Marree

SCB

Soil Conservation Board

District Plan
Revised 2004

Government of South Australia

MARREE SOIL CONSERVATION BOARD

Soil Conservation Council of South Australia

FOREWORD

The Marree Soil Conservation Board (MSCB) has seen changes since the last review of the District Plan including drought, the possibility of Natural Resource Management Reform (NRM) and some new faces on the board.

During the past two to three years, our district has seen most areas in a very severe drought and has only had patchy relief. The Federal Government proclaimed 'Exceptional Circumstances' in some areas, and without good summer rain most areas will remain in drought.

Also, this past two years has seen a proposed move toward the amalgamation of the functions of the Animal and Plant Commission (APCC), Soil Conservation Council (SCC) and the Water Catchment Management Board (WCMB). The new Act is to be called the Natural Resource Management Act. In the interim, the MSCB remains in its present form, but may change in the future. I believe we need a strong voice in the far northern regions of South Australia, so we can be involved with decisions, which affect the social and economic well being of our district. The proposed NRM Regional Board will need those strong voices to continue the work developed by the MSCB and other rangeland soil boards.

As the current Chairperson of the MSCB, I would like to thank the previous and present board members for the work they have done, and give special thanks to Marie Morton and Catriona McTaggart for staying on as board members. The current MSCB is a good cross-section of interest from the district, and I look forward to continuing to work with them.

Ken Ogilvy,
Chairperson,
Marree Soil Conservation Board

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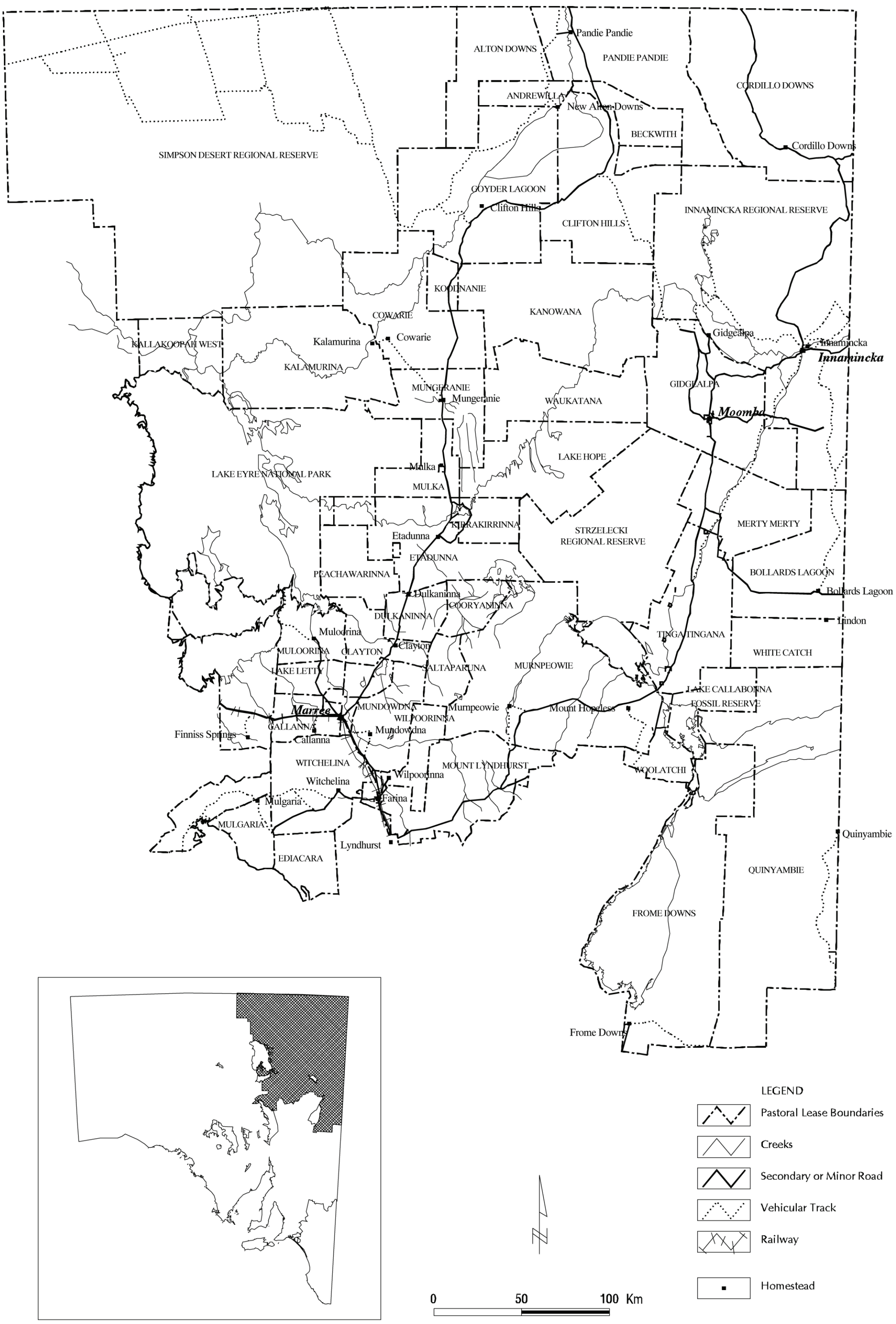


Figure 1 Marree Soil Conservation District location map.

PART I

NATURE AND PURPOSES OF THE DISTRICT PLAN

SOIL CONSERVATION PLANNING

Soil conservation legislation in South Australia, the *Soil Conservation and Land Care Act 1989,* is aimed at the prevention or minimisation of land degradation, to ensure the land is managed in such a way that its productive capability can be sustained indefinitely.

The Act provides for the division of South Australia into Soil Conservation Districts, each having a Soil Conservation Board, which in the Rangelands are prescribed bodies under the *Animal and Plant Control Act 1986*. The actual division into the present Districts has attempted to produce Soil Conservation Districts in which the nature of land-use enterprise is similar, and secondarily where the climate and landforms are reasonably consistent throughout. Hence the Flinders Ranges, although also arid with pastoral, conservation and tourist uses dominant, are placed in different Districts from the surrounding pastoral lands: the physical nature of the Ranges compared with the plains mean that the soil conservation challenges posed differ in kind, despite the other similarities in landuse.

A Soil Conservation District Plan, with a Three Year Work Program, is required by the Act.

The main broad aims for a District Plan are:

- Establishing land management standards to prevent land degradation
- Establishing standards for rehabilitating degraded lands
- Providing the focus for soil conservation strategies throughout the District
- Identifying goals and priorities to develop the Three Year Program
- Providing a concise description of the District and its land management issues
- Providing a resource of land management information and practices to help landholders derive or enhance their own property management plans.

The District Plan is intended to be a strategic document: for an area as large as the Marree Soil Conservation District it can hardly be anything else. Individual property plans are the tactical equivalent. Any District Plan will also be a changing document: circumstances change with time, technology advances, new issues appear, old challenges are met, landuse may change. Hence no District Plan can be "set in concrete". Questioning and revision will be needed, and is required every three years by the Act.

ROLE OF SOIL CONSERVATION BOARDS

Soil Conservation Boards have several functions. The most important requirements under the Act concern:

- Developing community awareness and understanding of land conservation issues;
- Promoting the principle that land needs to be used within its capability and suitability;
- Promoting the principle that forward planning, on the basis of land used within its capability, must become standard land management practice;
- Developing and supporting programs for land conservation and rehabilitation in which members of the community may participate;
- Providing advice and assistance on land conservation and rehabilitation to landholders, and also, when needed, advising the relevant Minister;
- Implementing the provisions of the *Soil Conservation and Land Care Act 1989;*
- Preparation of District Plans and Three Year Programs;
- Assisting the development of individual property management plans.

Under the *Soil Conservation and Land Care Act 1989*, all landholders have a duty to take all reasonable steps to prevent degradation of land. Degradation of land, in the Act, means a decline in the quality of soil, vegetation, water and other natural resources associated with the land resulting from either land use activities or failure to take appropriate action. Soil Conservation Boards can issue Soil Conservation Orders to prevent, minimise or rectify degradation of land.

The legal language of the Act, as with most acts directed at land management, tends to place emphasis on the negatives. The intention of the Act, though, is positive; its purpose is to attempt to ensure that land uses are sustainable. In keeping with this intention, the role of Soil Conservation Boards is mainly seen to be education, coordination and cooperation, aiming to sustain the land through assisting and encouraging responsible management.

THE MARREE SOIL CONSERVATION BOARD

Formation and Composition

The Marree Soil Conservation Board was formed in 1990. Its composition reflects the main land uses and industries of the District. Members are drawn from the pastoral industry, the oil and gas industry, and the National Parks & Wildlife. All have special knowledge of, and experience in, land management.

The current members of the Marree Soil Conservation Board are:

Ken Ogilvy (Chairperson)	Lindon Station
Anne Scammell (Secretary)	Mt Lyndhurst Station
Maree Morton (Treasurer)	Innamincka Station
Catriona Mc Taggart	Santos Ltd, Moomba
Janet Brook	Cordillo Downs Station
Shane Oldfield	Clayton Station

Names of previous Board members are contained in Appendix A.

Aims of the Board

In keeping with the intent of its governing Act, the Vision Statement adopted by the Board is:

'A shared conservation and land care ethic will be built for community benefit and survival.'

The aims of the Board are:

- To encourage and provide for communication within and between the local community, the wider community and agencies and organisations involved with land management:
  - To raise awareness in the local and wider community regarding land care in the Marree Soil Conservation District;
  - To provide a forum for resolving land use and land management conflicts;
  - To establish and maintain broad networks of people, within and outside the Soil Conservation District, for communicating and sharing information;
  - To make known the existence, responsibilities and abilities of the Soil Board;
  - To share and transfer land care skills and knowledge:
  - To share and transfer skills and knowledge of local land managers;
  - To share and transfer skills, knowledge and technology developed through industry and scientific activity;
  - To encourage and assist landholders to undertake special land care projects;
- To promote the maintenance of viable industries through sustained health of the land and improved quality of production;
- To encourage and promote the effective control of pest plant and animal species;
- To encourage, promote and support ongoing inventory of the District's natural resources;
- To encourage and promote improvement in land condition monitoring;
- To encourage and support other research which focuses on land management within the District.

THE DISTRICT PLAN AND ITS OBJECTIVES

The objectives of this District plan are to:

- Describe the District's climate, resources, land uses and land use history; and the District's Land Systems, their capability and uses;
- Describe the existing and potential land degradation problems and management challenges, with reference to all uses;
- Identify land management options which may limit those problems, and the practices best suited to sustaining the various Land Systems and the various uses on those systems;
- Identify means for rehabilitation of degraded land;
- Establish a program for the Board's proposed activities and undertakings in the District for the following three years.

OTHER ACTS ALSO AFFECTING SOIL CONSERVATION AND LAND CARE

The entire Marree Soil Conservation District is arid land considered unsuited to intensive agriculture. Much of the District is Pastoral Lease held under the *Pastoral Land Management and Conservation Act 1989.* This Act limits land uses on pastoral leaseholds almost solely to grazing specified stock on native pastures. Alternative land uses, open to choice in higher rainfall areas, are generally not an option. This affects consideration of land capability in the District Plan: on pastoral leases, land capability has to be considered in terms of sustaining the soil and pasture resource under total grazing pressure rather than, as elsewhere, under a range of possible land uses.

The Marree Soil Conservation Board is a prescribed body under the *Animal and Plant Control Act 1986.* This means that the board has a role in: -

- Raising awareness of animal and plant control issues
- Identifying animal and plant control priorities (in the District Plan)
- Determining in liaison with the APC Commission what action is required.

Large areas of the District are reserves dedicated under the *National Parks and Wildlife Act 1972.* While this Act may not necessarily limit the applicability of the *Soil Conservation and Land Care Act 1989*, control of activities on reserve lands falls normally under the *National Parks and Wildlife Act 1972*.

Most reserves dedicated for conservation purposes as the main land use, either possess or require a management plan under the *National Parks and Wildlife Act 1972 (including amendments to Act and schedules)*, and come under the direct control of the National Parks and Wildlife (NPWSA). The large, multi-use Innamincka and Strzelecki Regional Reserves were created to provide for multiple objectives under pastoral, conservation, oil and gas exploration and production, and tourism uses. They also require their own management plan under the *National Parks & Wildlife Act 1972.*

Of the other acts, which impinge on soil conservation, those covering exploration for oil and gas, and minerals, are currently the most important. The *Mining Act 1971,* the *Petroleum Act 2000,* and the special case of the *Cooper Basin (Ratification) Act 1975,* all provide for specific soil conservation and land care measures as part of exploration and operation. Activities under these Acts are also required to meet the objectives of the *Soil Conservation and Land Care Act 1989.* Also, the *Development Act 1993,* through its provision for Environmental Impact Statements (EIS), and the *Environment Protection Act 1993* may provide another level of required protection for some developments.

The *Water Resources Act 1997,* has resulted in the formation of the Arid Areas Water Catchment Management Board, which is responsible for the management of water resources (ground and surface) in the out of hundreds area of the state. Its role is to develop water management plans for the area. These will be consistent with the Soil Board district plans and any other relevant plans and legislation.

A portion of the Marree SCD, encompassing lands associated with the Cooper Creek between Innamincka, Coongie Lakes and Lake Hope, are subject to the 1971 Convention on Wetlands of International Importance (RAMSAR Convention). This is an international treaty, which may take precedence over any State legislation. Under the treaty, the Australian Government has obligations to include wetland conservation considerations within Australian national land-use planning. RAMSAR wetlands are considered to be of national environmental significance under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999.* Under the assessment and approval provisions of the EPBC Act, actions that are likely to have significant impact on the RAMSAR wetlands are subject to a rigorous assessment and approval process.

Whilst the Soil Conservation Board has no specific role in these Acts, matters may arise which come under the Board's responsibility, and the mining and related Acts require that activities also conform to the *Soil Conservation and Land Care Act 1989.* The Board has a more clearly defined direct role in the management of lands under pastoral land use; hence the emphasis within this District Plan tends frequently to be on pastoral land uses. However, the Board can be used as a forum for consultation where conflicts arise.

The Soil Board recognises and acknowledges that there maybe changes to these or any other legislation, including the introduction of new legislation, which may affect soil conservation and landcare, during the review period of this plan.

PART II

DESCRIPTION OF THE MARREE SOIL CONSERVATION DISTRICT

DISTRICT OUTLINE

The Marree Soil Conservation District is the largest in South Australia. It extends over more than 200,000 square kilometres, approximately 20% of the State.

Located in the far northeast corner of South Australia, the District stretches north from the northern Flinders Ranges, to the Northern Territory and Queensland borders, and east from Lake Eyre to the New South Wales and Queensland borders (Figure 1).

The District is well inside Australia's arid zone, and includes portions of the most arid areas of the continent, ie. The western portion about Lake Eyre. Rainfall is "reliably unreliable": the annual average is approximately 125 mm but "average" is a misleading word for a region where rainfall in a year may range from between zero at one extreme to over 500 mm at the other.

Arid, desert landforms dominate. In particular, much of the District is sandridge desert, containing the Tirari and Strzelecki Deserts, and part of the Simpson Desert. It also contains Sturt's Stony Desert, which despite its name is significant for pastoral production.

Most natural surface waters are ephemeral, the exception being a series of mound springs along the southern margin of the Great Artesian Basin. Over much of the District, purely local rains feed waters. In the northeastern portion, however, the watercourses and floodplains of the Cooper Creek and Diamantina River systems cross the District. Monsoonal deluges in their upper reaches in central and southwest Queensland feed these stream systems. The waters reach the District after heavy monsoonal falls, again, not on a regular and predictable basis, and terminate in an extensive network of fresh and saltwater inland flats, swamps and lakes such as Goyder's Lagoon, the Coongie Lakes and, in extreme flows, Lakes Eyre and Frome.

Deep below most of the District are the stored waters of the Great Artesian Basin, again with most of their source and recharge coming from Queensland. The water surfaces naturally in scattered localities to form the mound spring. Elsewhere, artesian bores tap the Basin for pastoral and other uses.

The primary land uses in the District are pastoralism, oil and gas exploration and production, conservation and, increasingly, tourism. 60% of the land is used for pastoral production. Most of the remainder is in National Parks or other conservation reserves, an area nearly the size of Tasmania. Part of Australia's main gas fields lie within the region, with production facilities centred at Moomba. The actual area of land utilised for gas production is small, but the supporting infrastructure (roads and underground pipelines) extends through much of the northeastern portion of the District.

For many years these industries have coexisted in the region. Their current contribution to Australia's annual revenue is major. Annual production of oil and gas was $740 million in 1993 / 94, of which $60 million went to the State government in royalties. The value of pastoral production in the District is more variable because of its dependence on season. Accurate figures for the Soil Conservation District are not available, however, pastoral production can be expected to average $20 - $30 million (Gibson, 1987).

The resident population of the District is small, with 150 -200 residents working in the pastoral industry, bolstered by a transient population of 200 - 300 petroleum industry workers at Moomba. In addition, between 40,000 and 50,000 tourists have been estimated to visit the District annually, experiencing in particular the Birdsville, Oodnadatta and Strzelecki Tracks, the Simpson Desert crossings and the Innamincka Regional Reserve.

The District infrastructure is minimal. Only unsealed roads service the District, with the three tracks and mail roads in the southeast corner being the major routes. The small community of Marree and the company town of Moomba are the main population centres, with the tiny village of Innamincka. Birdsville (Qld), although outside the District, should also be considered as contributing to the District's infrastructure.

