experience of staff from Delhi, Santos and PIRSA provide an evolutionary process for continued improvement of environmental planning, assessment and minimisation/avoidance of impacts from petroleum operations. Thus, as new knowledge accrued, revisions to the Codes occurred (1986, 1987, 1991 and 1997).

The 1991 revision of the Codes (Tunstill 1991) included a requirement for Santos to undertake environmental audits of programs in sensitive areas, including much of the reserve (eg the flood plains of the Cooper and Strzelecki Creeks). These audits also required validation by PIRSA.

The most recent Code is divided into operational components viz: seismic operations, drilling and workover operations and production facilities. Supporting these Codes are Environmental Procedures manuals which contain details for planning and carrying out operations. This continual improvement and keeping abreast with knowledge of the day will continue in the future, is a requirement under the current *Petroleum Act, 1940* and will be a feature of the proposed revision of this Act.

In 1994, PIRSA introduced the concept of Goal Attainment Scaling (GAS) (Sharp, 1994; Malavazos, 1995). This technique aimed to clearly document levels of acceptable environmental impacts and provide a quantifiable method of assessing achievement of the GAS criteria. The technique also enabled all stakeholders to assess achievement levels on an objective basis against documented standards (ie by assessing operational outcomes against documented GAS criteria) rather than more subjective measurement previously used where the level of 'minimal' may have varied from observer to observer. In addition, GAS permits more detailed sampling of seismic lines well sites and pipelines and from land unit to land unit, if required, providing a more detailed analysis of achievement of 'minimal impact'. This compares with earlier assessment techniques used which usually consisted of a checklist for each aspect on a survey or program basis, followed by considerable textural discussion.

This innovative development of GAS required considerable trialing to get to the form documented in the Statement of Environmental Objectives for Seismic Operations (Cockshell, 1998), and the Field Guide for the Environmental Assessment of Abandoned Petroleum Well sites (PIRSA, 1998). Criteria have been developed for all the major land systems within the Cooper basin (eg sand dunes, flood plains/wetlands, gibber plains/tablelands and salt lakes). All these systems occur within the reserve. Non-land unit specific criteria have also been defined (eg visual impacts and rubbish). This technique quickly shows the level of achievement of the standards set and can focus on the aspects or issues being under achieved

The GAS assessment criteria contained in Cockshell (1998) and PIRSA (1998) have been derived through a stakeholder consultation process. Therefore achievement of acceptable standards (GAS scores of 0, +1 or +2) are seen as achievement of minimal environmental impacts acceptable to the community in general and for the reserve in particular. Over time, these standards are expected to change in response to changing environmental knowledge and community expectations.

In addition to the GAS assessment technique, the Statement of Environmental Objectives (Seismic) identifies defined conditions as a method of determining the level of achievement of the objectives. These are similar to the prescriptive clauses contained in the earlier Codes of Environmental Practice. There have been no cases within the reserve where these conditions have been significantly breached.

The Statement of Environmental Objectives also acknowledges the need for scientific surveys in the assessment process. These have been discussed previously in this chapter, and form a vital role is validating the GAS criteria and acceptability standards. The Statement, in line with observations of Fatchen and Woodburn (1997, 1998) also indicate the usefulness of photomonitoring as an assessment tool. There has been a large number of photographs taken of petroleum operations, outcomes and rehabilitation examples, by PIRSA and company operators. PIRSA is nearing completion of an index to these photos and intends to develop a structured long term monitoring program to assist in validation of impacts and recovery rates.

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Transactions and Proceedings of the Royal Society of SA Vol XLI (41) pp 416 - 417

ATTACHMENT 1

SOUTH AUSTRALIAN
CENTRE FOR ECONOMIC STUDIES
ADELAIDE AND FLINDERS UNIVERSITIES

ECONOMIC IMPACT OF

INNAMINCKA REGIONAL RESERVE

Undertaken for:

Department for Environment, Heritage and Aboriginal Affairs

by:

The South Australian Centre for Economic Studies

September 1998

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CONTENTS

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Note: This study, while embodying the best efforts of the investigators is but an expression of the issues considered most relevant, and neither the Centre, the investigators, the Executive Committee, nor the Universities can be held responsible for any consequences that ensue from the use of the information in this report.

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EXECUTIVE SUMMARY

The Innamincka Regional Reserve (IRR) is located in the far north-east of South Australia and covers an area of nearly 1.4 million hectares. In 1988 the reserve was established under the amended National Parks and Wildlife Act 1972, which allowed for the conservation of wildlife, natural and historic features, as well as the utilisation of natural resources.

This provision of the Act therefore allows multiple uses of the land. Exploration and production of oil and gas is currently being undertaken by Santos and pastoral activities by the Kidman Pastoral Company. In addition the region also has a significant value in terms of tourism, cultural and environmental interests.

Under the provisions of the Act, regional reserves require review every ten years to assess the appropriateness of the classification. For the IRR this implies that a review report must be tabled in both Houses of Parliament by 22 December 1998.

The South Australian Centre for Economic Studies was engaged to prepare a report which assessed the impact, or potential impact, of the utilisation of the natural resources of the reserve on the economy of the State.

The Input-Output tables for the State of South Australia were used to estimate the contribution of each of the pastoral, petroleum and tourism industries in the IRR to the State's economy. Data were also collected on State government expenditure associated with the IRR.

The value, in 1995-96 dollars, of the output from the petroleum industry in the IRR between 1988 and 1997 was reported to be over $3.1 billion. Using industry standard multipliers, petroleum exploration and extraction over the ten year period, is estimated to have contributed over $2.6 billion to the State's Gross State Product. This expenditure has created net incomes for South Australians of over $1.4 billion and created over 40,800 full time equivalent jobs. This equates, on average, to $140 million in income and 4,080 jobs each year.

It is expected that extraction of existing gas resources in the IRR over the next ten year period will contribute nearly $950 million to the State's Gross State Product. This output may create net incomes for South Australians of approximately $522 million and create around 14,750 full time equivalent jobs.

The total expenditure for Innamincka Station in 1995-96 dollars between 1987-88 to 1996-97 is estimated to be nearly $7.6 million. Over the ten years of the Regional Reserve, it is estimated using industry standard multipliers, that Innamincka Station has contributed over $3.3 million to the State's Gross State Product. This expenditure has created net incomes for South Australians of approximately $3.3 million and created around 121 full time equivalent jobs. This equates, on average, to $330,000 in income and 12 jobs each year.

On the basis of several key assumptions it is expected that the contribution of the Station to GSP and employment over the next ten years will be at least as good as the previous ten year period.

To be conservative and consistent with personal communication, the Centre has adopted a total visitor number of 15,000 for this study. It is therefore estimated that over the ten years of the Regional Reserve, tourism has contributed over $9.4 million to the State's Gross State Product. This expenditure has supported net incomes for South Australians of approximately $7.5 million and underpinned over 300 full time equivalent jobs. This equates, on average, to $750,000 in income and 30 jobs each year.

With the increasing appeal of the product the region offers and government's increased commitment to tourism it appears likely that the increase in tourism in the area will continue.

Over the period from 1988-89 and 1997-98 SA government expenditure associated with the Reserve has been estimated at approximately $8 million in real terms (1995-96 dollars).

A central question with respect to the Regional Reserve classification is whether the various uses of the reserve can co-exist. As to be expected, those with an interest in the reserve have widely differing views on the issue of multiple use. To a large degree those differences reflect differing interpretations on the relative importance of conservation as the primary objective of the Regional Reserve classification.

The Centre holds the view that Benefit Cost Analysis is the appropriate tool for use in future reviews to determine the net benefits to the State of the current classification, and any possible changes to that classification. However, such an analysis will require extra quantitative information on the environmental impacts of pastoral, petroleum and tourism activities, both under the current classification and under the chosen alternative classification. It would then be possible to use the quantitative environmental impact information to guide the estimates of people's willingness to pay to either maintain or restore attributes of key aspects of the environment. This information would be included in the Benefit Cost Analysis to provide a more comprehensive assessment of the net benefits of the current classification compared to its alternative.

In addition to extra information on the environmental impacts and their valuation there is also a need to more accurately record State government expenditure associated with the IRR. As such, the State government needs to put in place more formal systems for recording and retrieving such information. Such information will be an essential input to any future Benefit Cost Analyses.

1. INTRODUCTION

The Innamincka Regional Reserve (IRR) is located in the far north-east of South Australia and covers an area of nearly 1.4 million hectares . In 1988 the reserve was established under the amended National Parks and Wildlife Act 1972, which allowed for the conservation of wildlife, natural and historic features, as well as the utilisation of natural resources.

This provision of the Act therefore allows multiple uses of the land. The exploration and production of oil and gas is currently being undertaken by Santos and pastoral activities by the Kidman Pastoral Company. In addition the region also has a significant value in terms of tourism, cultural and environmental interests.

Under the provisions of the Act, regional reserves require review every ten years to assess the appropriateness of the classification. For the IRR this implies that a review report must be tabled in both Houses of Parliament by 22 December 1998.

The South Australian Centre for Economic Studies has been asked to prepare a report addressing one of the requirements for the review, namely:

- assess the impact, or potential impact, of the utilisation of the natural resources of the reserve on the economy of the State.

In particular, the terms of reference for this part of the study are summarised as:

- assess the impact or potential impact of the utilisation of the natural resources of the reserve on the economy of the State;
- determine the actual, relative and potential importance on the State's economy of each of the major industries utilising the resources of the reserve; and
- include Gross State Product, including direct and indirect costs and benefits, employment and occupations and changes in occupations.

2. SOCIO-ECONOMIC PROFILE

In developing a socio-economic profile of the regional reserve, data from the Australian Bureau of Statistics' 1996 Census and specific information collected from the region was used. The smallest region reported by the ABS is the collection district (CD). The CD containing the regional reserve is geographically much larger than the reserve (see Appendix A) and includes Moomba and Merty and Mumpeowie Stations. To complement this collection, more specific information was collected, with thanks, from industry and persons living within the region.

2.1 ABS Census Data

As can be seen from Tables 2.1 and 2.2 the ABS Census data are strongly influenced by Moomba. Nevertheless, approximately one third of the oil and gas extracted from the region by Santos is sourced from within the Innamincka Regional Reserve. In addition, significant survey and exploration work also occurs within the IRR. It is therefore worthwhile analysing the ABS Census data more closely.

On census night, 22 per cent of all persons counted in the region were in their usual place of residence. Only 11 persons were overseas visitors and 4 were from within the same statistical area. Over 57 per cent of the population counted on census night reported South Australia as their usual place of residence. A further 10 per cent reported that Queensland was their usual place of residence. Overall these data illustrate both the relative importance of petroleum activities in the region and the 'fly in-fly out' arrangements for its workforce.

The temporary nature of the population is also reflected in the number of reported occupied private dwellings. While it is not clear how many occupants each dwelling contains, only 43 private dwellings were reported.

Table 2.1 below provides a basic demographic profile of those in the region on census night.

TABLE 2.1

DEMOGRAPHIC PROFILE OF THE REGION

	Male	Female	Total
Population	572	57	629
Aged under 15	6	6	12
Median Age			40
Aboriginal	16	3	19
Australian Born	383	42	425
Australian Citizen	490	49	539

Source: ABS 1997.

The first interesting aspect of the region is the very high percentage (91 per cent) of males. This may be one of the contributing factors to the very low number of children (12) under the age of 15. Another interesting feature of the region is the high proportion (32 per cent) of persons born outside of Australia.

Table 2.2 details employment by industry.

By far the largest employing industries are the Mining sector and Property and Business Services. At first glance Property and Business Services seems an unusual sector to employ a large number of persons in the region. However, at closer inspection the category includes the sub-categories scientific research, surveying services and technical services not elsewhere categorised (nec) which includes seismic survey data analysis and is consistent with the mining activity in the area.

TABLE 2.2
EMPLOYMENT BY INDUSTRY

	Male	Female	Total
Agriculture, Forestry and Fishing	21	9	30
Mining	200	3	203
Manufacturing	9	0	9
Electricity, Gas and Water	3	0	3
Construction	50	0	50
Wholesale Trade	4	0	4
Retail Trade	17	3	20
Accommodation, Cafes and Restaurants	34	6	40
Transport and Storage	18	0	18
Communication	0	0	0
Finance and Insurance	0	0	0
Property and Business Services	139	3	142
Govt Admin and Defence	6	0	6
Education	0	0	0
Health and Community Services	3	3	6
Cultural and Recreational Services	3	0	3
Personal and Other Services	0	0	0
Non-classifiable or Not Stated	7	0	7
TOTAL	514	27	541

Source: ABS 1997.

The extraordinarily low unemployment rate in the region (1.1 per cent) further reinforces the point that the population reported in the census has been moved into the area for specific employment.

The speciality of much of the employment in the region is also reflected in the weekly individual incomes. Nearly 25 per cent of the regions employed workers earn between $1,000 and $1,500 per week. Furthermore, over 50 per cent of the population reported a higher level of qualification.

2.2 Specific Regional Reserve Information

Table 2.3 contains data provided by DEHAA, the Innamincka Hotel and the Innamincka Pastoral Company. The number of people employed by Santos whose work relates to the reserve has been estimated from the ABS Census data on the assumption that this number of Santos staff will be directly proportional to the share of Santos' production in the region that is sourced from the reserve (i.e., 30 per cent). Whilst this is a simplifying assumption it helps to provide an overview of the workforce associated with the reserve.