Essential services are typical of the extreme outback, with health services provided by the Royal Flying Doctor, education over most of the District by School of the Air (supplemented by schools in Marree and Birdsville), and communications include radiophone, satellite and facsimile links.

CLIMATE

The climate of the District is arid; with hot to extremely hot, usually very dry summers and mild dry winters. In summer, the northern parts are weakly affected by the northwest monsoon, and occasionally moist tropical air penetrates further south producing thunderstorms with intense but relatively short-lived falls. For the remainder of the year, northwest cloud bands, originating over the Indian Ocean, are the main source of rain, but less than half of these bring effective rains to the District. Occasionally, slow moving upper level disturbances will bring major and prolonged rains. There is little variation in climate generally across the District, due to its distance inland and its lack of any sizeable ranges.

Winds

Broad seasonal variation in wind patterns is controlled by the location of large-scale high-pressure systems. From November to March, the path of the high pressure centres (the subtropical global ridge), Figure 2 is south of the District and surface airstreams tend to be southeasterly. During autumn, the path of the high-pressure systems moves north and remains there from April to October. Although there still tends to be easterly movement, westerly (north-west to south-west) surface airstreams may prevail in spring, especially in the southern part of the District.

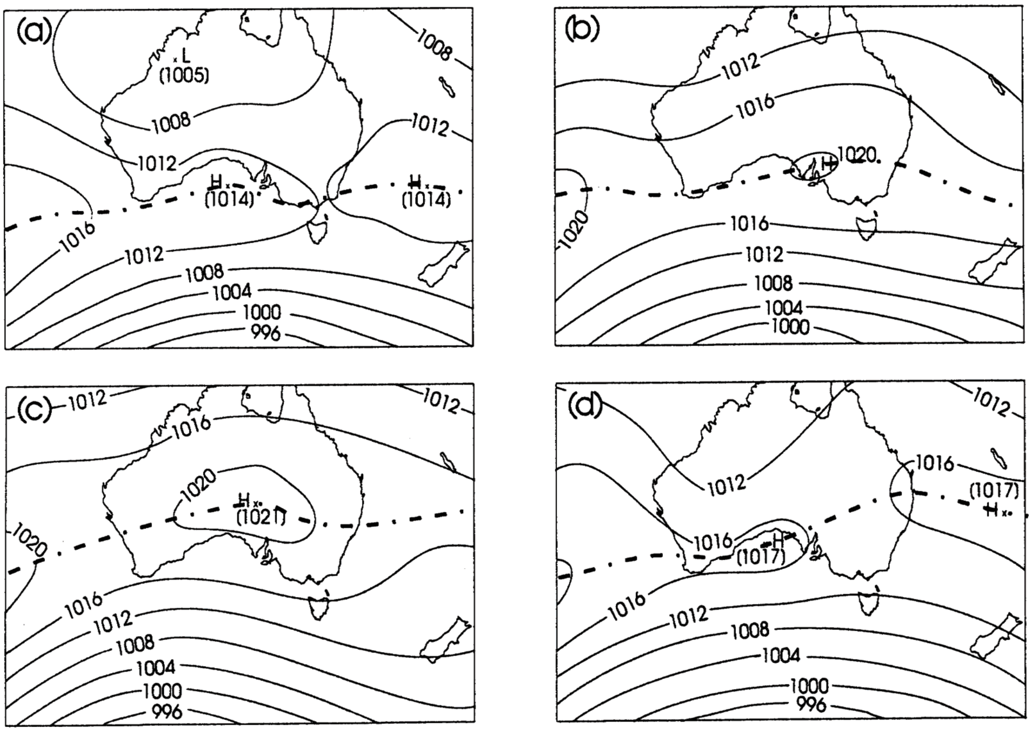


Figure 2 The average mean sea level pressure pattern for a) January, b) April, c) July, and d) October. Units are hecto-pascals. The subtropical ridge (dotted line) moves from south of the continent in January to over the Marree Soil Conservation District in July. *National Meteorological Operations Centre, Bureau of Meteorology.*

The most common wind direction throughout the year is from the southeast, more southerly in the southern part of the District, and more easterly in the northern part. Variability in direction is most pronounced from July to October. Light winds (<20 kph) are most common from May to July, while the greatest frequencies of strong winds (41 to 61 kph) occur from September to January. Gales (> 61 kph) are uncommon: they average less than 1 day per month, and are most frequent in October.

Rainfall

Rainfall variability in the District is amongst the highest in Australia, while average annual totals are amongst the lowest. There is no seasonality in the south of the District, and a weak summer maximum in the north. Rainfall records representative of the District are given in Figures 3 - 6.

Average (or *mean)* annual rainfall gives a misleading impression, since the combination of a large number of years of little rainfall and a few of very high rainfall will give an overstated figure. A better indicator is the *median*, the middle value of all observations. In 50% of years, the rainfall exceeds the median, and in 50% of years it is less than the median. Records for the long-term recording stations at Quinyambie in the southeast of the District, Marree and Cowarie in the central portion, and Cordillo Downs in the north give a good summary for the District (Table 1).

The aridity and variability is obvious, in particular, the thresholds of the lowest and highest ten per cent of records. Taking Cordillo Downs as an example, over the full run of records (104 years), one year in ten can be expected to be below 55 mm total, and one year in ten above 306 mm total. Lowest recorded yearly falls are also of interest: all figures mean basically no effective rainfall.

TABLE 1 - RAINFALL

Station	**Mean annual rainfall**	**Median annual rainfall**	**Lowest 10% of year totals are below:**	**Highest 10% of year totals are above:**	**Lowest and highest on record:**
Quinyambie	175 mm	156 mm	64 mm	306 mm	0 - 590 mm
Marree	164 mm	145 mm	81 mm	271 mm	39 - 409 mm
Cowarie	139 mm	108 mm	34 mm	291 mm	15 - 483 mm
Cordillo Downs	168 mm	151 mm	55 mm	316 mm	19 - 580 mm
Bureau of Meteorology, 1990.					

Highest daily falls occur in summer, when humid tropical air invades the region. The highest recorded 24 hour total was a fall of 241 mm at Cordillo Downs on the 5 - 6 February 1991. Highest daily falls of between 100 mm and 200 mm have been observed at many sites across the District. Individual falls may be much more intense than these 24 hour figures imply.

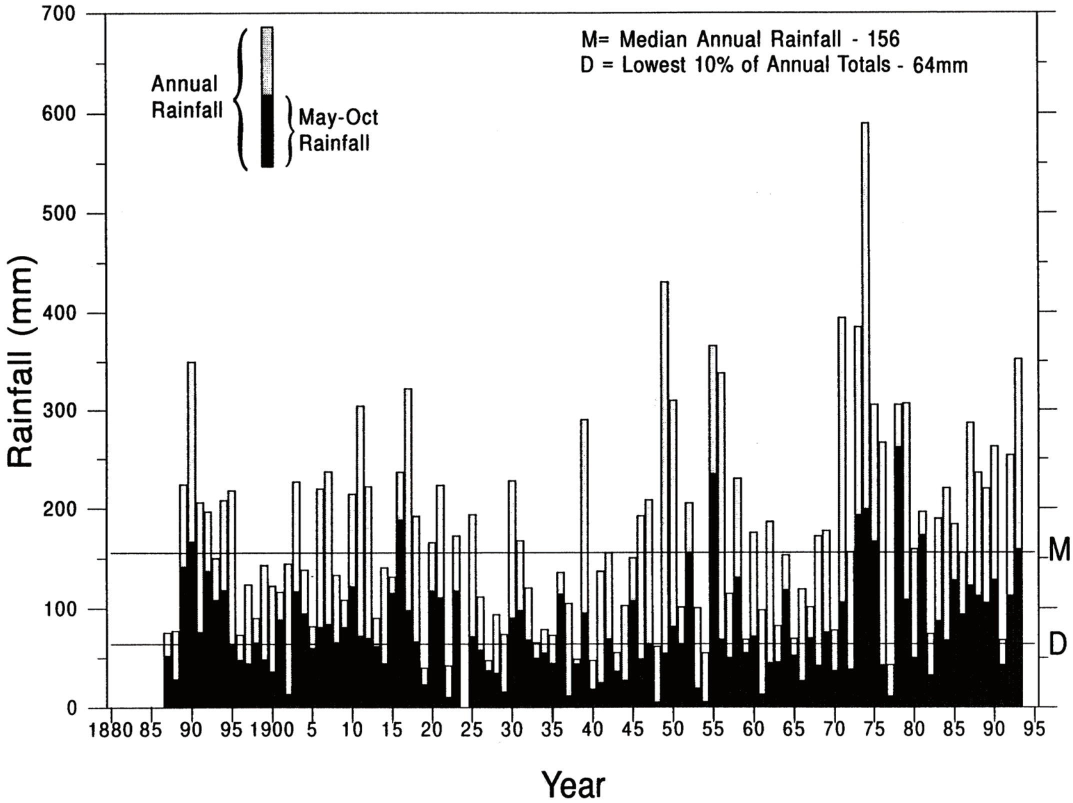


Figure 3 The composite long-term rainfall record for Quinyambie. The recording station was changed in 1973. Data are incomplete for the year 1924. *Bureau of Meteorology (1994).*

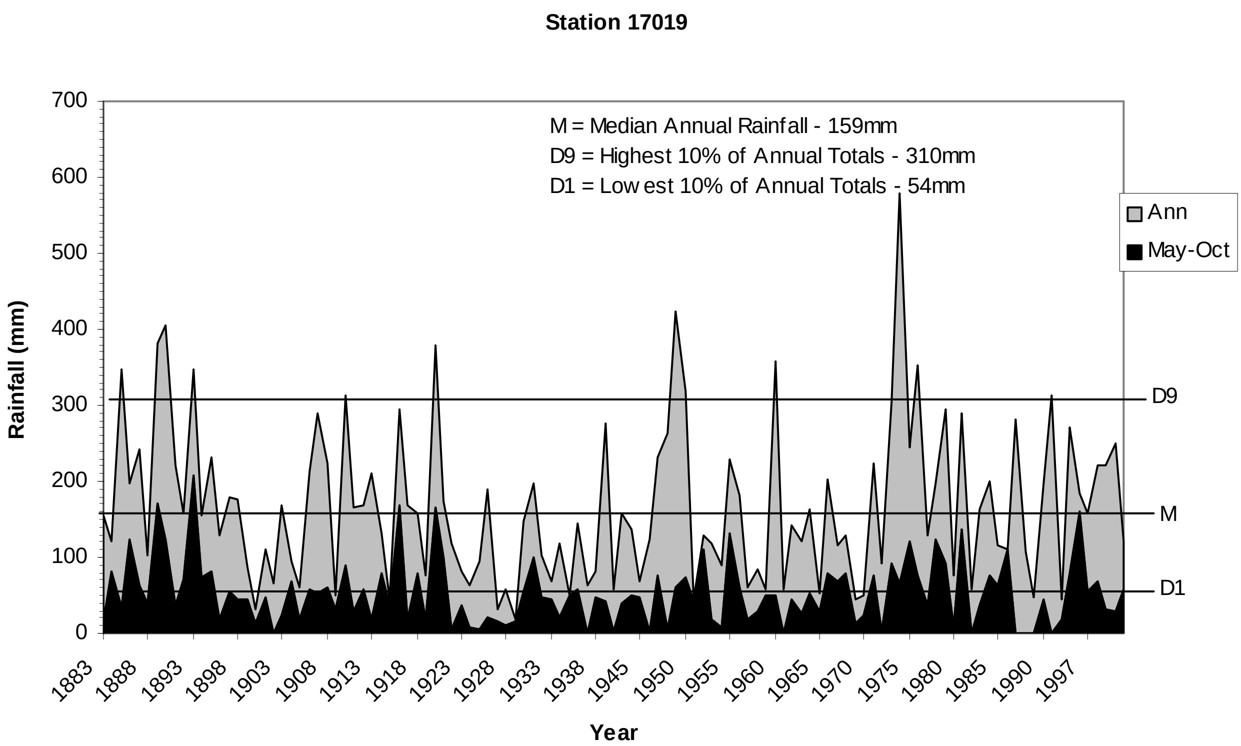


Figure 4 The long-term rainfall record for Cordillo Downs (elevation 120 m). Data are incomplete for the years 1943 - 44, 1986, 1989. *Bureau of Meteorology (2002).*

Evaporation

Evaporation is a factor adding to the aridity of the District. Average annual evaporation increases from around 3,200 mm in the extreme south to 3,800 mm in the northwest. Seasonal evaporation is shown in Table 2.

TABLE 2 - EVAPORATION

	Summer (January)	**Autumn (April)**	**Winter (July)**	**Spring (October)**
North-west	550 mm	275 mm	150 mm	400 mm
South-east	500 mm	225 mm	125 mm	325 mm
Bureau of Meteorology, 1990.				

Growing Season

Plants grow when rainfall is in excess of evaporation for a sufficient period. In the higher rainfall areas to the south, this occurs for three to five months, usually during winter / spring. The concept of a "growing season" is simply not applicable within this District. Growth occurs where rain is in excess of evaporation for a short period, perhaps only two or three weeks, and this can occur at any time of the year (Lange and Fatchen 1990). At the risk of stating the obvious, more rain is needed in summer to generate growth than in winter.

Drought

"Drought" refers to an acute *water* shortage. The water includes both rain, and the soil water store. Normally, rainfall is the best indicator of drought, but given the large, externally fed floodout areas in part of the District, it is difficult at times to reconcile drought as indicated by rainfall with naturally irrigated pastures. (Also, by definition, springs are never drought-struck, nor can they be an arid environment.)

For most of the District though, rainfall remains the single best indicator. Gibbs and Maher (1967) show that years with an annual rainfall within the lowest 10% of falls on record correspond well with droughts recorded from other sources. Using this simple guide, and rainfall records from stations across the District, the following years since 1900 were identified as having extensive areas in drought:

1900, 1902, 1927, 1929, 1940, 1965, 1967, 1977 & 1982, 2002.

Other methods, such as those used by the Drought Watch Service of the Bureau of Meteorology, will identify slightly different periods, including droughts of shorter duration and droughts extending over two calendar years. For example, prolonged drought conditions occurred over most of the District for 1922-1929 with only brief respites, and the southern part experienced extended drought through the 1960's.

Temperature

In the hotter part of the year, late October to March, average daily maximum temperatures exceed 30^{0}C, and during January and February, average about 36 - 38^{0}C. Temperatures over 40^{0}C have been recorded in each month from October to March, and are reached on around 7 - 10 days per month during December to February. The highest extreme temperatures recorded for South Australia have been 49.4^{0}C at Marree and 50.7^{0}C at Oodnadatta. Average minimum temperatures from November to March are around 20^{0}C.

For the cooler months, April to September, average daily maximum temperatures range from the high twenties down to the high teens in the June and July months. Maxima in excess of 30^{0}C have occurred in all but June and July. Sub-zero minimum temperatures have been recorded in each month between June and August.

Relative humidity

Relative humidity depends on both temperature and air moisture, and is generally higher in the cooler part of the day. Relative humidity in January varies from about 30% at 9am to less than 20% at 3pm. In June, levels are around 65% at 9am and 40% at 3pm.

Frosts

Frosts occur in the cooler months on cloudless, calm or near calm nights, when there is little moisture. Frost frequency depends on ground features: the amount of soil moisture, vegetation or the local topography ("frost hollows"). A standard air temperature (in a Stevenson Screen, 1.2 m above the ground) below 2.3^{0}C is a good indicator of ground frosts, while sub-zero temperatures indicate a severe frost. Many frosts in the region are "black". White frosts, with ice deposits, occur less frequently because of the extreme air dryness.

Frosts have been reported at Marree and Moomba between May and August: further north and west this may extend to September. Moomba experiences one to two frost-days per month, and Marree three to seven, with the greatest frequency in July. Frosts are more common in drought years.

Sunshine hours

Sunshine hours are dependent on latitude and cloudiness. There is some variation across the District, reflecting monsoonal cloud cover in summer in the north, and cold front cloud cover in winter in the south (Table 3).

TABLE 3 - SUNSHINE HOURS

	January Daily hours	April Daily hours	July Daily hours	October Daily hours
North-east	10.5	9.0	8.5	10.5
South-west	11.0	8.5	7.5	10.0
Source: Bureau of Meteorology (1990)				

Historical Changes in Rainfall Patterns

Climatic patterns have changed over the 100 - 150 years of instrument measuring. For the period 1913 to 1945, rainfall incidence tended to be spread, on average, throughout the year. Post-1945, however, the incidence of rain on average has shifted, from the previous even spread to a concentration in summer (Allan 1990). The increase in mean summer-month rainfall has been of the order 75 - 80% highly significant in a very low total rainfall area. There are present similarities with the earliest recorded period, 1870 / 1880 to 1915, when wetter conditions appeared in autumn to early winter than in the following thirty years.

The shifts and changes in rainfall match a recorded marked decrease in rainfall from about 1915 to 1945, over the whole eastern portion of the continent, and the scarcity of significant flooding reaching Lake Eyre over the same period. That the climate has changed and may change in the future should be kept in mind. Also, the increased summer rains have not eliminated drought, given drought years in the 1960's, 1977, 982 and 2002.

GEOLOGY

The Marree Soil Conservation District overlies sediments, which are over 4 kilometres thick and are 500 million years old. Some of the deepest sediments contain the oil and gas reserves in the Cooper Basin. The shallower and more widespread sediments of the Eromanga Basin form the artesian aquifer which permits continued pastoral use through much of the District.