TABLE 2.3
INNAMINCKA REGIONAL RESERVE INFORMATION

	Male	Female	Total
Agriculture, Forestry & Fishing	9	3	12
Mining	67	1	68
Manufacturing			
Electricity, Gas & Water			
Construction	17	1	18
Wholesale Trade			
Retail Trade	2	2	4
Accommodation, Cafes & Restaurants	3	3	6
Transport & Storage	2	0	2
Communication			
Finance & Insurance			
Property & Business Services	46	1	47
Government Administration & Defence	0	2	2
Education			
Health & Community Services	0	1	1
Cultural & Recreational Services			
Personal & Other Services			
Non Classifiable or not stated			
Total	**146**	**14**	**160**

These data support the significant contribution of mining, pastoralism and tourism to the reserve.

3. ECONOMIC IMPACT OF INNAMINCKA REGIONAL RESERVE

The Input-Output tables for the State of South Australia have been used to measure the economic impact of the IRR. For each industry the contribution to the State's economy over a ten year period has been assessed. Note that in the case of the pastoral activity, the period 1987-88 to 1996-97 has been used because financial reporting for 1997-98 was not available.

It is recognised that Input-Output analysis focuses on a demand side shift and does not consider supply side responses. For example, if a region experiences an economic stimulus, land and capital costs may rise in response to the increased demand. This may discourage alternative industry development and partially offset the impact predicted by using a demand side multiplier.

The tables used in this analysis are the latest available but were prepared on the basis of industry structure in 1995-96. As such, they do not reflect any structural changes that may have taken place in this state since then. Consequently, the estimates provided

should be taken to be broadly indicative of the effect rather than as more precise outcomes.

The definitions and terminology for Input-Output procedures are included in Appendix B. See Appendix C for the concordance between the 57 sector South Australian Input-Output table and ASIC classifications.

The measures of general interest are job and income creation. These can be categorised as:

- the **direct** impact — defined as the job and income creation of the project itself and through direct suppliers to the project. These jobs are immediately identifiable with the industry;
- the **indirect** impact — the job and income creation associated with the flow-on of purchases and wages earned and spent throughout the state. This concept is generally referred to as the multiplier impact; and
- the **total** impact — the sum of the previous two impacts.

In general terms the impact of a project or activity can be defined as the extent of expenditure which the industry supports in this state, and the extent to which that expenditure creates or generates local jobs and incomes. The economic impact, or the benefit of jobs and wealth creation, can be seen as justification for government input to a project which does not meet the economic criteria determined through the cost-benefit analysis.

The key question in the case of the project expenditure is a distinction between what might be considered:

- the *gross* economic impact of the project — which relates to all expenditure associated with the project, and is a measure of the economic activity *supported* by the project; and
- the ***net*** economic activity - which relates to the activity *created* by the project.

The difference between the two (local expenditure on the project) is described as transfer expenditure in that it would, in the main, have been spent in the region with or without the project happening, simply on a different activity.

This distinction is crucial for assessing the net benefits of the IRR and requires historical judgement on what management structure would have been in place had a regional reserve classification not been adopted. For example, it could have been left as a pastoral lease or it could have become a conservation park. The alternative management structures would have implications for the level of pastoral, petroleum and tourism activities and hence the net benefits of the regional reserve classification. Unfortunately it has not been possible to clearly establish what the alternative management structure for the region would have been.

Therefore it was agreed that the Centre should report on the gross economic impacts of the pastoral, petroleum, and tourism activities associated with the IRR. In addition, available data on South Australian government expenditure were also collected.

4. IMPACT OF PETROLEUM ACTIVITIES

The entire IRR lies within the Petroleum Licences 5 and 6 (PEL 5 & 6) which have been held by Santos since 1959 and which are due to expire without right of renewal in February 1999. Approximately 30 per cent of South Australia's Cooper Basin oil and gas production occurs within the IRR. These licences give exclusive petroleum exploration rights to cover an area of 73,000 square kilometres which includes the Coongie Lakes.

4.1 Activity Profile

According to the 57 sector State Input-Output table, Oil and Gas exploration and extraction occurs in industry 10 — Other Mining (see Appendix C). The value of the output from these activities, in 1995-96 dollars, was reported to be over $3.1 billion between 1988 and 1997.

4.2 Economic Impact

Using industry standard multipliers, Table 4.1 illustrates the economic impact of the above output for South Australia. The measures of economic activity used are — employment, wage and salary income and value added. Value added represents the difference between the value of the goods produced and the cost of materials and supplies used in producing them. Output of one firm often becomes the input of another in the production of a final product. Reporting the impact on output therefore involves considerable double counting. The stated value added figures contained in this study overcome the double counting problem as they represent the sum of the value added to a product at each stage of production.

The direct impact is the impact in terms of employment and incomes of local residents within the production itself, and in direct suppliers/services to the production. The total impact includes the indirect or flow-on effect as the expenditure recirculates within the economy.

TABLE 4.1

ESTIMATION OF THE ECONOMIC IMPACT, 1988 TO 1997

	Employment	Income ($'000)	Value Added ($'000)
Direct Impact	10,117	573,174	1,775,734
Indirect Impact	30,684	870,312	846,880
Total Impact	**40,802**	**1,443,486**	**2,622,615**

Note: Totals may not add due to rounding.

Over the ten year period, oil and gas exploration and extraction has contributed over $2.6 billion to the State's Gross State Product. This expenditure has created net incomes for South Australians of over $1.4 billion and created over 40,800 full time equivalent jobs (4,080 jobs per annum).

4.3 Future Prospects

There are two aspects with respect to the future prospects for the petroleum activity within the IRR. Firstly, the life of the wells which are currently being extracted from, and secondly the potential finds for the future.

The Stakeholder Working Group reports in their submission to the ten year review that there is an expectation that significant additional resources remain to be found in the region. With considerable expenditure on exploration and new technologies and geoscientific understanding of the area, the likelihood of significant discoveries is high.

It is estimated that undiscovered reserves of 80 to 1,550 peta joules of Sales Gas and 1,150 to 9,500 megalitres of oil may occur within the IRR. It is forecast that the oil and gas production from the area will remain high until at least the year 2005.

Because oil is sold onto the world market the future prospects for this commodity are positive but unclear. ABARE (1998a) explained the recent fall in the world price of oil to US$12.70 a barrel as the result of OPEC supplies rising faster than demand. A significant cause of the difference between supply and demand has been weaker world economic growth particularly in Japan and East Asia.

In response to the lower prices some of the higher-cost producers have cut back their production. In addition, ten OPEC members and six major non-OPEC producers have also agreed to restrain their output, possibly throughout the second half of 1998.

Nevertheless, an improvement in world economic growth, and consequent consumption of oil is expected to cause world oil prices to increase to US$17.50 a barrel in 1999. ABARE expects oil prices to remain firm in the medium term, but has not forecast oil prices beyond the year 2003. However, it is possible that the negative impact of the downturn in Asia will be prolonged and that the firming of oil prices will be delayed.

To estimate the potential impact of mining in the IRR on the South Australian economy for the next ten year period the estimated value of gas contracts has been used. This assessment only takes account of the extraction from existing resources in the IRR. That is, the potential for new discoveries has not been included. These estimates can therefore be considered lower bounds, as the market demand is much higher than the present supply and, as noted above, the probability of future finds is good.

South Australian production from the Cooper Basin is utilised in South Australia and New South Wales. Slightly discounting the value of gas contracts forecasted by ABARE (they were considered by MESA to be overly optimistic), future revenue was estimated for existing gas resources as $1.1 billion.

Using industry standard multipliers, Table 4.2 illustrates the economic impact of the above expenditure for South Australia.

TABLE 4.2
ESTIMATION OF THE ECONOMIC IMPACT OVER THE NEXT TEN YEAR PERIOD

	Employment	Income ($'000)	Value Added ($'000)
Direct Impact	3,659	207,285	642,187
Indirect Impact	11,097	314,745	306,271
Total Impact	**14,756**	**522,031**	**948,458**

Note: Totals may not add due to rounding.

Mining existing gas resources in IRR over the following ten year period is expected to contribute nearly $950 million to the State's Gross State Product. This output may create net incomes for South Australians of approximately $522 million and create around 14,750 full time equivalent jobs.

5. IMPACT OF PASTORALISM

Innamincka station consists of one 13,818 square kilometres lease located on Cooper Creek in the north-east of South Australia. It incorporates the former Coongie pastoral lease which was purchased by Sydney Kidman in 1904 and the Innamincka pastoral lease which was purchased in 1909. The later purchase also included Merty Merty which is today a separate pastoral lease.

5.1 Activity Profile

The total expenditure for Innamincka Station in 1995-96 dollars between 1987-88 to 1996-97 is estimated to be nearly $7.6 million.

On the basis of the expenditure profile provided by S Kidman & Co., the expenditures were distributed to industries (or categories) in which they would have their impact.

To estimate the effects of the wages and salaries (and therefore consumption), on-costs have not been included[1] and the $2.2 million has been discounted by 25 per cent to account for the leakages from the South Australian economy due to personal income tax collections[2] and savings. The remaining $1.7 million has been distributed across 57 industry sectors on the basis of household consumption shares.

The Input-Output tables are based on basic prices. That is, transport costs and retail mark ups are not included in the value of goods associated with each industry. These services are sourced by each industry from the Trade and Transport related industries. The retail and wholesale mark ups associated with the purchases of some of the expenditure items has been estimated at 30 per cent and attributed to the Trade industry.

1 Note that on-costs, in the main, are transfers to Government (WorkCover, Payroll Tax etc), although part is superannuation that will raise future consumption. No account has been taken of this future benefit.

2 Note that it is likely that at least part of the leakage (to both Governments) will return to the community in some form of benefits (and therefore raise disposable income). However, due to the uncertainty of the value and type of this return it is best to remain conservative and exclude an estimate from the analysis.

The expenditure was also adjusted to reflect the source. For example Kidmans reported that only 15 per cent of their cattle were purchased from South Australia. The value of cattle purchases was discounted accordingly.

The industry distribution of expenditure used in the assessment therefore includes that which would have occurred as a result of the Station's activities and that which would have occurred as a result of the consumption expenditure resulting from the wages paid to the Station's employees.

5.2 Economic Impact

Using industry standard multipliers, Table 5.1 illustrates the economic impact of the above expenditure for South Australia.

TABLE 5.1
ESTIMATION OF THE ECONOMIC IMPACT OF PASTORALISM OVER THE TEN YEAR PERIOD

	Employment	Income ($'000)	Value Added ($'000)
Direct Impact	55	1,521	1,745
Indirect Impact	66	1,829	1,600
Total Impact	**121**	**3,351**	**3,345**

Note: Totals may not add due to rounding.

Over the ten years of the Regional Reserve, Innamincka Station has contributed over $3.3 million to the State's Gross State Product. This expenditure has created net incomes for South Australians of approximately $3.3 million and created around 121 full time equivalent jobs.

5.3 Future Prospects

The Innamincka Station is working towards achieving best management practice of grazing activities in the area. In the past, stock levels have been adjusted in response to climate and land conditions in the area and this management approach is expected to continue. Even if the climatic conditions were assumed to be cyclical and the stock levels were based on the previous ten year period, it is difficult to estimate the future *value* of pastoralism to the State because it is very dependent on the price which is set on the world market. The future prospects of the Innamincka Station will depend on several factors. These will include:

- world beef prices;
- the carrying capacity of the land; and
- seasonal variation.

Bailey, Barrett, Rodriguez and Toyne (1998) forecast that in real terms the saleyard price for beef will increase slightly until 1999-2001 and then level out in 2001-02. Over the medium term ABARE projects that Australian saleyard prices will increase in real terms

by about 3 per cent from 1997-1998 prices to reach 180c/kg in 2002-03. Estimates of expected saleyard prices over the longer term were not provided.

On the assumptions that previous average stocking rates are maintained, future seasonal patterns are similar to those experienced over the last 10 years and that beef prices are relatively unchanged then it would be reasonable to suggest that the contribution of the Station to GSP over the next ten years will be at least as good as the previous ten year period. However, there is a measure of uncertainty attached to each of these assumptions.

6. IMPACT OF TOURISM

Tourism is a major contributor to economic activity in Australia. The Bureau of Tourism Research estimates that tourism contributed 6.6 per cent or $27.7 billion to Australian Gross Domestic Product (GDP) in 1993-94. Tourism expenditure by Australian residents is estimated to have contributed 4.8 per cent and international visitor expenditure contributed 1.8 per cent.

As a service industry the output of the tourism industry is mainly intangible and is often consumed at the same time as it is produced. Service industries are usually labour intensive and the measurement of net output and productivity presents special difficulties

In February 1996 the Centre undertook a study on the economic value of tourism to the South Australian economy. In the period up to the year 2000 the South Australian Tourism Commission has set annual growth rates for South Australian tourism of 5 per cent in the interstate market, 15 per cent in the international market and 2 per cent in the local market.

The Centre used its FEDERAL-SA model of the South Australian and Australian economies to project the effects of achieving these targets, if realised, on the South Australian economy. The targets imply that interstate and international tourists would spend an additional $250 million per annum in the State. The results of these projections are:

- an increase in real GSP in South Australia of between $100 million and $170 million (in current dollars) on an average annual basis;
- the creation of up to 3,600 net full-time jobs in the State; and
- an increase in activity in a wide range of service industries in South Australia.

While the international and interstate visitors clearly provide economic benefits to the State, the economic contribution of intrastate tourism is not as clear. An increase in intrastate tourism will only have an effect on the South Australian economy if it is at the expense of tourism spending interstate or overseas. That is, unless the tourism activity in South Australia undertaken by a South Australian resident is in place of undertaking a tourism activity outside of the state, then the expenditure cannot be considered a net benefit to the state as it would have occurred in the state anyway.