About 190 million years ago, extensive river systems deposited large thicknesses of sand up to 1,000 m thick in a huge subsiding basin. This sand unit is called the Algebuckina Sandstone and it contains impressions of fossil leaves and wood, which indicate a moist and temperate climate at the time of deposition. As the subsidence increased, the sea invaded the region from the north about 110 million years ago, and deposited the dark grey and fine-grained Bulldog Shale, which is up to 350 m thick. As the sea retreated 90 million years ago, marshes and shallow lakes were formed with extensive forests and ferns. Under these conditions, fine-grained lignitic sandstones and siltstones of the Winton Formation were deposited in great thicknesses (up to 1,200 m). The fine grained sediments of the Bulldog Shale and Winton Formation were subject to erosion and weathering for many millions of years and where exposed today (Figure 7), have a hard silcrete capping on top of an intensely bleached weathered zone up to 25 m thick of white, yellow, pale grey or mauve clays.

Deposition began again in the Lake Eyre Basin about 50 million years ago with extensive sand deposits of the Eyre Formation laid down by river systems in a warm and wet monsoonal climate. After another 25 million years, the climate became drier with the landscape dominated by extensive and shallow brackish lakes, which led to the deposition of magnesium - rich limestones, dolomites and siltstones of the Etadunna Formation. These lakes dried up about 10 million years ago, and evidence of ancient shorelines can still be seen in some areas.

The geological events, which shaped today's landscape, occurred over the last million years when a drier climate led to the formation of the present day salt lakes and dune fields. At this time also, faulting along the southern margin of the basin allowed the escape of artesian water from the deep aquifers to the surface and the formation of mound springs. Dry windy periods about 200,000 years ago commenced the creation of the current dunefields. Between 25,000 and 40,000 years ago, much wetter periods filled the lakes beyond their present shorelines, leaving pebbly beach deposits around the lake margins, which are well preserved, especially around the southern margin of Lake Eyre South. A combination of lower lake levels about 18,000 years ago and periods of major winds blew fine-grained lakebed sediments into large dunes up to 30m high on the eastern margins of the major lakes. Those and subsequent periods also contributed the material for the sand dunes themselves. Dune building and advance is still active through much of the District, (as this has a number of consequences for the management of the land, it is discussed more in Part III of this Plan.)

In the southwestern corner of the District lie the Willouran Ranges, an outlier of the Flinders Ranges. They consist of much older sediments than those of the Eromanga and Lake Eyre Basins described above. They are about 1,000 million years old and are made up of shale, sandstones, limestones and glacial tillites. Between the Willouran Ranges and Lake Torrens lie the young unconsolidated sand and clays of the Pirie - Torrens Basin.

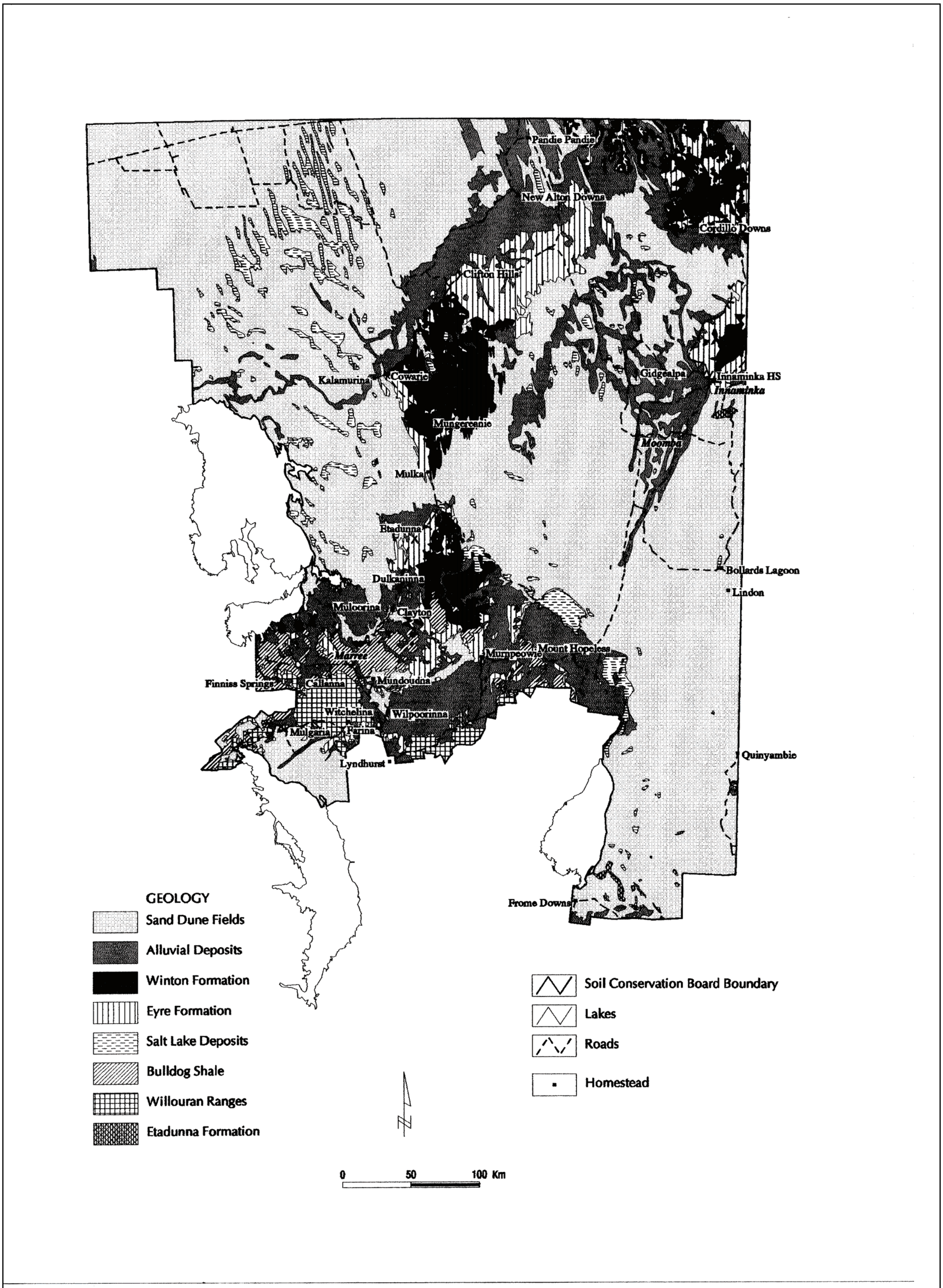


Figure 5 Geology of the Marree Soil Conservation District.

HYDROGEOLOGY

Great Artesian Basin

The most important groundwater source for the District, and the best quality, occurs in the main aquifer of the Great Artesian Basin (GAB), which is the popular name for the water bearing sediments of the Eromanga Basin. This consists mostly of the Algebuckina Sandstone (see Geology). The aquifer outcrops on the edges of the Willouran Ranges and deepens in a northeasterly direction, from a depth of a few metres to 300m in the Lake Eyre South area, and 500m in the Lake Frome area, to a depth of over 1,500m in the northeast corner of SA. Most water enters the aquifer by rainfall in the Great Dividing Range in Queensland, and moves in a southwesterly direction into South Australia at a very slow rate of between 1 - 5 metres per year. It takes somewhere between 1 and 2 million years to travel from the Great Dividing Range to Lake Eyre. There are subsidiary rainfall recharges also to the west and northwest, beyond the Simpson Desert. Water from these areas generally does not extend into the District.

The aquifer is confined by the overlying fine-grained Bulldog Shale, which keeps the groundwater under pressure. Because of the great depth of the aquifer in some areas, the temperature of the water can often reach boiling point (100^{o}C).

Groundwater is discharged from the GAB by mound springs, flowing bores (pastoral bores), and diffuse upward leakage through the Bulldog Shale. It is also extracted for the Cooper Basin petroleum wells and the water supply to Roxby Downs. The visible discharge amounts to about 240 - 260 megalitres per day. Although it has not yet been fully quantified, the upward leakage has to be roughly equivalent to this visible discharge, given that the known total inflow to the SA portion of the GAB is about 425 megalitres per day. Detail of outflows from the GAB, and their management, are discussed below.

The salinity of the GAB groundwater is quite good, being generally less than 2,000 mg/L over most of the area, although increasing on the margins of the basin.

Mound Springs

Mound springs within the District, (which does not include the major spring complexes at Dalhousie or about the Peake and Denison Ranges) are spread in an arc along the south-west portion of the District, across the northern end of the Flinders Ranges, and across Lake Frome to NSW. Within the Marree SCD, there are major spring concentrations about Hermit Hill and at the northern edge of the Flinders Ranges.

Mound springs form along fault lines or fractures which allow the groundwater to discharge more easily up through the confining Bulldog Shale. As the aquifer is shallow in these areas, the discharge is only mildly warm.

The name "mound spring" is used in a generic sense, although "artesian spring" would be more accurate. Mounds develop at the spring vent either through deposition of carbonate from the artesian water, or by the trapping of windblown material by spring vegetation and its subsequent cementing, or a combination of the two. However, in the Marree Soil Conservation District, very few "mound" springs develop mounds.

Other Groundwater Sources

There are other sources of groundwater in the District, but few are useable and those are minor by comparison with the GAB. In the dunefields, good quality groundwater can be found at shallow depths adjacent to the major watercourses, (eg. Strzelecki and Cooper Creeks, and Diamantina River). This groundwater is non-artesian and is in unconfined aquifers mainly recharged from the surface stream flows. Very minor sources, with a rainfall recharge only, exist in parts of the Simpson Desert: these were tapped by Aboriginal wells. Elsewhere, in the Willouran Ranges and to the south, where occasional surface flows in drainage lines are much less, groundwater quality is highly variable with stock quality groundwater often available at shallow depths along drainage lines.

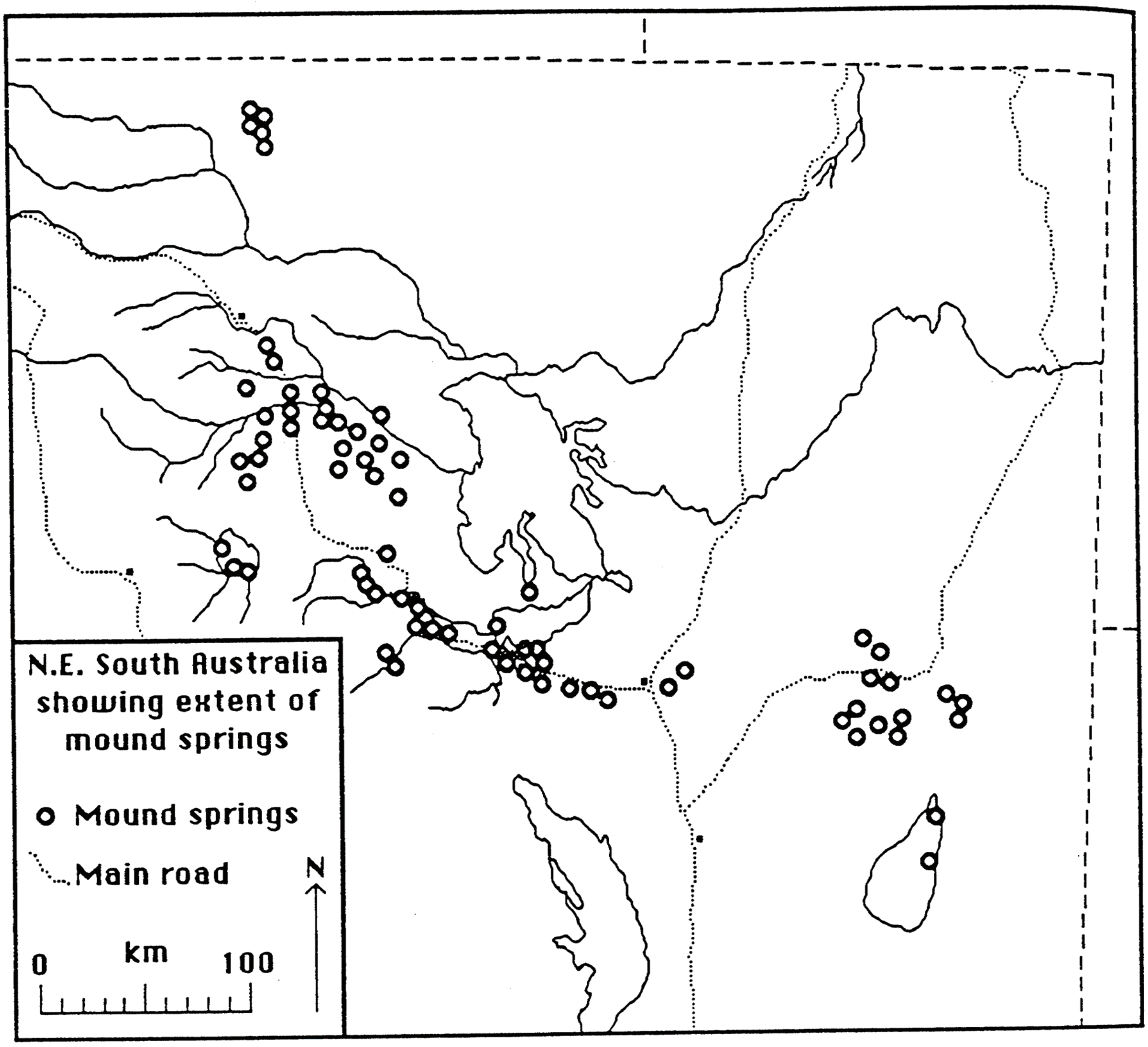


Figure 6 The Great Artesian Basin in SA, and general location of mound springs. *Boyd, 1990.*

LANDFORMS AND SOILS

The District is dominated by three major groups of landforms; the "hard" country of the stony tablelands and downs, where soils are light clays to loams and red earths, with and without gibbers; the dunefields of the major Simpson, Tirari and Strzelecki Deserts and their outliers, with sands or sandy soils prevailing; and the floodplains, channels and ephemeral lakes of the major river systems where heavy clays predominate. Minor groups of landforms include arid ranges and playa lakes.

Ranges are minor in terms of area, the Willouran Ranges being the largest block. Soils here are skeletal, with minor alluvial deposits in the valleys. There are also limited areas of gently sloping alluvial plains with solonized brown soils, mainly associated with the outwash from the Flinders Ranges in the extreme south-east of the District, but with some minor occurrences about Innamincka.

The giant saline and playa lakes, Lakes Frome, Blanche and Eyre form a further broad category, although the areas of most concern to the Board are the shores rather than the lakebeds themselves.

Soils of the far northeast of SA, including most of the District, are described at more length in Wright *et al.* (1990), and there is more discussion under Land Systems, below.

Stony Tableland and Gibber Downs

Gibber-covered downs and plains extend across much of the south of the District, and in a belt running along the Birdsville track, including Sturt's Stony Desert, to the far northeast.

The landscape is usually gently rolling, with small slopes and well-defined drainage lines. The soils are clays and loams, with a surface cover of small to large gibber stones. The gibbers are remnants of ancient soil surfaces, the major part of which has been eroded and removed over millions of years.

Typically, there is a complex arrangement of clay gilgais and gibber-covered level "shelves". Gilgais are stone-free, often circular depressions in which the clays mulch themselves by slow heaving and circulation when wet, rather like a giant sponge. Shelves have a pavement of stone of variable size, shape and cover. At the extreme, the pavement may be complete, but more usually there is at least some exposure of soil between gibbers. Soils under the gibber pavement are desert loams. Plant growth is mainly in the gilgais, with shelves acting as mini-catchments and irrigating the depressions: hence even minor rains may produce more growth on gibber than other landscapes (Figure 9).

The desert loams of gibber shelf areas have a thin, very friable loam layer over heavier red to brown clays. The surface loam is easily lost, and the underlying clays rapidly erode if the gibber surface is removed or damaged. The loam breaks and "dusts" easily, and the clays are moderately to strongly saline, easily dispersed (broken apart) when wet and are very susceptible to water erosion. Intact surfaces have very poor water penetration: most water normally runs off, and as a result, salts and gypsum are not leached very far down the soil profile. Fertility levels are effectively low because of the combination of salinity and poor water penetration.

For significant growth to occur on shelf areas, rains need to be sufficient, not only to penetrate the surface rather than run off into the gilgais, but also to wash salts further down the soil profile. Plant growth on the shelves can be both very rapid and abundant following major rains, while there is a soil moisture store and while the salts remain below the immediate surface layers. The growth however is always short-lived. The soil moisture store is limited and is rapidly used by plants or simply evaporates. Salts rise in the soil profile as this store diminishes, preventing further growth.