As depicted in Table 6.1, intrastate tourism represents a significant proportion of the number of tourism nights in South Australia.

TABLE 6.1
ORIGIN AND VISITOR NIGHTS OF VISITORS TO SOUTH AUSTRALIA

1994-95	International	Interstate	Intrastate	Total
Number of Nights	3,179	6,128	9,823	19,140
Share	17%	32%	51%	100%

6.1 Visitors to Innamincka

A survey conducted in 1988 by Gillen used total petrol sales from Innamincka as an indicator of visitor numbers and estimated that 15,891 tourists visited in 1986 and that in 1987 it increased to 24,460 tourists. In 1988 the South Australian National Parks and Wildlife Service estimated that visitor numbers to the area were 30,000 per annum and likely to be increasing. Factors such as the improved road access created by the mining activity, increased knowledge and interest in the natural environment, changes in leisure time, a desire to avoid over crowded destinations and an increase in four wheel drive ownership were thought to be contributing to this growth.

The Tourism Resource Group's submission to the review report that during the late 1980s and early 1990s, the number of visitors ranged from 15,000 to 30,000. This latter figure is disputed by the South Australian Association of Four Wheel Drive Clubs as being too high and the Centre would tend to agree.

Measuring the number of visitors to the Innamincka region should be easier than most locations because all visitors have to stop at the Trading Post to fill up on fuel. Intuitively, 30,000 visitors to the region implies that over 80 persons (approximately 27 vehicles) every single day throughout the year would have to visit the Trading Post. This seems extraordinarily high but unfortunately, for confidentiality reasons, the owners of the Trading Post were unable to confirm nor negate our concerns. However, personal communication with other people with knowledge of the area agree with this conclusion.

To be conservative and consistent with personal communication, the Centre has adopted a total visitor number of 15,000 per annum for this study.

6.2 Activity Profile

Visitors to the IRR are a little different to those reported in many tourism reports. In the majority of cases they are self sufficient and their spending is, in the main, limited to fuel and supplies.

Having said that, Innamincka does have one tourism business — the Cooper Creek Cruises. This operation has been operating for over four years and employs one person (owner/operator). The cruises operate between April and October of each year and over the four year period the operator estimates that there has been a 10 per cent increase in

business. In 1997 over 1,900 tourists undertook the tour. The expenditure profile outlined below takes accounts of this reported growth.

Businesses in the town that would benefit from tourism to the area are the Innamincka Trading Post and Innamincka Hotel as well as the grader operator and the windscreen repair business. Unfortunately, due to the confidential nature of the information required, the Innamincka Trading Post was unable to provide information to the review. As a result, a limiting assumption was that the expenditure on fuel and supplies remained constant.

The owner of the Innamincka Hotel currently employees four full time equivalent persons and reported that over the eight years that he has been proprietor, his bed nights have increased three fold. In fact, the Hotel is currently booked out until October. This dramatic increase in visitor nights has been included in the expenditure profile below.

TABLE 6.2

TOURIST EXPENDITURE PROFILE ($'000) OVER THE TEN YEAR PERIOD

	Industry	Expenditure
11	Meat Products	248
12	Milk Products	338
13	Fruit and Vegetable Products and Margarines, Oils and Fats	96
14	Flour Mill and Cereal Food Products	135
15	Bread, Cakes and Biscuits	169
16	Confectionary and Other Foods	378
17	Soft Drinks	158
18	Beer	72
19	Wine	45
20	Spirits	5
22	Knitting Mills, Clothing and Footwear	248
25	Chemicals and Petroleum Products	5,677
47	Trade	3,244
49	Railway, Water and Services to Transport	133
53	Hotels	1,043
	Total Expenditure*	**11,989**

Note: * = Totals may not add due to rounding.

As reported above, in establishing the benefits of tourism to the State it is important to distinguish between intrastate, interstate and international tourists. Advice from people in the region has suggested that a very high proportion (80 per cent) of visitors are from interstate or overseas. The number of visitors to the region has therefore been discounted to remove the intrastate component.

Table 6.2 depicts the tourist expenditure profile for the ten year period using advice from several people in the industry and region.

6.3 Economic Impact

Using industry standard multipliers, Table 6.3 illustrates the economic impact of the above expenditure for South Australia.

TABLE 6.3

ESTIMATION OF THE ECONOMIC IMPACT OVER THE TEN YEAR PERIOD

	Employment	Income ($'000)	Value Added ($'000)
Direct Impact	125	2,605	4,310
Indirect Impact	182	4,931	5,117
Total Impact	308	7,536	9,428

Note: Totals may not add due to rounding.

Over the ten years of the IRR, Tourism has contributed over $9.4 million to the State's Gross State Product. This expenditure has supported net incomes for South Australians of approximately $7.5 million and underpinned over 300 full time equivalent jobs.

6.4 Future Prospects

As reported above the State government is keenly targeting an increase in tourism in the next few years. In fact, the recent State Budget included a doubling of the tourism marketing budget.

Although the reported visitor number of 30,000 appears too high, current evidence seems to suggest that tourism in the area is on the increase. With the increasing appeal of the product the region offers and government's increased commitment to tourism it does appear likely that the increase will continue.

7. IMPACT OF GOVERNMENT ACTIVITIES

Unfortunately it has not been possible to gain an accurate estimate of State government expenditure in the IRR. This is due to several factors, including the relocation of the DEHAA Office with overall responsibility for the Reserve. The relocations have resulted in the loss of some files containing details of some DEHAA expenditure. A further difficulty was caused by the absence of a specific project accounting code for the Reserve. The presence of such a code would facilitate a more accurate identification and allocation of the costs and revenues associated with the Reserve. In particular, it would help to pick up the costs relevant to central administration, water monitoring, pastoral assessment and biological surveys and data maintenance.

The estimates presented below are based on Docket searches and the recall of key DEHAA and PIRSA staff.

Based on this information, the present value (1995-96 dollars) of SA Government expenditure in the Reserve of the period from 1988-89 to 1997-98 has been approximately $8 million.

Major expenditure during this period included:

- a $500,000 contribution in 1995-96 to the reconstruction of the Australian Inland Mission building. This building is now used as DEHAA's office in the Reserve. In addition, it provides accommodation for the Reserve's Park Ranger;
- the realignment of the Strzelecki Track in 1996-97 by the Department of Transport at a cost of $3 million;
- expenditure by the Outback Areas Community Development Trust of $52,500 in 1992-93 for the town's water supply. Between 1988-89 and 1997-98 the Trust's Innamincka expenditure has totalled about $113,0000 in real terms (1995-96 dollars);
- expenditure of $280,000 to assist in the establishment of the Coongie and Cullyamurra Conservation Paddocks;
- expenditure by the PIRSA Petroleum Inspectorate of $1.7 million in real terms (1995-96 dollars) over the review period; and
- over $580,000 in real terms (1995-96 dollars) spent on biological surveys.

The nearest Police are located at Leigh Creek and some of their time and budget would be spent dealing with matters in the Reserve. The Centre has not gained information from the Police about the costs of this involvement.

DEHAA gains income annually from the sale of its Desert Park Passes. The annual value of sales for these passes is approximately $250,000. The IRR gains approximately $30,000 annually from the sale of the passes. In addition, S. Kidman and Company pay an annual pastoral rent of $14,700.

Whilst the above discussion has provided details on SA government expenditure related to the Reserve, government involvement in the reserve does not directly generate income for the Reserve. However, government involvement could be expected to lead to economic benefits through its contribution to the management of the reserve. As such its involvement could be expected to contribute to both market and non-market benefits. It is however, beyond the scope of this report, to attempt to estimate the magnitude of those benefits.

A key question with respect to government's involvement in the Reserve relates to its level of involvement. From an economic perspective the optimal level of involvement would be where the marginal benefits of involvement equal the marginal costs of involvement. However, determining this point is complicated through the unquantified, but believed to be high, non-market benefits of the environmental attributes of the region. To the extent that a role of the Department is to protect these attributes then it is possible that the benefits of further involvement could be high. However, the Centre is not able at this stage to form an opinion on the optimal level of the Department's involvement in the reserve.

8. RESOURCE ISSUES AND CONFLICTS

A central question with respect to the Regional Reserve classification is whether the various uses of the reserve can co-exist. There are several aspects to this question. One is whether the reserve system has been effective up to date. The other is whether the reserve system will be able to cope, despite increased demands on its resources, in the future. As discussed in an earlier section of this report it seems that tourism activity has been increasing and is expected to increase further over the next decade. It is more difficult to draw robust conclusions about the extent of future oil and gas activity. In the short term Santos could be expected to increase its exploration activities before PELS 5 and 6 expire. Following the expiration of those licences, there is the potential for extra exploration activity as other companies gain licences and search for oil and gas. There is also the possibility that Santos' extra exploration activity will result in increased production. Overall it would appear that oil and gas industry activity is likely to increase over the next decade. On the other hand, the level of pastoral activity over the next decade is expected to be similar to the previous 10 years.

As to be expected, those with an interest in the reserve have widely differing views on the issue of multiple use. To a large degree these differences reflect different interpretations of the relative importance of conservation as the primary objective of the Regional Reserve Classification Systems. There are some that insist that the Reserve system is conceptually flawed and should be abolished. Others support the current system. Between these two positions is the view that there is potential for improvements in the management of the reserve. Amongst the improvements suggested, are increases in the area from which pastoralism, tourism and petroleum survey, exploration and extraction are prohibited. There are also suggested changes to current management practices to minimise the impact of industries on the environment.

In essence, this latter approach gives some recognition of the contribution of these industries to the economic welfare of the people of South Australia and Australia. It also takes the view that this contribution imposes significant costs on the community with respect to, amongst other things, reduced biodiversity, land degradation, and lower aesthetic value. It attempts to protect those areas of most value whilst maximising the potential benefits that come from future pastoral and oil and gas activities.

Nevertheless constraints on the areas to be operated and changes to management systems also impose costs on the pastoral and petroleum industries, and to the State and nation. Where these costs become too high the activities may become financially unviable and close down.

As such, trade-offs are involved. While it is relatively straight forward to identify the extra costs imposed on industry, the costs in terms of environmental attributes are much more difficult to quantify. Whilst some qualitative assessment of the likely impacts of grazing and petroleum exploration and extraction have been made, there is little quantitative information as yet available which can be used to identify the magnitude of such impacts. Indeed the extreme variability of conditions within the reserve and across time further complicates such quantitative assessments. Nevertheless, sound, scientific quantitative analyses of the specific impacts of pastoral, petroleum and tourism uses of the Reserve are essential for future reviews of the success of the Reserve Classification.

Such analyses would form a foundation for estimation of the net economic benefits of the Reserve system.

9. FUTURE REVIEWS

Whilst the legislative requirements of the review process are for an economic impact assessment, the Centre holds the view that a Benefit-Cost Analysis would be more appropriate for future reviews.

Whereas an economic impact study has provided information on the contributions of the pastoral, petroleum and tourism activities to the South Australian economy the Centre understands that the core question for future reviews is whether or not the current regional reserve classification should continue or whether it should be replaced by an alternative classification. This question is better answered by Benefit-Cost Analysis as this technique quantifies the net social benefits from such a change.

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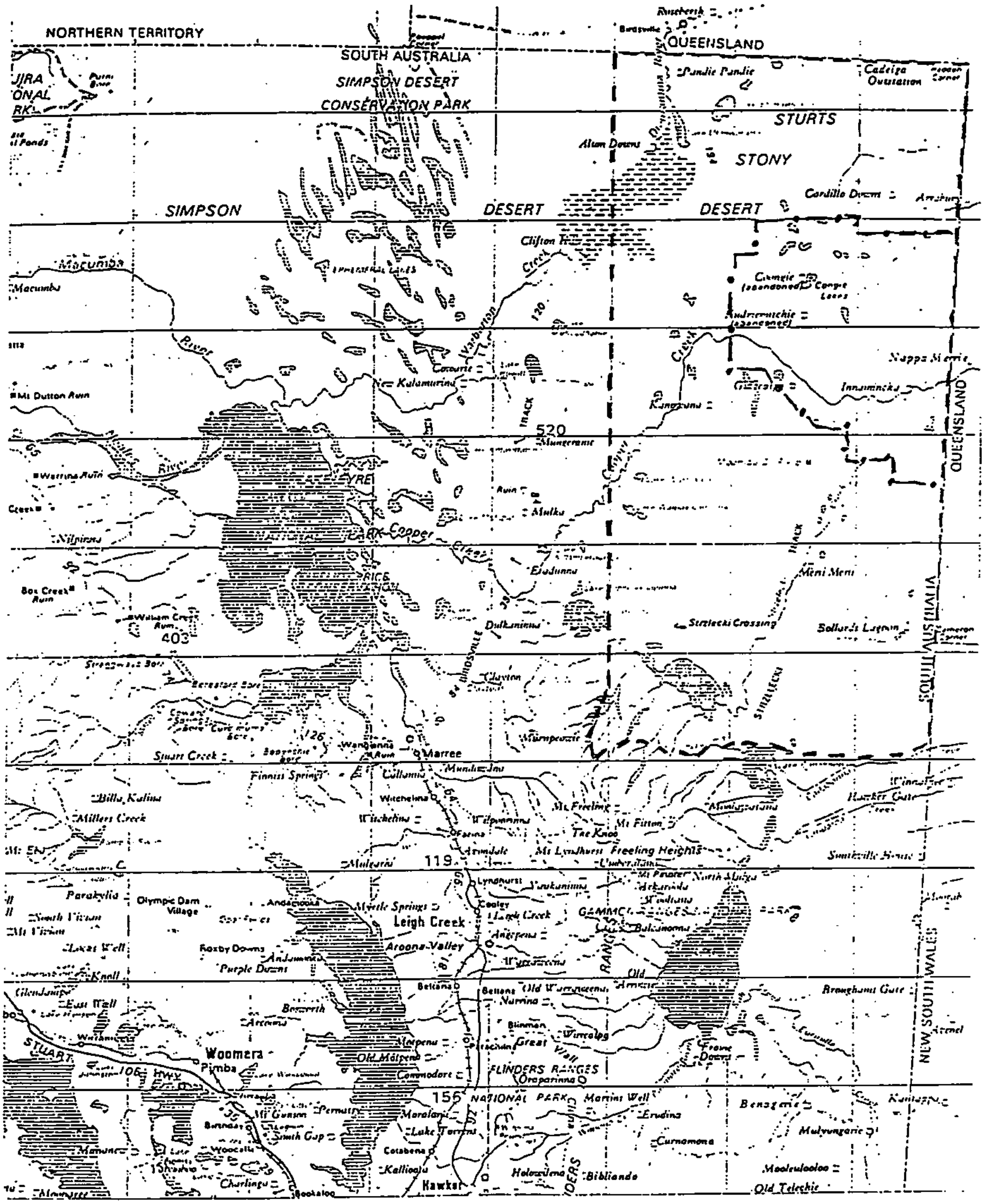
APPENDIX A