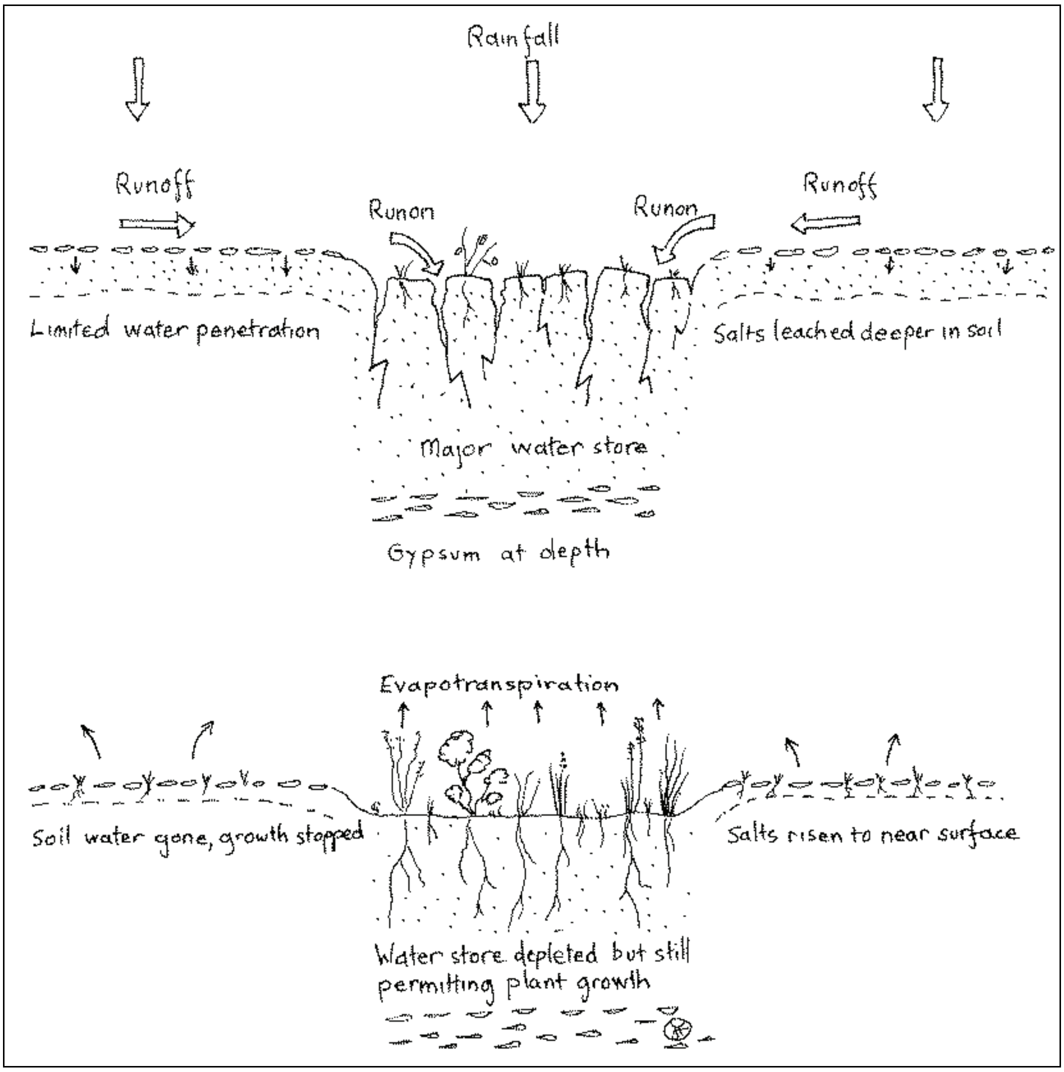


Figure 7 Growth patterns on shelves and gilgais in stony tableland (gibber) soils.

Perennial plant growth in gilgais is a result of irrigation (run-on) from surrounding shelves, good water holding capacity, and relatively low soil salinity. The red clays of the gilgais are neutral to alkaline, with salts and often carbonate and gypsum leached to below 50 – 60 cm depth. The clays crack when dry, which permits a rapid water uptake to considerable depth, and swell when wet. As a result, the soil water store is much greater than under the gibber shelves. Even so, salts and gypsum at depth mean that perennials are generally limited to dwarf shrubs, particularly chenopod shrubs, and herbaceous species such as Mitchell grass rather than larger shrubs or trees.

Overstocking can degrade Gilgais. Apart from removal of vegetation, pugging and compaction by hooves, soil drift from surrounding lands can infill gilgais, partially seal their surfaces and consequently reduce their ability to take up water rapidly and at depth. The water store available after rain is lessened and subsequent plant growth is limited accordingly.

The gibber pavement, not the sparse plant cover, is the main protection against soil erosion. A partial loss of plant cover, normal in drought conditions, does not increase erosion levels much, but break up of the gibber pavement can lead to rapid erosion, especially where the land is sloping. Tableland with an intact gibber cover is inherently very stable, it is difficult for influences, which affect the vegetation, such as grazing and fire, to alter the general stability of the land surface. But the landscape is not very resilient, and the erosion, which follows damage or removal of the gibber pavement, is irreversible.

Grading roads is the most common cause of removal of the gibber pavement. Gibber pavement can be damaged by vehicle tracks or other ground disturbance, such as laying of water pipelines without replacing the gibbers, or as occurred prior to 1985, when procedures were changed, the grading of seismic tracks. Concentration of stock about waters on sloping gibber country can also result in erosion, but concentration on flat ground usually will not, other than local dusting and wind erosion.

Other "Hard" Country

Other "hard" country is a collection of level or undulating landscapes where gibbers are absent or do not form dense pavements, and gilgai formation is minor or lacking. It is a convenient label for what is really a mixture of unrelated soil types. The one thing these soils all have in common is a reliance on the vegetative cover for erosion protection, rather than the "armour" provided by gibbers.

Calcareous loams with clay increasing at depth (solonized brown soils) are present in interdune areas in the dunefields, that is, in the far northeast of the District, and in the southeast. They range from sodic to non-sodic, and saline to non-saline. They are powdery and loose when dry, and so, prone to both wind and water erosion. The natural vegetation cover is chenopod shrubland, which is also the main protection against wind and water erosion.

Red earth soils are present in stony tablelands, in the low hills and plains of the far northeast, and in the alluvial plains near the Flinders Ranges. Soils are well drained and so have limited water storage capabilities, but the depth of soil profile compensates for the limited water store. These soils support open woodlands (usually mulga) with usually ephemeral groundcover.

Texture contrast soils, similar to those of stony tableland but lacking the gibber pavement, are present but relatively uncommon in the District. The very shallow loam or sandy loam surface overlies massive clays, and loss of the surface layer results in a new ground surface which seals when wet, preventing water infiltration and limiting subsequent plant growth. This "scalding" is one of the most intractable and well-documented consequences of accelerated erosion following removal of perennial plant cover. It is also a natural part of systems in the District, with some Land Systems, particularly within dunefields, but also elsewhere, having extensive pans and smaller natural scalds. The presence of a scald may indicate a past loss of vegetation cover but does not automatically imply a past artificial impact such as grazing.

A special case of a texture-contrast soil is the hardpan soil found in the far northeast, north of Innamincka, and also present in some other areas in stony tableland. Soils are thin red loams over a hardpan layer, which is a silica-cemented ancient soil surface. Water-holding capability is poor, and the hardpan is a barrier to plant root penetration. Plant cover may be ephemerals or chenopod shrubs. Kopi deposits are also associated with similar soils.

The hard country is initially stable but only moderately resilient. The stability depends on maintaining the drought-resisting shrubs. Where their cover is reduced, there is greater exposure to erosion. Where some of the soil surface is lost, and the nutrients with it, the system has less ability to recover, and is likely to only recover some of its past productivity. At the extreme, a total removal of shrubs can result in a more-or-less permanent loss of long-term productivity.

This is not uniform for all texture-contrast soils. Hard country where the surface soil layer is sandy tends to be more resilient than are areas where the surface soil is an easily crumbled loam. Soils where the surface layer grades into the deeper clays are more resilient than those where hardpans of clay or limestone are close to the surface.

But as plants are the main erosion protection, the hard country requires the most care in management, and the closest watch on land condition. The productivity of damaged land can be partially restored through direct but expensive rehabilitation techniques, or by judicious and very light use. The partial restoration can take decades, whereas damage can be caused through a few weeks of overgrazing, whether by domestic stock or feral animals, at the onset of drought conditions, or by a single fire at the wrong time.

Dunefield and Sandplain

Sandridge systems (dunefields) cover the major part of the Soil Conservation District. As well as the dense and extensive sandridges of the Simpson and Strzelecki Deserts, less regular dunes are present in the southwest and southeast. The linear dunes trend NNE-SSW overall, and individual dunes may be up to 250 km long. The dunefield sands overlie totally different soils, particularly the grey clays of floodplains and the loams and clays of stony tablelands. Where dunes are closely spaced, these underlying soils may be totally hidden by sands or sandy loams. Where dunes are more widely spaced, the underlying soils are exposed in the interdune. This gives rise to the very common situation of sand and heavier soil types being inextricably intertwined. The combination of landscapes in close proximity but having dramatically different capabilities, fertility, growth responses, stability and resilience poses challenges for effective land management.

Sands are siliceous, not calcareous (in this they differ greatly from coastal sands). Sand colour ranges from red through yellow brown to pale yellow, the latter two in the vicinity of major streams and playa lakes. The red dunes are the more fertile, although nutrient levels are low for all sands.

Sands generally have a far lower water-holding capacity than loam and clay soils, but the sheer thickness of sand deposits, particularly dunes, allows the storage of a large proportion of rainfall water. Almost all this storage is available for those plants, which can reach the depths involved. In clay soils, much of this water is held too tightly by the clay particles for plants to have access to it. Hence most dunes carry at least some perennial vegetation, and compared with the gibber country, often have extensive tall shrub or low tree cover.

Sandridges in the District are mobile to at least some extent: there is always some sand movement. The extremes are in the deserts, where dune crests are bare and very mobile. Also, most of the potential vegetation cover is drought-evading grasses and herbs. Because of this, dunes show extreme variation between drought and moist conditions. In drought, their surfaces, particularly on upper slopes and crests, can be bare and blowing. In wet seasons, there can be a total cover of drought evaders. This cycle of stability and movement occurs regardless of domestic stocking.

Sandridges are formed and maintained by wind action. The ridges result from prevailing winds being from two directions, with the line of the sandridge pointing in the "average" direction of the winds. The ridges, as ridges, stay in place. Sand moves along them, generally from south to north, with little movement to one side or other of the sandridge. The pattern of the winds keeps the dunes in position and the position or stability of the dunes can be improved by the extent of the vegetation cover on the dunes. Most dune fields in the District are still "active", the river systems bring in new sources of material, which is wind-transported onto lunettes on the north and east side of lake areas and from there onto the sandridges.

Wind erosion and surface sand movement is thus a fact of life. Water erosion however can also affect dunes. Older (redder) dunes have clayey cores, with clayey sands exposed on their flanks. These cannot accept water as rapidly as pure sand, and the combination of water runoff and even a minor slope may result in gullying and water sheeting where plant cover is reduced. Clayey sands of dune flanks and lower slopes tend also to be the areas with pasture species most valuable to stock.

Because sandridges are wind-formed, they are particularly resilient landforms, but at the same time very unstable because of the continuing sand movement. Their resilience is most spectacularly demonstrated by the way road or seismic track cuts over dunes are filled in a short time. Their resilience is also demonstrated by the absence of much slumping or sideways movement when completely bared of any vegetation, as was the case in much of the Simpson Desert following the major fires of 1975.

Floodplain, Channel and Lake

The major intermittent streams of the Diamantina and the Cooper, and several smaller streams such as Eyre Creek, enter the region from southwest Queensland. The streams and their floodplains are interlaced with dunefields, giving an enormous system of intermittently flooding clay swales, ephemeral wetlands and lakes.

The Diamantina-Cooper-Eyre Creek-Georgina group, commonly called the "channel country", contains braided streams, (multiple intertwining small channels) and flood courses spreading into the ephemeral wetland ("swamp"), channels and floodplain of Goyder's Lagoon before recombining into the narrow flood courses and channels of the Warburton and Kallakoopah Creeks.

Cooper Creek enters SA as another braided stream, but rapidly spreads through shallow lake systems and large flood outs between the dunes of the Strzelecki Desert. The Cooper does form a single well-defined channel below White Crossing, and stays this way for most of the remaining distance to Lake Eyre. When floods are large enough, waters follow broad and shallow floodplains through the gibber country toward Lake Eyre.

The dominant soils are grey clays, sometimes with a thin veneer of silt or sand. Coarser alluvium and sand is present on some stream banks and terraces and on dune margins. The grey clays have a strong shrink and swell capability, with wide and deep cracking when dry and some to high self-mulching capability. "Crabholes" are present on some floodplain areas: these have nothing to do with crabs but are voids in the clay, penetrating to some depth, produced by soil shrinking on drying. After rain, a surface crust may be formed.

Cracks and crabholes permit deep penetration of water when clays are dry, and result in some circulation of soil material as silts and organic debris are washed deep into the profile and other material brought to the surface, before the clay swells and seals against further water infiltration (Figure 10). The difficult passage of water vapour upwards from the soil moisture store through the dry surface layer also slows the drying process of this soil type. Combined with flooding, which delivers far more water than the local rainfall, the deep cracking results in a high soil moisture storage capability, which between floods supports large perennial plants, (trees, primarily coolibah), and tall chenopod and similar shrubs such as old man saltbush, Queensland bluebush and lignum. Also, the clays are moderately fertile, and where flooding deposits silt on the surface, initial fertility may be very high.

Floodplain clays are increasingly alkaline with depth, and often contain carbonate and gypsum at depth. Salinity increases toward the terminus of the drainage systems near Lake Eyre, a reflection of salt transported through the Lake Eyre Drainage Basin and concentrated by evaporation at or near the drainage terminus. Kallakoopah Creek, for example, has extensive areas of saline clay floodplains in its southernmost reaches.

Claypans vary in size, from small interdune pans to extended pan areas within floodplains. Clays in claypans are massive (ie. non-cracking), are not self-mulching, and seal immediately on wetting. Water ponds do not penetrate far into the soil profile and the soil water storage is accordingly low. Plant growth on claypans is accordingly absent or very limited.

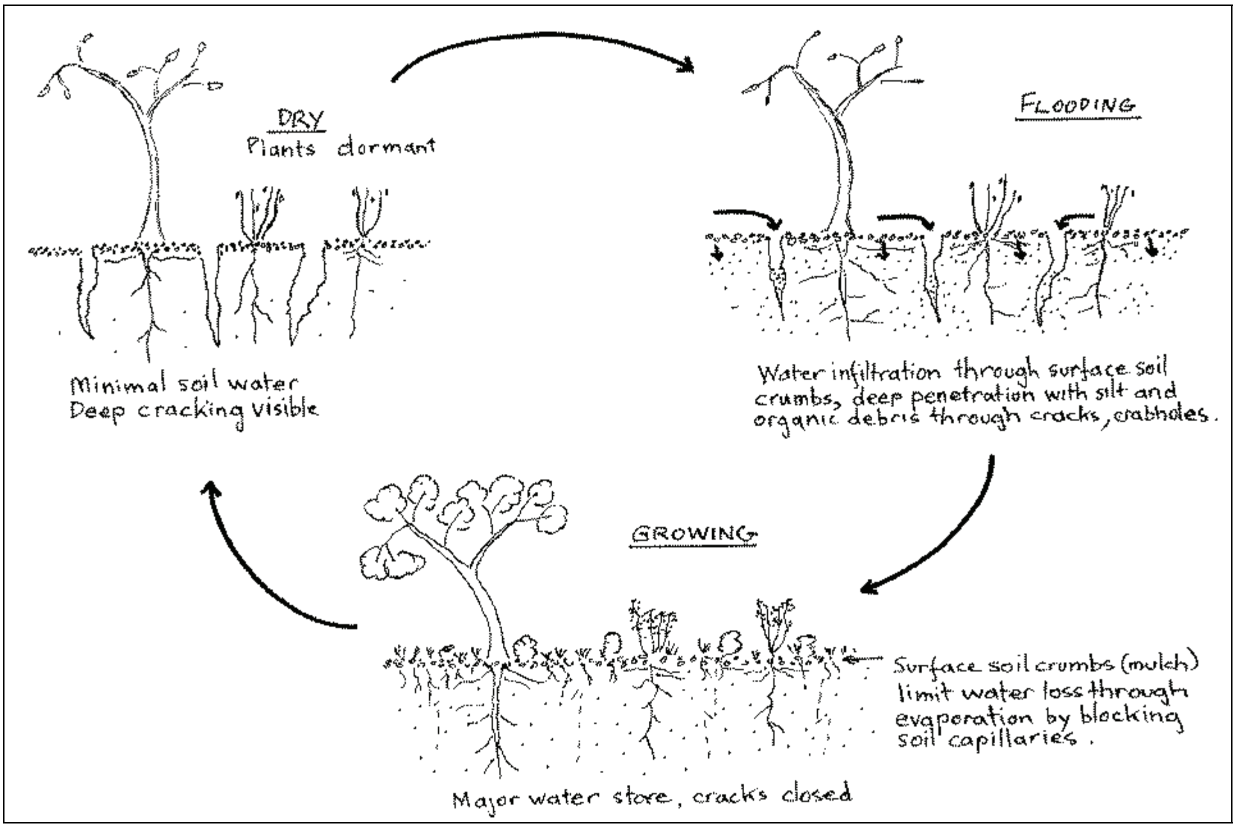


Figure 8 Water penetration and mulching in grey clays of floodplains.

Floods naturally intermittently irrigate floodplains. The irrigation leads to lush ephemeral growth, and the capability to support both increased wildlife populations and significant pastoral activity while the growth persists. This irrigation with its importation of silt and nutrients, and the growth, which follows, make the floodplains very resilient in many respects. Stability, though, is highly variable. Although the floodout areas have very little slope, channels may shift with floods, lighter soils can be eroded by the faster-moving water sheets, and minor surface activities such as road-making can result in major changes in patterns of flooding if the roading is not specifically designed to avoid drainage interruption. Also, it should be noted that plant growth and replenishment of perennial species comes at the same time as maximum pastoral usage, following floods when pastures are at their most productive.

The majority of floods owe their extent to monsoonal and cyclonic rains in Queensland, not to local rainfall, hence floodplains can be in extreme contrast with their surrounds, with lush water-meadows appearing in the middle of severely drought-stricken lands. However, the extent of the largest floods on record, in 1974, was due to a combination of major floods from Queensland, and extremely high rainfall and flooding within SA.