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APPENDIX B

DEFINITION OF INPUT OUTPUT PROCEDURES AND TERMINOLOGY

B.1 INTRODUCTION

Input-output models or tables have been regularly applied at the regional level for assessing regional economic change, around Australia and internationally. Most states and sub-regions of the country have at some time or other been described within the boundaries of an input-output table. While they have a fairly simple construct they are powerful analytical tools, and are rich in quantitative endowment. They underpin even more extensive economic models such as general equilibrium frameworks.

B.2 THE INPUT-OUTPUT TABLE

An input-output table is a quantitative description of the economic structure of a region, in matrix or table form. The economy is divided into industry sectors. The columns of a table illustrate the value of purchases or inputs by an industry from other industries within the region. It also contains the values of primary inputs into the production process, including wages and salaries (the labour input) other value added (return earned on capital and paid as either interest on previous investments, or a return on equity or as a direct tax). The rows illustrate the sales of an industry to other industries and sales to final demand (from a regional perspective) including sales directly to households, other final demand (investment and government expenditure) and exports (out of the region, including interstate and international). As such the total of the column for an industry (inputs) must equal the total of the row (outputs). The following is an example of a table structure within this context.

		Sales to Industry Sectors			Final Demand			Output (Total Supply)
		Agriculture	Manuf-acturing	Services	House-holds	Other Final Demand	Exports	Total
Industry Purchases	Agriculture	10	30	20	10	5	25	100
	Manufacturing	20	20	30	10	10	20	110
	Services	30	10	10	20	5	20	95
Primary Inputs	Wages/ Salaries	10	15	20	0	-	-	45
	Other Value Added	20	15	10	0	-	-	45
	Imports	10	20	5	20	10	-	65
Total Use	Total Inputs	100	110	95	60	30	65	460

This table then provides a very useful description of the economy. It can be used to assess the relative importance of individual industries within a region, the use of labour and pattern of final demand, and very importantly the interconnections that exist between an industry in the region. These interconnections can be very important in determining how growth or decline in a given industry will affect the region as whole (through the interconnection effect). The table above illustrates for example that the agriculture industry on average purchases 60 per cent of its total input costs as products produced in the region, and 10 per cent is paid as wages to workers from the region. The

table suggests that labour in the region is spending more than it is earning and has a balanced trade picture (that is, imports equal exports). It can also be seen that a drop in manufacturing output would also have significant implications for the agricultural industry, who sell 30 per cent of their output to manufacturing.

B.3 THE DEFINITION OF MULTIPLIERS

Most people who have undertaken some study of economics are comfortable with the concept of a Keynesian multiplier. In an economy with minimal supply constraints new expenditure within the economy circulates and flows through to generate more activity than the initial amount. Because of the identification of the linkages that exist within the economy, a multiplier can be developed from the input-output table — a multiplier that is specific to an individual industry.

More generally, it has become understood that extra exports from a specific industry generate activity within that industry, but also support activity in supplying industries, and will result in wages and salaries that in turn are spent and are responsible for activity in other areas. This is called the flow-on or multiplier effect, and an input-output table provides the mechanism for estimating the value of industry multipliers for a given region. The following summarises their interpretation.

Multipliers have a number of "stages":

- *direct* — indicates the economic activity associated with the initial expenditure itself;
- *first round* — activity created though the local purchases generated to support the expenditure;
- *production* induced — the direct and first round impact, and the further rounds associated with inter-industry linkages, as supplying industries in turn buy from other industries and the effect works its way through;
- *consumption* induced — the working through of the impact as the wages paid in supporting the expenditure in turn generates consumption expenditures which works its way through the economy; and
- *total* — the sum of the production and consumption induced effects which demonstrates the total influence of an increase in demand on the economy as a whole.

Multipliers can be provided which measure a number of parameters or different elements of economic activity. These measures basically fit with the national accounting conventions or definitions and include:

- *income* — this measure of activity provides multipliers which indicate wages and salaries paid to workers within the region;
- *value added* — this measure indicates wages and salaries and return on capital, and is consistent with the concept of Gross Domestic Product at a national level, or Gross Regional Product at a regional level; and
- *employment* — the jobs created in association with the initial expenditure.

APPENDIX C

MAPPING SA's 1995-96 INPUT-OUTPUT TABLE (57 INDUSTRIES) TO ASIC INDUSTRIES

	SA Input-Output Table	ASIC code	ASIC industries - description
1	Sheep and cereal grains	0182 0184 (part) 0185 0181 0183 (part)	Sheep-cereal grains Sheep-meat cattle Sheep Cereal grains Meat cattle-cereal grains
2	Meat cattle	0186 0184 (part) 0183 (part)	Meat cattle Sheep-meat cattle Meat cattle-cereal grains
3	Milk cattle and pigs	0187 0188	Milk cattle Pigs
4	Poultry & Agriculture nec	0124-5, 0135-6, 0143-4 0191-6	Poultry Fruit Vegetables Other agriculture
5	Services to agriculture	0204-6	Services to agriculture
6	Forestry and logging	0303-4	Forestry and logging
7	Fishing and hunting	0431-4 0440	Fishing Hunting and trapping
8	Ferrous metal ores mining	1111-2	Ferrous metal ores mining
9	Non-ferrous metal ores mining	1121-9	Non-ferrous metal ores mining
10	Other mining	1201-2 1300 1401-4 1501-5 1611-2 1620	Coal Oil and gas Construction materials Other non-metallic minerals Mineral exploration Mining and exploration services nec
11	Meat products	2115-7	Meat products
12	Milk products	2121-5	Milk products
13	Fruit and vegetable products Margarines, oils, fats nec	2131-2 2140	Fruit and vegetable products Margarines, oils, fats nec
14	Flour mill and cereal food products	2151-3	Flour mill and cereal food products
15	Bread cakes and biscuits	2161-3	Bread cakes and biscuits
16	Confectionary and other food nec	2173 2171 2174 2175 2176	Confectionary and cocoa products Raw sugar Processed seafoods Prepared animal and bird foods Food products nec
17	Soft drinks	2185	Soft drinks, cordials and syrups
18	Beer	2186 2187	Beer Malt
19	Wine	2189 (part)	Wine and brandy (part)
20	Spirits	2188 2189	Wine and brandy Alcoholic beverages nec
21	Textiles	2341 2342 2343 2344 2345 2348 2351 2346 2347	Cotton ginning Wool scouring and top making Man-made fibres and yarns Man-made fibre broadwoven fabrics Cotton yarns and broadwoven fabrics Narrow woven and elastic textiles Household textiles Worsted yarns & broadwoven fabrics Woollen yarns & broadwoven fabrics