The Soil Conservation District also contains numerous playa lakes, including the very large Lakes Frome, Callabonna, Blanche and Gregory, part of Lake Eyre, and the system of smaller playas, which extend from Lake Eyre to the NT border. All are usually dry; fillings of large lakes are episodic and irregular (Williams 1990). Some lakes are true salinas with a heavy salt crust present, such as the southern portion of Lake Eyre. Others are playas, without crusts, as is the northern portion of Lake Eyre (Dulhunty 1990). The lakes are unvegetated. Surface sediments are saline clays and silts, usually highly gypseous.

Arid Ranges

The Willouran Ranges provide the one extensive block of hilly country within the District, although scattered hills and small ranges are present elsewhere. Slopes are steep, and soils are skeletal and characterised by extensive exposed rock. The soils are shallow sands to clay loams with much coarse material (lithosols), most of which is partly weathered rock fragments. Sands, gravels and clay loam deposits appear along drainage lines. Erosion potential is greater on gentler slopes than on the steep slopes: the gentler slopes are where the soils accumulate and rock exposures are least, whereas the steep slopes have little soil to erode, and greater rock exposure as protection.

Lithosols are also found associated with slopes and flat-topped hills in stony tablelands, with the low hills northeast of Innamincka, and in the Hermit Hill area. They are calcareous powdery loams and light clays, grey-brown on the surface but may become pale with depth. Fertility and water-holding capacity is low. Kopi (gypseous clays) may be present in quantity, particularly associated with mesas and some tableland country.

VEGETATION

General

The land cover is almost entirely native. Introduced (alien) plant species comprise less than 10% of the plant species known from the Soil Conservation District (Badman, 1994). Introduced species are most common in areas, which receive at least some water additional to rainfall, (watercourses and run-on areas), although some species are present in all land units. Rarely are alien species a major component of the vegetation, and then only as ephemeral cover. The native land cover contrasts strongly with the almost entirely introduced cover found in higher-rainfall Districts, where native vegetation is present only as remnants.

The plants are the base of most food chains and also one of the major limiters of erosion. We need to maintain the long-term productivity of the plant cover, for both these reasons.

There are limits to how much plant material can be removed, whether by native fauna, feral animals, domestic stock, or other activities. If too much is taken off, erosion increases and the long-term productivity is lowered. In some landscapes, this loss can often be reversed by the passage of time or a run of wet years, or by active management. In others, the loss can be permanent.

There is room, though, for some use of the plants, through their conversion into protein by grazing animals, both native and introduced, which can then be removed from the region. This “off take”, mainly as wool and beef but also as kangaroo meat, feral horses and goats, must only be a small fraction of the total plant production, to maintain adequate plant cover. This is why domestic stocking levels are so very low compared with most farming country. It was learnt last century and in the first half of this century that too great an off take by domestic stock, rabbits, or any other herbivore, leads to a rapid loss of plant production, animal production, and income.

The most common plants are drought evading. These are the grasses and herbs, which, with enough water, germinate, grow and set seed rapidly, then die. They are capable of very high production rates, and with good rainfall or extended flooding, can bring about a carpet of almost complete cover. They are *ephemeral,* the equivalent of annual species of higher rainfall areas, although rarely annual in their growth.

Drought resisting plants (perennials) are present all the time. Tall shrubs and trees maximise their access to water by a combination of very shallow root systems which can capitalise on light rains in drought, together with a taproot system reaching the deep soil water reserves which the drought evaders cannot obtain. The dwarf chenopod shrubs, especially the saltbushes, bluebushes and bindyis, grow while the soil still contains some moisture, but then become dormant, often shedding most of their leaves to cut down water loss.

Mitchell grasses and some perennial herbs behave more like drought evaders than drought resisters. As conditions dry, these species die back to below the surface, maintaining their root systems ready for rapid growth when wet conditions return, but with no active growth visible above the surface. Hummock grasses such as spinifex and sandhill canegrass do not die back so extensively, but aboveground parts become dormant.

Drought-resisting species may be very long-lived. At the extreme, river gums on watercourses may live for several centuries. Mulgas may have a life of two to three centuries, but many of the tall shrubs such as sandhill wattles may only live for ten or fifteen years. Dwarf shrubs are longer-lived than might be thought. The common bladder saltbush may live for thirty years, whilst some bluebushes are as long-lived as the larger trees.

Dynamics

Plant growth responses to both drought and good seasons are known, but the unpredictable climate prevents any attempts at anticipating either. A run of good seasons can be followed by years of drought. Even the background climate isn't fully known, the last fifty years have been slightly wetter than the preceding half-century, but there are some tree species, which, rabbits, stock and fire aside, are not regenerating. The lack of present regeneration implies that conditions were wetter at the time the present generations became established. Whether this means a wetter climate at some stage in the last two centuries, or only an unusual run of wet years in the past is not known.

Plant growth after rains and floods is spectacularly rapid, as the drought-evaders appear. A large part of the nutrient store in the soils is taken up by the plants in the race to set seed, so much so, that further rains after a growth period may not give much additional growth until the original burst has died back and recycled, and the soil nutrient store has been replenished.

Biodiversity is particularly high in the District because plant species have evolved many different tactics to cope with the erratic climate. Of the ephemeral drought-evaders, some only appear in quantity after summer rains, others only after winter rains, and there are particular requirements for the exact timing of the rains and for particular temperatures needed for successful germination. Drought-resisters are stimulated to set seed in some seasons and not others, and the seeds themselves are often "programmed" to wait several seasons before germinating. As an example, bladder saltbush will not germinate above a particular temperature, an adaptation to avoid the "cooking" which would result if the seeds germinated in the height of summer following a transient storm. A high proportion of bladder saltbush seeds also require more than one occurrence of suitable germination conditions before the seeds actually germinate.

So there is not a uniform "boom-and-bust" cycle for growth. The "boom" following rains in late summer may be quite different from the "boom" following winter rains; ephemeral grasses following summer rains, ephemeral herbs and wildflowers following winter rains.

The vegetation dynamics mean that the appearance and short-term productivity of the land will always be changing. Wetlands after floods present a very different appearance compared to the same land after several years of drought. A dunefield after major rains has a completely different aspect from the same dunefield in its normal, dry state. In some respects, it could be said that the land condition is changing seasonally. However, the “land condition”, which has to be assessed under the *Pastoral Land Management and Conservation Act 1989,* is the long-term condition, not the seasonal dynamics. Condition in this sense is better considered as the capability of the land to continue to respond to seasonal changes without impairment, rather than the apparent condition at any given time. Because the dynamics of the vegetation are so variable, and erratic in response to an erratic climate, it may be particularly difficult to separate long-term trend from short-term variation.

Classification

Vegetation is now almost always referred to by a combination of its physical structure and the most obvious and usually the most common plant species within it.

Physical structure is described by life form, (eg. tree, grass), height and cover, which together define *structural formations.* The classification scheme used is that of Specht (1972) (Table 4). Within this structural classification, a woodland is a woodland regardless of the species, which make it up. Hence a low open woodland of mulga is structurally equivalent to a low open woodland of coolibah, although there may be almost no species in common between the two.

The use of the term "chenopod shrubland" is the one common exception to the use of Specht's classification; "Chenopod shrubland" is a more general, "shorthand" way of referring to plant communities, which have a significant component of chenopod shrubs. Chenopod shrubland embraces several of Specht's classes: shrubland, open-shrubland, low open shrubland and occasionally tall open shrubland and tall shrubland. Chenopod shrublands usually have as major constituents, perennial shrubs of the family Chenopodiaceae, the saltbush and bluebush family, but unrelated, similar shrubs are also normally included within the general term chenopod shrubland, particularly perennial ice plants (*Gunniopsis* species) and nitrebush. In some areas of the District these species are the major component of the "chenopod" shrubland, while saltbushes and bluebushes are present but minor.

Specific communities or plant associations are distinguished within structural formations, usually by reference to their tallest major species. Hence a red gum woodland is distinguished from a coolibah woodland, or an old man saltbush / Queensland bluebush shrubland distinguished from a lignum shrubland.

The communities or associations based on the species, which make them up, are not very precise. There is an underlying rationale, that associated species have somewhat similar habitat requirements and will tend to be found together. However, it is possible to define communities very broadly or very tightly, depending on the purpose for which the definition is actually being made. For example, over large areas and for general description purposes, one may define a bladder saltbush / low bluebush low open shrubland, even though the relative amounts of the two major species and the abundance of secondary species may vary greatly. The same broadly defined community, if examined in detail, might well be subdivided into several distinct communities, depending on the relative density of the major species: a bladder saltbush low open shrubland, a mixed saltbush / bluebush low open shrubland, a low bluebush low open shrubland, and possibly other communities or even different formations for areas where the saltbush and bluebush are effectively absent.

In dealing with the District as a whole, the variation in vegetation is very great, and the following thumbnail sketches of vegetation on the broad land types within the District are necessarily brief. Considerably more detail is given in the descriptions of Land Systems, below, but even these Land Systems are necessarily coarse, with a great deal of internal variation.

Vegetation of dune systems

The major dunefields of the Simpson, Tirari and Strzelecki Deserts have an alternation of vegetation between the sandridges themselves and the interdune areas. Sandhill canegrass open hummock grassland is the primary cover of dune crests in all three areas, and of dune flanks in the Simpson and Tirari deserts. Lobed spinifex hummock grassland is common on dune flanks in the Strzelecki Desert, and in small parts of the Simpson and Tirari Deserts. Areas of tall shrubland to low woodland are present on dune flanks: sandhill wattle and needlebush in all three areas, and a variety of tall shrub and small tree species in the Strzelecki Desert, particularly whitewood and narrow-leaved hopbush.

Vegetation of interdunes depends on the dune spacing. Close-spaced dunes will have interdunes in which the sand covers the underlying soils. Vegetation here is similar to that of dune flanks. Where dunes are widely spaced, gibber soils or floodplain soils may be exposed, and the vegetation is similar to that found elsewhere on those soils. All intergradations between these two extremes exist. Hence interdune vegetation may by hummock grassland, of sandhill canegrass or lobed spinifex, chenopod shrubland, or tall open shrubland or low open woodland.

TABLE 4 - VEGETATION: STRUCTURAL FORMATIONS (AFTER SPECHT 1972)

Life form and height of tallest stratum	Projective foliage cover of tallest stratum			
	Dense (70-100%)	***Mid-dense (30-70%)***	***Sparse (10-30%)***	***Very sparse (<10%)***
Trees 10-30m[#] Trees 5-10m	Closed forest Low closed forest	Open forest Low open forest	Woodland Low woodland	Open woodland Low open woodland
Shrubs 2-8m[#] Shrubs 0-2m	Closed scrub Closed heath	Open scrub Open heath	Tall shrubland Low shrubland	Tall open shrubland Low open shrubland
Hummock grasses 0-2m	-	-	Hummock grassland	Open hummock grassland
Herbs (including grasses and grass-like species	Closed herbland* Eg. Closed tussock grassland, Closed sedgeland	Herbland* Eg. Grassland	Open herbland* Eg. Open grassland, Open sedgeland	Ephemeral herbland

A tree is a woody plant more than 5m tall, usually with a single stem. A shrub is a woody plant under 8m, with multiple stems arising from the base

* Names for these communities depend on the nature of the most common herb.

Vegetation of larger watercourses, floodplains and outwash plains

Woodland, often with a tall shrubland layer, is characteristic of major intermittent watercourses. Red gum woodland fringes semi-permanent waterholes on the largest streams, but the most extensive woodlands are coolibah, with river cooba and Broughton willow. The heavy clays of major floodplains have more variable vegetation, depending on degree, intensity, frequency and duration of flooding. Coolibah woodland, open woodland or low woodland, with a variable shrub or ephemeral groundcover is common in more frequently flooded areas. Tall shrubland of Broughton willow or prickly wattle, as well as understorey fringing major watercourses, extends further out onto floodplains, and with old man saltbush and scattered coolibah, may be the main cover of tributary streams. Shrubland of lignum, old man saltbush or Queensland bluebush may extend into the coolibah woodlands, but is more characteristic of outer floodplains. Groundcover on floodplains has a high ephemeral component, with very rapid growth after flooding.

Vegetation on outwash flats is very variable across the whole District. To the north, Queensland bluebush, Mitchell grass, cottonbush and ephemerals form a mosaic of low open shrubland, tussock grassland or ephemeral herbland. To the south, old man saltbush shrubland, swamp canegrass grassland, tussock grassland of various relatively short-lived species, or tall shrubland particularly of prickly wattle are common.

Vegetation on swamps and depressions with frequent inundation and long retention times is commonly grassland of swamp canegrass, with or without lignum. Swamp canegrass grassland is replaced by samphire low open shrubland in more saline depressions.

Vegetation on salt lake surrounds

Although salinas and playas are themselves unvegetated, their immediate surrounds have a distinctive vegetation. The immediate saline margins carry low open shrubland of samphire species, with sea-heaths appearing a short distance from the immediate shore. Soil salinity drops off relatively rapidly inland, but there may be a high level of gypsum in soils for a greater distance. Over most of this transition between the vegetation of the immediate shore and that of the hinterland, vegetation is still low open shrubland, but with nitrebush, bladder saltbush and some bluebushes appearing.

Vegetation on uplands and ranges

Ranges within the District have a mosaic of low open woodland to tall shrubland both in valleys and on slopes, with low open shrubland on footslopes.

Woodlands or tall shrublands contain variously mulga, red mallee, dead finish, fuschia-bushes and emu-bushes, with sparse low bluebush, bladder saltbush, rock sida or grassy groundcover.

Vegetation of stony tableland and gibber downs

A variety of chenopod shrublands with some Mitchell grass tussock grasslands are most characteristic of the gibber country. The chenopod shrublands range from saltbush or mixed saltbush-low bluebush low open shrublands with long-lived perennial shrub species, to copperburr low open shrubland where the main species are relatively short-lived.

The range of variation on gibber country over the whole District is immense. On the southern and southwestern margins, relatively dense low open shrubland of bladder saltbush, low bluebush and cottonbush are common. Further north in the Sturt's Stony Desert region much of the area is naturally bare. In other gibber areas the main cover may be short-lived copperburrs and ephemeral grasses, more a herbland than a shrubland. Mitchell grass tussock grasslands become more frequent to the north, initially in run-on areas rather than over the extended gibber areas. Hence, around Marree, low open shrublands predominate, while in gibber land about Innamincka, Mitchell grass is a major constituent. Further variation is introduced by hills, rises and drop-offs, where small trees or tall shrubs, particularly emu-bushes, may form a tall open shrubland.

Drainage lines and local pondages and swamps add more variety. The supplement of water run-on, silty or alluvial soils, and often better water storage capabilities permits denser vegetation, and the more additional water, the more the vegetation. Minor drainage may have low open shrubland to low shrubland, often with spiny saltbush, Oodnadatta saltbush, blackbush or cottonbush, with Mitchell grasses increasingly present to the north. Drainage with more frequent or higher volume flows carries open shrubland or shrubland of old man saltbush (with Queensland bluebush in the northern half of the District) with some tall shrubs, particularly spiny wattle, sennas or Broughton willow. The latter species may form tall shrubland or tall open shrublands in larger lines. As drainage lines become larger still, coolibah appears and the vegetation is effectively that of major watercourses and outwash plains, discussed above, and distinct from the surrounding gibber lands.

Smaller swamps and depressions may support only short-lived copperburrs. Larger swamps and depressions, gibber-free and with silty clay or clay soils, normally support shrubland or perennial grassland. Shrubland may be old man saltbush, lignum, Queensland bluebush, or a mixture. Grassland is usually characterised by swamp canegrass. As with drainage lines, these communities are related to the watercourse and floodout communities rather than the surrounding gibber communities.

WATER RESOURCES

Water resources exert a critical control on land use in the District. The two major resources, both of which derive their water from well beyond SA, are the Great Artesian Basin (briefly introduced in Hydrogeology) and the surface waters of the monsoon-fed Cooper and Diamantina / Warburton river systems which not only provide semi-permanent waterholes in some areas, but also recharge local shallow aquifers which can be tapped by shallow (non-artesian) wells. Secondary sources, of particular importance in the southeastern part of the District, are the Frome River system, originating from the Flinders Ranges, and other shallow aquifers associated with local surface drainage. Over much of the District, rainfall is so low and erratic that little reliance can be placed on utilising earth tanks (dams) to catch and hold the limited surface runoff. Dams are used in the northeast corner of the District and, in the southernmost portion of the District they are used to complement shallow bores and to extend the areas available for grazing when the dams are holding water.

The *Water Resources Act 1997,* has resulted in the formation of the Arid Areas Water Catchment Management Board, which is responsible for the management of water resources (ground and surface) in the out of hundreds area of the state, which includes the Marree Soil Conservation District. Its role is to develop water management plans for the area. It has started the process of preparing a catchment water management plan for most of the Lake Eyre basin and the Great Artesian Basin in SA. These will be consistent with the Soil Board district plans and any other relevant plans and legislation.

As part of the Lake Eyre Basin (LEB) community management initiative both the Co-ordinating Group and the Georgina Diamantina and Cooper Creek Catchment Committees have developed strategic plans. They are currently in the process of implementing these plans. Also as part of the LEB management initiative, there is a Lake Eyre Basin Agreement, which binds the Queensland, South, Australian and Commonwealth governments to discuss and consult on any activities that may impact on the Diamantina Georgina and Cooper creek systems, focussing on water and related natural resource issues.

ARTESIAN SUPPLIES AND THE GREAT ARTESIAN BASIN (GAB)

Water usage in the GAB

The GAB is the most important water resource in the District, permitting permanent pastoralism and supplying industry. There is an estimated total inflow into SA of about 425 mega litres per day. Slightly under half this daily inflow is lost through vertical leakage from the aquifer. Vertical leakage involves losses of very small quantities of water per unit area but over a huge total area. The remainder is discharged from springs and bores (Table 5).

TABLE 5 - WATER BUDGET FOR THE SA PORTION OF THE GAB.

Source	Volume (Mega litres per day)
Inflow into the SA portion of the GAB	425
Upward Vertical Leakage	190
Flowing bores	20
Natural discharge from mound springs	66
Cooper Basin product and process water	22
Olympic Dam Operations	15*

Sibenaler, X. (1996) *The Great Artesian Basin, a 25-year water use scenario.* PIRSA Journal, Vol. 2, July 1996. PIRSA.
* The Olympic Dam approvals, granted by the State and Australian Governments in 1996, allow for an increased water extraction up to 42mg/day.

Artesian water conservation

Until recently the major visible discharge was from free-flowing bores. As well as these uncontrolled flowing wells wasting large amounts of groundwater, they also reduce the pressure of the GAB. Recognising this wastage, the former Department of Mines and Energy, now DWLBC started a program in 1977 to rehabilitate wells and control flows. To date, the Department has rehabilitated 98 wells, plugged 96 wells and drilled 42 replacements leaving only about a five to be rehabilitated, (GAB Strategic Management Plan 2000, GAB Consultative Council).

Rehabilitation involves the capping of bores, and establishment of new headworks, which permit control of flows and a reduction of wastage. The rehabilitation program is vital: the GAB is unlikely to run out of water, but if too much pressure is lost, mound springs and bores would cease to flow, and pumps would be required to obtain a supply.

The total flow from all SA wells has been reduced to about 20 mega litres per day through this program. Increases in water usage, for example the water supply to Roxby Downs, have to date been balanced by these reductions.

As well as the well rehabilitation program, the conservation and reduced use of the GAB bore waters has been greatly aided by the increasing availability of polythene piping (poly-pipe). Relatively recent improvements in plastics permit the pipe to cope with the water temperatures experienced and also with exposure generally. Before suitable poly-pipe was available, options for directing bore waters for stock purposes were limited to either open drains, or highly expensive and short-lived steel piping.

Future industrial and other water requirements

Industrial and related use of GAB water can be expected to increase. At present, the two major users are gas and petroleum liquids industry in the far northeast; others include the Olympic Dam mine and process plant, and the Roxby Downs Township southwest of the District.

22 mega litres per day of GAB water is discharged as part of gas and petroleum liquids production. Some increase may occur where additional gas wells are developed but major increases are not anticipated.

The current Roxby Downs water supply of 15 mega litres per day is extracted from the GAB and pumped about 100 km south, out of the Soil Board District, to the mine and township. Note that Olympic Dam Operations has approvals, granted by the State and Commonwealth governments in 1996, that allow for increased water extraction up to 42mg/day. This is in recognition of potential expansion of mining operations and the associated township. The effect of the withdrawals from Wellfield A and Wellfield B on nearby mound springs is being monitored.

There is potential for more mining / industrial development on a scale similar to that of the Olympic Dam development outside the southwestern margins of the GAB (and also well outside the Marree SCD). However, development is dependent on it for water.

The present and potential increases in water demand will require more efficient water usage for the SA portion of the GAB. From Table 5, the two biggest outflows from the GAB are the existing flowing bores and the vertical leakage. Reducing outflows from flowing bores to compensate for new outflows required for industry seems the more obvious approach to maintain the water balance, and further reductions in flowing bore outflows may be sought in future. However, water extraction also reduces the vertical leakage.

Any bore reduces the artesian pressures of the aquifer around it, most strongly, immediately around the bore, with the pressure drop (drawdown) reducing with distance. Hence a major extraction in one part of the basin can have a major effect on nearby bores or springs, without having any detectable effect on distant bores and springs. Additionally, the pressure drop reduces the vertical leakage; hence the bore can access water, which would have been lost under normal artesian pressures. This means that increased outflow from industrial, mining or oil / gas activities can be balanced partly by reductions in flowing bores, but also compensated by reduced vertical leakage.

The size and distribution of groundwater effects from bores is also affected by the physical shape of the aquifer in the region, particularly on the margins where artesian pressures are low and there are embayments in the aquifer. Water extraction in one area may result in drawdown affecting other bores at considerable distances in one direction while at the same time not affecting other relatively nearby outflows, because the latter are in a different embayment.

The effect of new artesian bores, or new borefields, on the GAB is thus not a simple and clear-cut matter. Modelling of groundwater systems is used in investigations to account for as many variables as possible.

Shallow Groundwater

Pastoral bores, which penetrate shallow aquifers associated with surface drainage, are distinct from the wells tapping the GAB. They are especially important for pastoral leases south of the GAB, but also for leases where the GAB itself is very deep, for example Cordillo Downs. Generally, the larger and more frequently flowing the surface waters, the more the availability of good quality water at shallow depths, for example shallow bores in dunefields along the Strzelecki and Frome Creeks. Away from major drainage lines, local aquifer recharges are much less, and shallow bores will reduce in quantity and quality, if not run dry, in extended drought.

River Systems

Heavy monsoonal rain in the Queensland catchments of the Diamantina (including both the Georgina-Eyre Creek and Diamantina River proper), and less frequently the Cooper Creek, will flood out over the plains of the channel country en route to termini in Lake Eyre or the Coongie Lakes system. The major floods in these systems result from monsoonal rains in Queensland. The requirements for major flows in both the Diamantina and the Cooper appear to be:

- Monsoonal depressions crossing Queensland further south than normal;
- Two or more consecutive wet years in the catchment.

Waters of these systems are of major importance both as a direct water source, replenishing previously dry or salty lakes and waterholes which can then remain fresh from months to years, and recharging local near-surface aquifers, and as effective if intermittent irrigators of huge areas of land. The largest flood on record, in 1974, involved at least 30% of the District.

As a natural "irrigation" source, the Cooper system is the more important, its major floods extending over much of the northeast portion of the District, whereas the greater flows of the Diamantina / Warburton system are much more channelled. One consequence of this is that, when water does reach Lake Eyre, the Diamantina / Warburton is the major source and the Cooper only one of several relatively minor sources. Mean annual inflows are estimated in Table 6. Note that these are mean figures, and do not indicate variation.

TABLE 6 - LAKE EYRE WATER SOURCES

Source of water	**Percentage**
Diamantina / Warburton	64%
Cooper Creek	17%
Other (Macumba, Neales, Peake, Warriner, Margaret, Frome)	19%
Armstrong, 1990.	

Minor floods elsewhere in the District, particularly on the Frome, may come from persistent heavy rains in SA, but these rains do not significantly contribute to the major Diamantina and Cooper flows.

There is much argument about the frequency, amount and extent of flows in the two large systems. There are simply not enough nor long enough records, and the following is worth quoting:

> "In an area of high seasonal and annual climatic variability, an extremely long record of rainfall and river flows is required to obtain a useful level of understanding of the hydrological behaviour of a system. Owing to the remoteness of the area such a record does not exist. All drainages in the basin are ephemeral and, at best, we can only rely on indirect methods to advance our state of knowledge pending the accumulation of a suitably long record." Armstrong, 1990.

What actually constitutes a 'flood' or a 'filling' of Lake Eyre is highly debatable. On the basis that large floods are needed to fill Lake Eyre, we can use the ten known major fillings over the last century as an indication of the frequency of the biggest flows (Table 7).

The dates illustrate the variability of major flows: gaps between major floods may be as short as two years, or extend for twenty. The biggest flows, resulting in filling of Lake Eyre, have been a 27-year interval (1889 to 1916), a 33-year interval (1916 to 1949) and a 25-year interval (1949 to 1974). Present modelling of the Lake Eyre Basin suggests that the 1974 filling was a once in 100-year event, the 1949 and 1889 fillings a once in 50-year event, and the 1916 flooding a once in 20-year event (Armstrong, 1990).

Between 1859 and 1984, 25 floods in the Cooper sufficient to reach the Birdsville Track have been recorded (Badman, 1989). The Cooper did contribute a considerable amount of water to the 1950 filling of Lake Eyre, and another seven may have reached Lake Eyre but with little or minor contribution to its filling. The timing of the floods again points to the erratic climate: between 1859 and 1898, the floods came at 3- to 5-year intervals. The next two floods were in 1906 and 1918, but there was then a 31-year gap to 1949. There were five major floods in the next seven years, a 7-year gap to 1963 and another flood in 1966, a further 8-year gap to 1974, with another flood two years later, and an 8- year gap to 1984.

TABLE 7 - MAJOR FLOODS AND FILLINGS OF LAKE EYRE

Year	Flooding or complete filling	Volume (cubic km, km^3)
1869 - 1871	-	-
1886 - 1887	Flooding	-
1889 - 1890	**Filled**	**21**
1916 - 1917	Flooding	19
1920 - 1921	Flooding	-
1940 - 1941	Flooding	-
1949 - 1950	**Filled**	**29**
1955 - 1956	Flooding	-
1974 - 1977	**Filled**	**39**
1984 - 1985	Flooding	-

Allan, 1990. Williams, 1990.

The difference between the Diamantina / Warburton and Cooper systems is worth expanding further, since it has a major effect on pastoral operations. The Diamantina / Warburton are braided streams, with numerous channels in a (relatively) narrow floodplain. Although both Goyder's Lagoon, which separates the Diamantina from Warburton Creek, and its anabranch, Kallakoopah Creek are areas of mixed channel and floodout, and although the alluvial flats above Goyder's Lagoon extend away from the streamlines for some tens of kilometres into the Simpson Desert, there are enormous areas of shallow floodout around Goyder's Lagoon.

On the Diamantina / Warburton, flooding peaks will overflow the channel areas and extend onto the alluvial flats, but the flooding subsides rapidly as water returns to the channels with their eventual terminus in Lake Eyre. On the Cooper, however, the waters, once at Innamincka, will spread over extensive floodplains, on alluvial flats within dunefields, and into diffuse floodout areas. The spread is south along the floodplain of the Strzelecki Creek and extending into dunefields, north to the Coongie Lakes, and west toward the Birdsville Track along a very diffuse course. The Coongie Lakes, from Tirrawarra Swamp in the south to Lake Goyder in the north, are an obvious example of a diffuse terminus of the Cooper waters, but for most Cooper Creek flows, the broad floodplain and surrounding flat lands toward the Birdsville track are also a terminus.

The extent of flooding of the Cooper very much determines the extent to which the numerous semi-permanent waterholes are replenished, and especially the amount of pasture growth in the floodout area. Flooding in the Diamantina has similar effects, but much more narrowly limited.

Other stream systems within the District are either very minor, or rely primarily on rainfall largely outside the District, with the exception of streams rising in the Willouran Ranges. Lacking the monsoonal input of the northern creeks, all are truly ephemeral, with flooding events characterised by very rapid and short-lived rises and falls.

PASTORAL HISTORY

Aboriginal Living and Land Use prior to Settlement

The purpose of this District Plan is to give the present context of land use and land conservation, and to provide guidelines for improved management of lands within that present context. The District Plan is not an archaeological or ethnographical document. It is recognised, however, that prior to European colonisation, the land was held, and used, by Aboriginal people for thousands of years, and that despite major changes in land use since the advent of pastoralism 140 years ago, much of the landscape may still reflect the imprint of Aboriginal occupation.

Aboriginal subsistence was nomadic, dependent on hunting and gathering. The whole of the region was used, including the extreme of the central Simpson Desert, which does not now sustain any permanent occupation. Sources of water were vital: the springs on the GAB margins, the intermittent streams of the northeast and in the otherwise waterless Simpson Desert, deep wells. Tribes speaking languages closely related to each other occupied most of the District, and tribal (language) boundaries, while present, were not necessarily clear-cut (Hercus, 1990).

Throughout Australia, Aborigines made use of fire to manage their habitat. In particular, spinifex grasslands were patch-burnt to encourage the growth of food plants or for hunting purposes (see Walsh 1990 or Morton 1990 for summaries). It is probable that fire was used similarly in spinifex areas of the District at least, and potentially in other areas. This burning regime altered with the cessation of traditional management, to the present situation of infrequent but very large fires. Part of the present distribution of vegetation and wildlife in the region may reflect the long history of Aboriginal fire management.

Special legislation exists for the protection of areas of Aboriginal significance, and non-pastoral developments in the region all require an assessment of anthropological and archaeological significance and impacts. It is difficult for a non-Aboriginal to fully comprehend the interweaving of living, behaviour, geography, history, and myth, which form the Aboriginal dreaming. In the region, the expression actually used for "Dreamtime" was "History Time" (Mick McLean, quoted in Hercus 1990). Physical sites which need not necessarily appear "special" to a non-Aboriginal are a part, but not the whole, of individual dreaming, and as such may have more significance than might be realised. Such areas may need special respect and management. As well, much of the history of Aboriginal use is present on the land as middens, quarries, worksites, campsites and burial sites, all of which also can be damaged and may need special protection.

Settlements, such as the Ghan town of Marree provided a focus for development and enabled human habitation of extremely unhospitable areas.

Afghan influence

In 1866 Thomas Elder imported the first shipment of commercial camels from India. These camels, with their Afghan handlers enabled new settlers to develop pastoral interests by transporting supplies such as fencing wire, tools, food and everyday living requirements from the railhead. The camels and the camel men are thought to have advanced the opening up and development of outback Australia by 50 to 60 years (Cigler, 1986). From 1884, Marree was the hub of a vast pack-camel transportation network. Afghan descendants still live and work in the region.

Exploration and Lease Establishment

The first Europeans to explore the District were led by Captain Charles Sturt in the north (1844 – 45) and Edward John Eyre in the south (1840). Eyre reached Lake Eyre South, and moving east named the Frome River. His sightings of the various salt lakes led to the conclusion of one great horseshoe-shaped salt lake, not dispelled until the explorations of Babbage in 1858 and Samuel Stuckey, who in 1859 found a passage through the supposed "horseshoe" and named Lake Hope. Sturt operated from a base near Milparinka and in 1844-45 named the Strzelecki and Stony Deserts whilst exploring as far north as Birdsville.

Pastoral leases rapidly followed exploration, almost overtaking it. By 1857 John Baker had founded and rapidly stocked Blanchewater on the McDonnell Creek, 4,000 square miles of which became Murnpeowie in the 1890's. Stock were introduced to Finniss Springs and Davenport Springs in 1859. Thomas Elder leased Lake Hope in 1860, the year Burke and Wills went north. Mundowdna lease was taken up in 1861, in the same year John McDouall Stuart found some horses lost the previous trip on the lease. Rescue missions seeking the stranded Burke and Wills expedition in 1861-62 under William Howitt and especially John McKinlay, further explored the northeastern area of the District.

A major drought between 1864 and 1867 briefly halted pastoral expansion. The introduction of the camels and camel men in 1866 assisted further expansion, and German missionaries had established missions at Kopperamanna and Killalpaninna by 1867. With better seasons came a major increase of pastoral activity and expansion. Elder acquired further leases (Manuwaukaninna) on the western shore of Lake Gregory in 1868, and in 1872 combined the Murnpeowie section of Blanchewater with his adjoining holdings. Leases were rapidly taken up at Innamincka (1874); Coongie, originally named "Land of Promise" (1875); Cowarie (1875); the Tinga Tingana (Strzelecki) leases of William Burkitt (1874 - 1876).

As an indication of the rapidity of pastoral development, and of the numbers and diversity of people involved with it, Post Offices were operating at Cowarie, Innamincka, and Manuwaukaninna on the Cooper in 1877. The mail run serving these stations, from Umberatana via Mt. Freeling and Blanchewater, was extended in the same year with a monthly run to Innamincka. Leases served, initially by packhorse, were Lake Hope, Lake Perigundi, Perricherrie, Coongie and Innamincka. Pastoral lands were thus becoming increasingly occupied.

Remaining lands were rapidly taken up. The Cardilla (Cordillo Downs) lease in the far northeast was taken up by Peter Waite in 1879. The Monte Collina lease, taken up in 1882, completed the pastoral coverage of the whole of the Strzelecki Creek and Desert area. Finally, Callabonna lease was taken up in 1883.

Two factors fuelling pastoral expansion in the late 1860s onward were the displacement of grazing leases in higher rainfall country by the advancing of the agricultural frontier (Meinig 1970), and the relatively moist climate conditions after the droughts of 1864 / 65 and up to the mid-1890's (see Climate, above).

Government Controls

Pastoral leases had been regularised under the *South Australian Land Act* of 1867. Leases were held for 21 years at 2/6d per square mile. Under the *Crown Lands Consolidation Act* of 1878 the leases were reduced to 14 years tenure with the right of renewal for a further 14 years, the initial rent being 2 / 6d per square mile per annum, 1d per head on the average number of sheep and 6d per head of "great cattle depastured thereon". Terms were to be doubled for the second period of 14 years. The Government had the right of resumption on three years notice generally, but one month only in the case of railways or roads. If the lease were to be resumed during the first 14 years, compensation would be payable in full for improvements. The later Act also required that leases were to be stocked, and kept stocked, for the term of the lease. The intention was to prevent land speculation, to ensure production (and Government revenue), but had little to do with sustainable management of the land itself.