TABLE 1 CONTINUED

	FEDSA-TAX industry	ASIC code	ASIC industries - description
22	Knitting mills	2349	Textile finishing
	Clothing	2352	Textile floor coverings
	Footwear	2353	Felt and felt products
		2354	Canvas and associated products nec
		2355	Rope, cordage and twine
		2356	Textile products nec
		2441-3	Knitting mills
		2451-6	Clothing
		2460	Footwear
23	Wood and wood products Furniture and mattresses	2531	Log sawmilling
		2532	Resawn and pressed timber
		2536	Wooden containers
		2537	Hardwood woodchips
		2533	Veneers and manufactured boards of wood
		2534	Wooden doors
		2535	Wooden structural fitting & joinery nec
		2538	Wood products nec
		2451-2	Furniture and mattresses
24	Paper and paper products Publishing, printing and publishing	2631	Pulp, paper and paperboard
		2632	Paper bags
	Paper stationary, printing trade services nec	2633	Solid fibreboard containers
		2634	Corrugated fibreboard containers
		2635	Paper products nec
		2641	Publishing
		2642	Printing and publishing
		2643	Paper stationery
		2644	Printing and bookbinding
		2645	Printing trade services nec
25	Chemicals and petroleum products	2751	Chemical fertilisers
		2752	Industrial gases
		2753	Synthetic resins and rubber
		2754	Organic industrial chemicals nec
		2755	Inorganic industrial chemicals nec
		2762	Paints
		2763	Pharmaceutical and veterinary products
		2764	Pesticides
		2765	Soap and other detergents
		2766	Cosmetics and toilet preparations
		2761	Ammunition, explosives and fireworks
		2767	Inks
		2768	Chemical products nec
		2770	Petroleum refining
		2780	Petroleum and coal products nec
		2850	Glass and glass products
26	Clay products and refractories	2861-4	Clay products and refractories
27	Cement	2871	Cement
28	Other non-metallic mineral products	2872	Ready mixed concrete
		2873	Concrete pipes and box culverts
		2874	Concrete products nec
		2881-4	Other non-metallic mineral products
29	Basic iron and steel	2941-5	Basic iron and steel
30	Basic non-ferrous metals and products	2951-7	Basic non-ferrous metals
		2961-3	Non-ferrous metal basic products
31	Structural metal products	3141-3	Structural metal products
32	Sheet metal products	3151-3	Sheet metal products
33	Metal products nec	3161-8	Other fabricated metal products
34	Motor vehicles, ships, locomotives and aircraft	3231-4	Motor vehicles and parts
		3245	Transport equipment nec
		3241	Ships
		3242	Boats
		3243	Railway rolling stock and locomotives
		3244	Aircraft
35	Photographic, professional and scientific equipment	3341-3	Photographic, professional and scientific equipment

TABLE 1 CONTINUED

	FEDSA-TAX industry	ASIC code	ASIC industries - description
36	Electronic equipment	3351 3352	Radio and TV receivers; audio equipment Electronic equipment nec
37	Electrical equipment nec	3353 3354 3355 3356 3357	Refrigerators and household appliances Water heating systems Electric and telephone cable and wire Batteries Electrical machinery and equipment nec
38	Agricultural machinery Construction machinery, machinery and equipment nec	3361 3362 3363 3364 3365 3366 3367 3368 3369	Agricultural machinery Construction machinery Materials handling equipment Wood and metal working machinery Pumps and compressors Commercial space heating and cooling equipment Dies, saw blades and machine tool accessories Food processing machinery Industrial machinery &equipment nec
39	Leather and leather products Rubber products	3451-2 3461-2	Leather and leather products Rubber products
40	Plastic and related products	3471-4	Plastic and related products
41	Other manufacturing	3484 3486 3481 3482 3483 3485 3487	Signs and advertising displays Writing and marking equipment Ophthalmic articles Jewellery and silverware Brooms and brushes Sporting equipment Manufacturing nec
42	Electricity	3610	Electricity
43	Gas	3620	Gas
44	Water and sewerage	3701-2	Water, sewerage and drainage
45	Residential construction	4111 4112 4231-49 (part)	Housing construction Residential building construction nec Special trade construction
46	Non-residential building and construction	4113 4121-2 4231-49 (part)	Non-residential building construction Non-building construction Special trade construction
47	Trade*	4710-96 4814-97 (part) 4731 (part) 4860 (part) 4857	Wholesale trade Retail trade Farm and construction machinery wholesalers Motor vehicle dealers; petrol and tyre retailers Electric appliance repairers nec
48	Road transport*	5111-23	Road freight and passenger transport
49	Railway transport * Water transport* Services to transport*	5200 5500 5307-9 5711-3 5721-4 5730 5741-4 5801-3	Rail transport Other transport Water transport Services to road transport Services to water transport Services to air transport Other services to transport Storage
50	Air transport*	5405-7	Air transport
51	Communication	5900	Communication
52	Insurance*	6231-4	Insurance
53	Hotels*	9340-64	Restaurants, hotels and clubs

TABLE 1 CONTINUED

	FEDSA-TAX industry	ASIC code	ASIC industries - description
54	Finance	6141-4	Banking
		6151-6	Non-bank finance
		6161-3	Investment
		6171-2	Services to finance and investment
		6240	Services to insurance
		6310	Real estate agents
		6322	Property operators and developers nec
		6334-6	Technical services
		6371-2	Legal and accounting services
		6381-9	Other business services
		6390	Plant hire and leasing nec
55	Public administration and defence	7111-30	Public administration
			Defence
56	Community services	8141-60	Health
		8231-52	Education, museum and library services
		8304-6	Welfare and religious institutions
		8461-95	Other community services
57	Personal services	6321	Residential property operators
		9131-44	Entertainment and recreational services
		9231-44	Personal services
		9400	Private household employing staff