Lack of Sustainability of Initial Development

The stocking requirement, the speed with which fortunes could be made (or lost) together with lack of knowledge of the country would have been a major contributor to the overstocking and crushing losses, which occurred from the mid-1890 into the early 1900's. Other factors were the appearance of the rabbit in 1887 and the rapid build-up to plague levels coinciding with the onset of major drought, and the Australia-wide depression of the late 1890's.

A further contribution came from the systems of stock running. With no boundary fencing, let alone internal fencing, large mobs and herds were run, focussed on available natural water, the waterholes and springs, and often shepherded. For example, Cordillo shore 80,000 sheep in 1888, up from 10,312 sheep (and 580 cattle) only five years before; and Murnpeowie sheared 106,000 sheep in 1894. These were not unusually high figures for the time.

Stocking at such rates was simply not sustainable. While the leases were often large, 4,800 km^2 at Cordillo in 1890, 3,864 km^2 in the Tinga Tingana lease, 3,663 km^2 in the Innamincka lease, permanent waters were limited, causing uneven grazing pressure. Concentration of large mobs on limited waters could be carried in the succession of good seasons up to the mid 1890's, but subsequent droughts led to crashes of both pastoral enterprises and lands in proximity to water throughout the arid pastoral regions.

Damage was most pronounced where waters were semi-permanent, on the stream frontages and near floodplains, and where springs were present. Equally, damage from stock overgrazing in poorly watered areas would have been slight away from the stream and spring systems. Much of the land certainly escaped the levels of devastation wreaked in smaller and better-watered holdings along the Olary Spur and especially, in much of western New South Wales.

In the case of springs, the absence of much vegetation beyond the springs themselves is as likely to be a result of the high salinity as a result of early land degradation. The same view is often applied also to the very bare gibber country about mound springs in the southwest and southeast of the District, but this may not be the case. Mound springs are often set in the Oodnadatta Land System, where the gibber soils are highly saline because of vertical leakage from the GAB. The springs themselves have, ironically, been salting their surrounds for thousands of years. Although the spring water is of reasonably good quality in most cases, it is still saline and the salts are deposited in the soils around the springs when the water evaporates.

Rabbits and Plagues

Another reason why the early stocking rates were not sustainable in the long-term was the arrival of rabbits. Rabbits first reached plague proportions coinciding with the onset of major droughts of the 1890's. Subsequently, plagues developed at intervals until the early 1950's, when myxomatosis was introduced. Rabbits remain present, in quantity, throughout the District. Although myxomatosis eliminated widespread plagues, its effectiveness is declining. Local rabbit populations can at times approach the pre-1950's plague levels.

Since its release in 1995, Rabbit Calicivirus Disease (RCD) has had a significant impact on rabbit populations in the arid zone, with recurrent outbreaks occurring in many areas.

Part of the reason for the rabbit's continuing success is its ability to mimic the "boom and bust" population growth of the native plague species, the plague rat. Plague rats tormented Burke and Wills' party in 1860, and major plagues ("irruptions") in abundant seasons remain a feature of the northern part of the District.

Grasshoppers and water hens also frequently follow floodwaters down from Queensland in plague numbers. These combined with the plague rat and the ever-present rabbit, can devastate new growth.

Fauna Extinctions

A high proportion of the mammal species of arid Australia have had their original distribution and abundance greatly reduced, or have become extinct as a consequence of European settlement. Habitat change, as a consequence of over-optimistic pastoral use and subsequent land degradation and introduction of feral predators and competitors, are cited as major causes (Morton, 1990). Mammals have been affected more than birds, reptiles and plants.

The group of mammals which has been most affected comprises the medium-sized species such as bilbies: Smaller species, such as the plague rat and larger species, such as the kangaroos appear either not to have been affected or to have been advantaged. The best explanation available at present is that of Morton (1990). On his model, the medium-sized mammals required specialised habitat, which in the arid-zone was small, patchy and prone to disappearance in drought with few refuges available. The rabbit, grazing stock, and feral introduced herbivores would concentrate on these patches. With the addition of an altered fire regime, and finally, introduced predators, insufficient local populations survived to maintain the species.

Early Pastoral Development and Land Degradation in Context

It is easy, but far too simplistic, to paint the pioneering pastoralists as rapacious and uncaring and the source of severe environmental damage. This view is often put forward in hindsight but it does not take into account either the times in which pastoral expansion took place, or the real benefits that derived from the pastoral expansion.

First, there was no prior experience to learn from. The vagaries of the climate and the slow growth rates of perennial plants were unknown. Initial expansion took place in a wetter period, with the abundance of forage from rains and floods giving a misleading impression of land capability.

Second, for all the damage which early development caused, the absence of water away from the major stream systems and springs limited the extent of grazing impacts.

Further, there was no attempt in the District to cut leases into smallholdings. This contrasts with the intensive lease subdivision, which occurred in western New South Wales. The failure of closer settlement policies in New South Wales, and the damage done by the high stocking (an economic necessity for survival on small holdings) has been chronicled in a series of Royal Commissions and enquiries, starting in 1902 and continuing to the present. The NSW experience was not reflected in SA due to major differences in the history of the area and the way land tenure was applied. The importance of low stocking rates was recognised before World War II and actively promoted through legislation. The subsequent partnership which developed between the Pastoral Board, who administered the Pastoral Act 1936 and the pastoral lessees led to improved land condition and an understanding of the need to hold total grazing pressure to the threshold of regeneration.

Finally, there is no doubt that the early development of the District injected considerable wealth into the economy of a struggling and at times, almost bankrupt South Australia. It tends to be forgotten that the State at various times has owed its very survival to mining, starting with the copper finds of the early and mid 19th Century and continuing with the effective "capture" of Broken Hill, and to pastoral expansion which advanced general exploration and paved the way for agricultural expansion in the higher rainfall areas. The earnings from these, as well as giving rise to major companies which then furthered development beyond the pastoral sphere, contributed greatly to the development of the State infrastructure, as a whole and made it viable for communities to establish themselves in the pastoral areas.

Early Approaches to Sustainable Management

The challenge of sustainability was understood, though not by that name, from the early days as experience with the land increased. The most outstanding example in South Australia was of course, Surveyor General Goyder, and his attempts to limit agricultural expansion to where it could be sustained, and so prevent damage to pastoral lands (Meinig 1970).

Within the District, special note should be taken of the work of Peter Waite, not only for his later endowment to the Waite Agricultural Research Institute, but also for his efforts in pioneering sustainable management approaches in arid pastoral areas. Far from being a modern viewpoint, the notions of paddock subdivision to suit the country, multiple watering points under the control of the manager rather than the stock, closing of paddocks for pasture regeneration, and reduced herd sizes on individual waters were all worked out and applied by Waite to the Cordillo lease. Cordillo originally was dependent on relatively few waterholes, which lasted for a maximum of nine months after rain. Waite sank wells and built dams rapidly, not only to extend the water supply, but also to avoid the pasture degradation accompanying large stock numbers concentrated around limited water points. Later, as a recognised successful pastoralist, Waite actively promoted his management system (*Adelaide Observer*, 26 September 1896).

Subsequent Development

By the late 1890’s, the pattern of land use in the District had been set, with pastoral activity concentrated in the flooding country and elsewhere where major waterways existed (eg. along the Frome), on the gibber country along the Birdsville and Oodnadatta tracks, and in areas with springs. Except where penetrated by floodplains, the Deserts were left unoccupied.

Sheep had been dominant and cattle secondary in the early expansion: there was a ready export market for wool which could be transported and stored without losing condition, whereas markets for cattle were much more limited and the cattle had to be got to them without losing condition. However, depredations of the dingo seriously affected viability of enterprises, and by 1904 - 1906, the Dog Fence in the southern part of the District was under development. This resulted in the present division of cattle enterprise over most of the District north of the Dog Fence, and sheep south of it.

Further pastoral development was aided by the tapping of the Great Artesian Basin. The first artesian bore was drilled at Marree in 1884. This was relatively shallow, but was followed by a deeper bore at Lake Harry in 1890, and then the deep bores at Kopperamanna (1897), Goyder's Lagoon and Mt. Gason (1900), Mirra Mitta (1901) and Mulka (1906). As well as permitting pastoral use of previously unwatered areas, these bores also aided the travelling of stock. Again, the problem of large numbers of stock concentrating on a point water source appeared. There were no means for getting the bore waters away from the source, other than bore drains which could not be run great distances. This remained a major block to effective land management until the last two decades, with the advent of poly-pipe.

Bores took up to two years to drill, and the machinery was steam-powered and wood-fuelled. Local sources of wood were used. Given that a large stationary steam engine can consume wood at rates of a tonne or more an hour, the absence of old timber for long distances about the older bores needs no other explanation.

The division into cattle country and sheep country, coming more or less at the turn of the century, may have saved much of the District from further land degradation in the ensuing droughts. The period up to the mid-1940s was drier than both the original period of expansion or subsequently. Sheep could be held into these droughts, but cattle could not. It is likely that the damage to shrub pastures in particular, reported over this period, was far greater in the better watered and more heavily stocked sheep country than in the cattle lands.

Droughts in the 1930s were so severe as to prompt various Government investigations into the causes and extent of land degradation. Francis Ratcliffe in the late 1930's was brought out from England to deliver specialist opinion, and provides graphic descriptions of the effects of drought on both the land and the people (Ratcliffe 1939). He later had a major part in the development and spread of myxomatosis for rabbit control.

There were one or two attempts to diversify land use beyond pastoral use. The camel men brought a unique culture and understanding of arid lands to Australia and prompted some government assistance with experimental date plantations. Lake Harry was one such plantation, watered by GAB bore water, established in 1905. By 1935 it was "an established experimental plantation of two thousand date palms having reached maturity". It was not successful due to severe drought and siltation of channels by dust storms. There has been no further experimentation with date plantations in the region.

Petroleum exploration commenced in the District after 1945. First attempts at exploration were disappointing, and the original licence, which incidentally covered all of the present day gas fields, was surrendered in 1956. Subsequent exploration was not particularly successful, until 1963 when the SA Government demanded that the new licensees drill a particular well or suffer the consequences (Wopfner 1990). This was the Gidgealpa No. 2 well, which resulted in the discovery of the first of the major gas fields.

Subsequent development of the gas and petroleum liquids fields in the north-east of the area have transformed parts of the District, with the development of Moomba, the provision of roads, and the inevitable exploration activities.

Changing Social Infrastructure and Technology

The greatest contrast between the early period and the present is the huge reduction in numbers of people living and working in the District (apart from the special case of the Moomba facilities). For example, Cordillo Downs in the 1890s was said to have 150 people on the books: 50 on site, 50 on their way south, and 50 on their way north. The present direct workforce is a tiny fraction of this. The decline has been most noticeable over the past forty years. It is a consequence both of changes and improvements in technology and of reduced gross margins of primary industry. Pastoral industry has remained viable within the reduced gross margins because the technology has enabled the vastly reduced manpower to achieve far more in management.

Various examples:

- The Cordillo woolshed accommodated 150 hand shearers. Mechanical shearing was introduced in 1907, with a major reduction in workforce.
- Motor vehicles superseded the use of camels, camel men, and coach-horses on mail runs from 1920. The appearance of reliable motor vehicles, and the gradual development of roads, also reduced the number of outstations needed on leases, with further workforce reductions.
- The development of fencing, the introduction of piped watering systems, the upgrading of roads, and the appearance of large stock transports have eliminated the need for the drover, and the numerous station hands.
- A greater appreciation of the value of education, and its cost, has reduced the number of itinerant working families available as experienced station hands.

Also between the early pastoral period and the present, the Overland Telegraph and the Central Australian Railway came, with the workforce necessary to establish, maintain and run them, and went, taking most of the workforce with them.

It is ironical that communications, health and education steadily improved from the turn of the century while the population decreased. In the early days, poor and inferior water led to typhoid, and there could be no immediate assistance after accidents. Spanish Influenza devastated the population, particularly the Aboriginal population, in 1918. The Australian Inland Mission (AIM), forerunner of today's Royal Flying Doctor Service (RFDS), was launched in 1928. The AIM hostel at Innamincka was one of the first places linked directly to the outside world through AIM radio contact. By 1958, most stations had their own transmitters linked to the RFDS, with both health and education services available. The most recent development has been the appearance of telephone services even for distant localities. Increasingly efficient local power generation has played a part in health, communications, and education. Power and lighting has advanced from fat and kerosene lamps and steam engines, to 12-volt free lights, to 32-volt lighting plants, to 240 volt generators, either fuel-driven or hydroelectric utilising GAB bore pressures.

CURRENT LAND USES AND PURPOSES

Pastoral

About sixty per cent of the District is under Pastoral lease. The main enterprise is beef cattle production on native pastures, with wool production south of the Dog Fence in the southern portion of the District.

Pastoral production within the District is significant but highly variable. Accurate figures for the value of pastoral production both cattle and sheep (wool) within the Soil board area are difficult to source. Whilst the annual Pastoral Board stock returns gather data on stock and other herbivore numbers, economic data is not obtained. Due to low wool prices, very dry seasonal conditions and recently very high prices being obtained for sheep suitable for market, sheep numbers are likely to have declined since the previous plan (average 749,000 for the Lake Eyre Basin in SA in early 1990's).

CONSERVATION

Parks and Reserves

The District contains some of the State's largest conservation reserves, dedicated under the *National Parks and Wildlife Act 1972* for biological and landscape conservation purposes (Table 9). National Parks and Conservation Parks are intended for those purposes only, with visitation under the control of National Parks and Wildlife and are subject to a management plan.

Fossil Reserves exist for the specific purpose of legally protecting major fossil deposits from damage.

Regional Reserves are Australia's first attempt at seriously managing for multiple uses, with biological conservation, continued pastoral use and oil, gas and mineral exploration and production within the same area. They are also subject to management plans under the *National Parks and Wildlife Act 1972*, but with users having input both to formulation of the plan and to management.

Figure 9 on page 43 shows the location of National Parks and Wildlife Reserves throughout the District.

TABLE 8 - PARKS AND RESERVES WITHIN THE MARREE SOIL CONSERVATION DISTRICT

Reserve	Area (Ha)	Comment
Lake Eyre National Park	1,356,000	Oil exploration permitted
Elliott Price Conservation Park	64,570	
Simpson Desert Conservation Park	692,680	
Innamincka Regional Reserve	1,381,995	Regional Reserves are multi-use, with biological conservation, tourism, pastoral use and oil / gas and mineral exploration and production permitted with controls
Strzelecki Regional Reserve	793,290	
Tinga Tingana Regional Reserve	362,598	
Simpson Desert Regional Reserve	2,964,200	
Lake Palankarinna Fossil Reserve	-	Reserves for the protection of fossil deposits rather than biological conservation
Lake Callabonna Fossil Reserve	500	
Coongie Lakes National Park	27,900	Covers most of the Coongie Lakes area, formally within the Innamincka Regional Reserve, now all grazing and mining is excluded from this area.

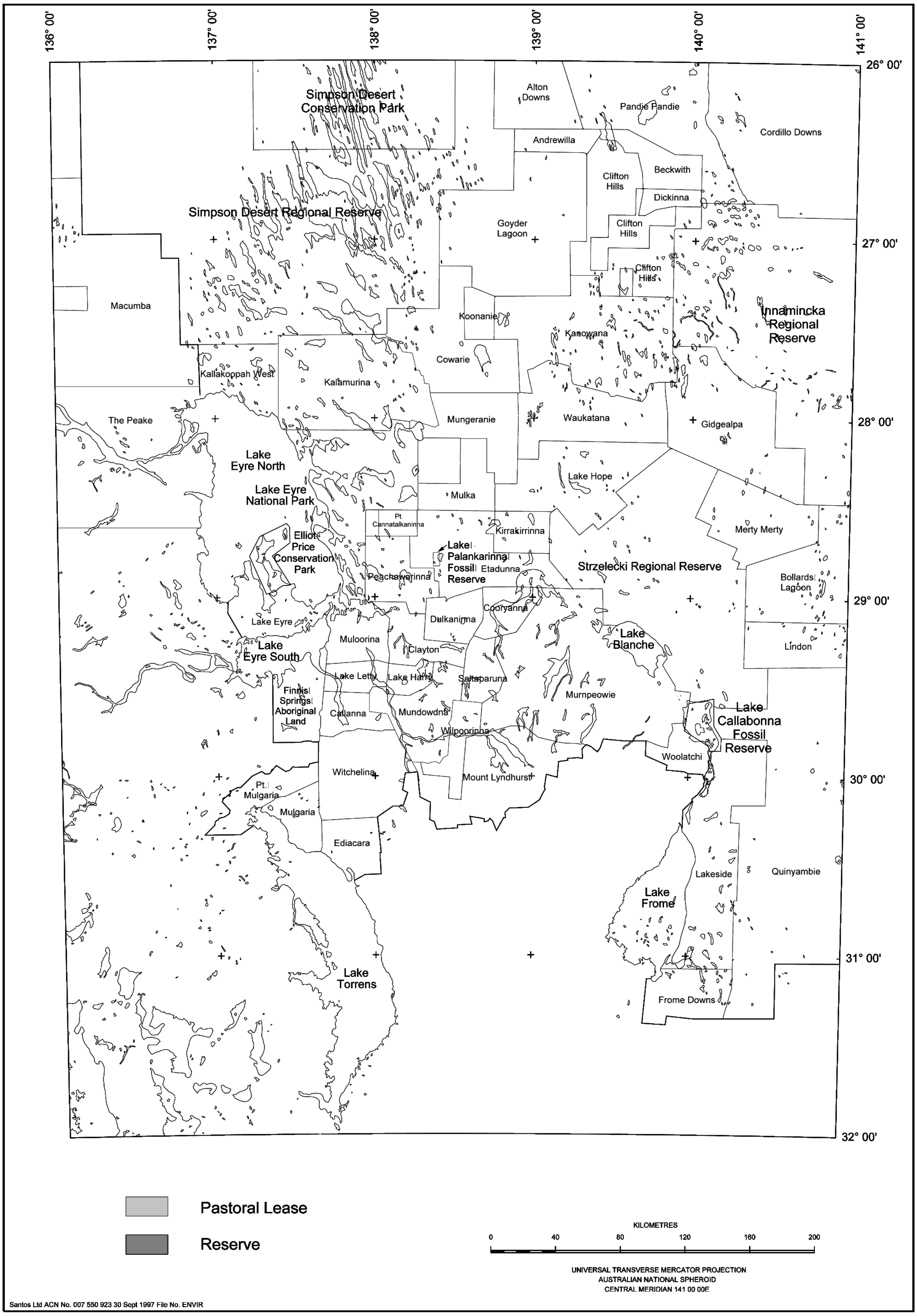


Figure 9 Parks and Reserves of the Marree SCD. Source: *Santos Ltd*

The *National Parks and Wildlife Act 1972* (Section 37) requires that the Minister and executive management associated with the NPWSA "must have regard" to the following objectives in managing reserves:

- The preservation and management of wildlife;
- The preservation of historic sites, objects and structures of historic or scientific interest within reserves;
- The preservation of features of geographical, natural or scientific interest;
- The destruction of dangerous weeds and the eradication or control of noxious weeds and exotic plants;
- The control of vermin and exotic animals;
- The control and eradication of disease of animals and vegetation;
- The prevention and suppression of bush fires and other hazards;
- The encouragement of public use and enjoyment of reserves and education in, and a proper understanding and recognition of, their purposes and significance;
- Generally the promotion of the public interest; and
- 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.

A Draft management plan exists for the Simpson Desert Conservation Park (NPWSA, 1983) and a management plan was gazetted in 1993 for the Innamincka Regional Reserve (1988). Objectives for the two reserves contrast the primary biological and landscape protection role intended for a Conservation Park, and the integration of different and at times conflicting land uses intended for a Regional Reserve.
For the Simpson Desert Conservation Park, major management objectives rotate about biological conservation and protection, and provision for limited visitor use:
For the Innamincka Regional Reserve, the emphasis in the Management Plan is on the integration of the different uses; biological and cultural protection and conservation, visitor use, and resource use. Hydrocarbon and mineral development are mentioned specifically and pastoral use (stock grazing) is considered as an existing legal use. A Crown Lease Agreement exists between the Department of Environment and Heritage and S Kidman and Co.

RAMSAR wetlands

In 1987, part of the Cooper Creek system was proclaimed as the Coongie Lakes Wetland of International Importance under the 1971 RAMSAR Convention, to which Australia is signatory (see Part I). While the Coongie Lakes name was given and has drawn most public attention, Coongie Lakes is only a small portion of the area listed under the Convention, with the region defined by Lake Moorayepe to the north, Cooper Creek at its crossing of the Queensland border to the east, and a point south-west of Lake Hope (Figure 13). Approximately one-third of the Ramsar area is included in the Innamincka Regional Reserve, dedicated in 1988. In 2003 the Coongie Lakes area (27,900 hectares) within the Regional Reserve was created into a National Park, where grazing and mining and petroleum activity is excluded.

The boundaries of the RAMSAR area include extensive areas of dunefield and lands, which are rarely flooded, as well as the more frequently flooded lakes and floodplains associated with the Cooper Creek system. This RAMSAR Wetland is currently being used as part of a case study to determine an international process for reviewing RAMSAR boundaries.

Within the Innamincka Regional Reserve, management is being developed through a cooperative approach between the SA Government, pastoralists and the oil and gas industry. At present, wetland management outside the Innamincka Regional Reserve is also anticipated to be a cooperative process involving individual property holders and government.

OIL AND GAS EXPLORATION AND PRODUCTION, MINERAL EXPLORATION, AND WATER EXTRACTION

The producing oil and gas fields of northeastern South Australia are spread through pastoral lands and some regional reserves in the northeast of the District. Facilities include about 800 producing wells, collecting pipelines, local processing facilities, road systems and the major processing, distribution and work centre at Moomba. Buried pipelines transfer hydrocarbon liquids (crude oil and condensate) to Port Bonythion near Whyalla; and gas to Adelaide, Canberra and Sydney as well as many regional centres along the way.

Production from the region generally (including fields in Queensland) is of national importance. The value of production by Santos in 1993 / 1994 was $740 million. Royalties to the SA Government for the same period were $60 million.

There necessarily is continuing exploration to find and prove new reserves to replace those being used. Exploration may eventually entail the development of local networks of rig roads to service exploratory wells. Oil exploration still continues intermittently further to the west, and there remains the real long-term possibility of productive oilfields eventually being discovered in the Tirari and Simpson Desert.

There is no significant mineral extraction operation in the District, but the water supply for the copper, uranium, gold and silver mine, process plant and township at Roxby Downs is drawn from the GAB near the southwestern margin of the District and piped south.

ABORIGINAL LANDS

The status of the former Finniss Springs Pastoral lease is now under the ownership of the Aboriginal Lands Trust. The long-term proposal is for the land to be available for use and management by the appropriate local Aboriginal group.

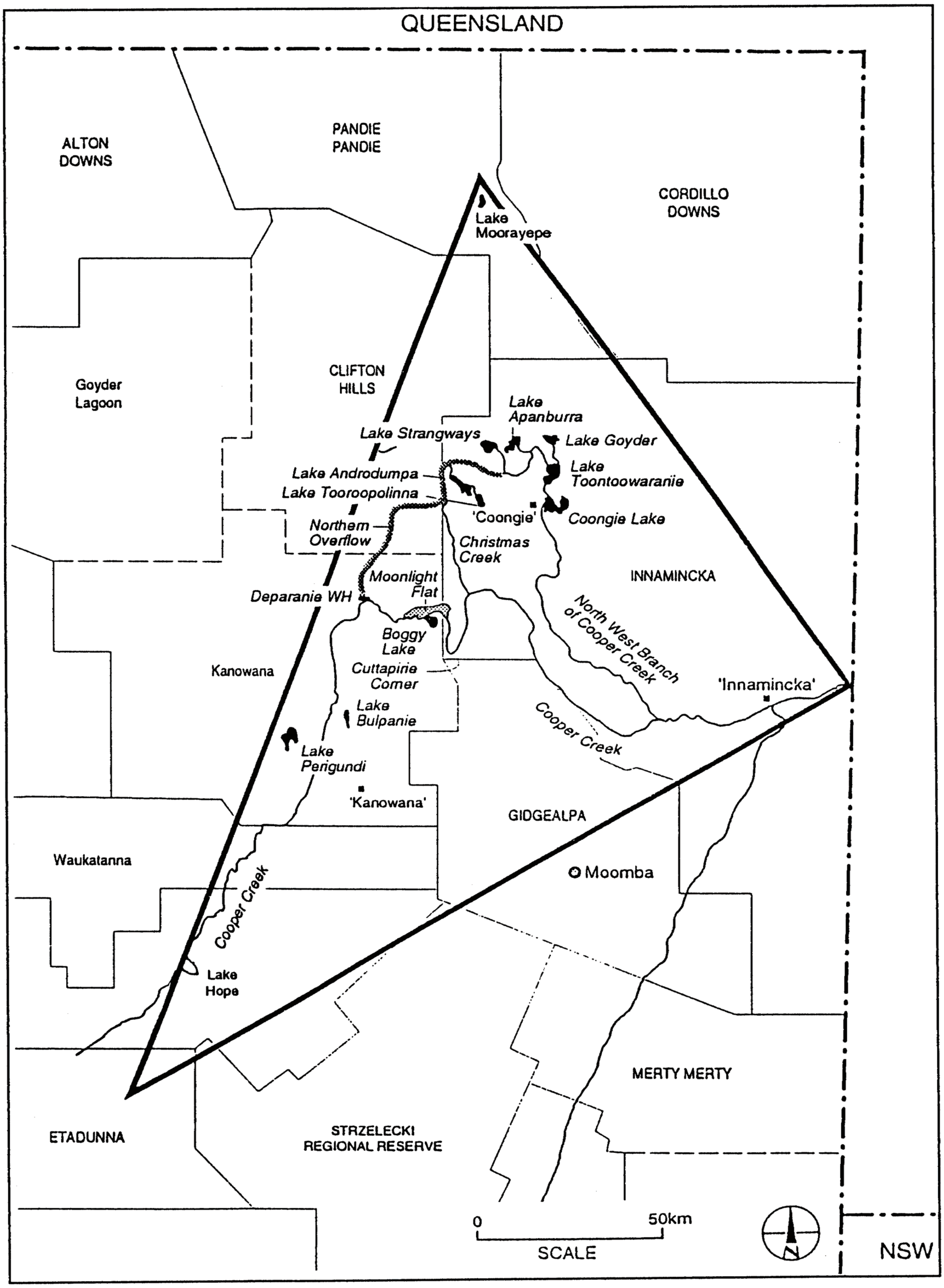


Figure 10 Wetlands of international significance: boundary of region defined under the RAMSAR convention. *Gillen and Drewien, 1993.*

INFRASTRUCTURE

Townships

The most notable aspect of the District's infrastructure is the lack of it. There are three townships, the small town of Marree, the "village" of Innamincka, and the company town of Moomba. While Moomba has the highest population, it is effectively a transient one, and the town is "closed" to visitors.

Marree has a population of about 80. Half the population is under 40 years of age. Marree's facilities include a hotel, two caravan parks, store, cafe, motor garage, hospital, Marree Aboriginal School, and a police station. There is a township water and power supply. Development within Marree is controlled under the Development Plan for the Far North (out of Councils) Area, and management of the area once known as the Marree Common is the responsibility of the Marree Progress Association. Additional services have been provided to the community by successful applications for funding by various community groups.

Innamincka has a resident population of eighteen. There is one hotel and a store / roadhouse. Town water is supplied from Cooper Creek, but individual residents generate power. A town plan is currently being developed.

The Outback Areas Community Development Trust, a State Government Statutory body constituted in 1978 can assist with development projects for remote communities. Their area of responsibility is that part of the State not covered by local government, excluding the Maralinga and Pitjatjantjara Lands.

Transport

Roads

Transport SA (TSA), Northern and Western Region, maintains 2,400 km of public roads in the Marree SCD The major roads are the Birdsville, Oodnadatta and Strzelecki Tracks (Figure 14).

Road upgrading has been carried out since the early 1970s. The majority of TSA roads are now formed and sheeted, replacing the original flat grade tracks. Re-sheeting gangs can re-sheet approximately 60 - 70 km of road per year, and form and sheet approximately 50 km of new road per year. Gangs rely on depots maintained at Marree and Leigh Creek, the latter servicing the Strzelecki Track.

Water is needed for road construction or re-sheeting, and also for sections prone to bull dusting, where wet maintenance rather than dry grading is needed. Water requirements for re-sheeting and maintenance (wet grade and roll) range from 130 - 220 kilolitres per day. With stations piping water from the artesian bore network, the Department's own bore network has assumed greater importance in the supply for road works.

Special precautions are taken in construction and maintenance to avoid water erosion and to minimise interruption to natural water flows. Road surface drainage is constructed to divert water to selected road crossings. In tableland country, the gibber cover is replaced on the necessary drains, and offshoot drains used to dissipate flows. For drainage channel crossings, extensive culverting was originally used, with disadvantages of impeding streams and not coping with extreme (thunderstorm) falls. As existing culverting comes to the end of its useful life, and in new construction, crossings are rebuilt using floodway. These cross channels at or close to grade, are constructed to the full channel width.

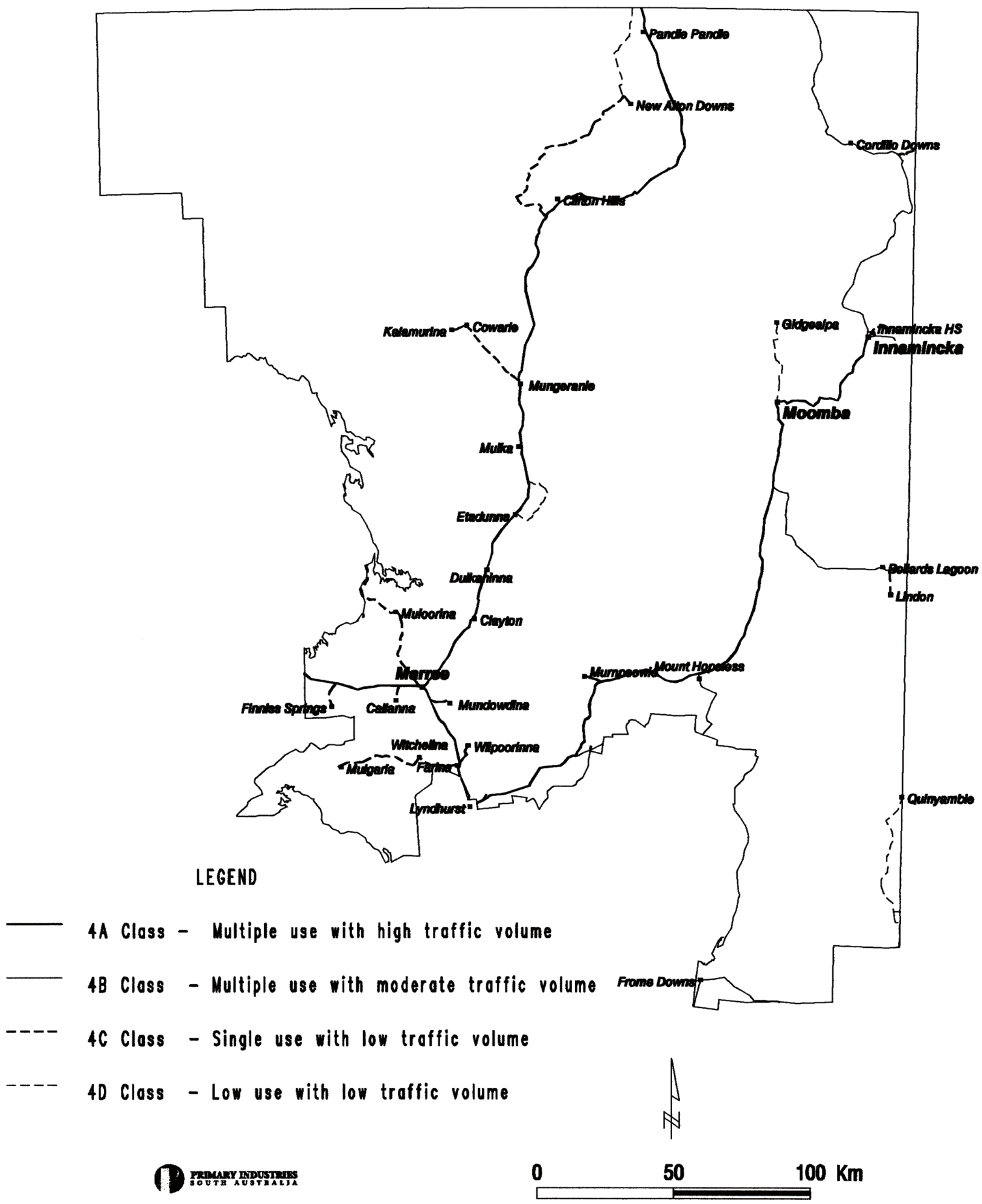


Figure 11 Roads maintained by the Transport SA (TSA) in the Marree SCD.

A full approval process is required for new or changed road alignments. This includes consultation with Aboriginal groups, local Progress Associations, the Soil Board and other stakeholders, and a biological survey being undertaken as part of planning. TSA have an Environmental Code of Practice and have employed an Environmental Officer, based at Port Augusta.

TSA has implemented the current Road Closure System (in April 1999) with the prime objectives of creating a consistent road closure system throughout the State, protecting the unsealed road network from damage during and after rain events, and ensuring the safety of travellers in the Region.

A total of 35 signs were installed at 24 locations in the Far North areas of the State. The location of signs attempts to provide information on all public roads that led to all prominent destination points in the Far North areas. Signs cover roads with the classification of Primary Local and Secondary Local and Tourist roads.

The closing, opening or change in classification of roads is based on reports from road users, local residents and Transport SA personnel. Using this information, Transport SA uses its delegated powers to open or close roads. Currently, the information on road status is faxed through to volunteers throughout the road network. Once received, any changes to signs in their designated area are required to be changed within one hour of receiving the notice. This process is being reviewed to improve the efficiency of the system.

Other services provided by TSA are the Cooper Creek Ferry when the Birdsville Track is flooded (historically, about once in fifteen years on average), a road condition reporting service which relies on a network of people and businesses in the area, local police and TSA employees, assistance to stranded travellers, and assistance in maintaining town and station airstrips.

Station tracks are the responsibility of the lessees, and are not public roads. Intended usage of tracks within National Parks and Conservation Parks is determined by the NPWSA. Road and exploration tracks serving the oil and gas industry are not public roads, except in limited cases. Which roads can and cannot be used for public access is defined under the *Pastoral Land Management and Conservation Act 1989* as Public Access Routes.

SANTOS Ltd maintains an extensive road network for the transport of oil and gas production activities. The majority of these are not public access routes.

The improvement of roads over the last quarter-century, allowing the use of heavy vehicles for rapid stock transport, has significantly increased flexibility of pastoral and stock management.

Current TSA policy is to rehabilitate borrow pits and campsites, however there are some old ones in need of restoration. Also after rains, large quantities of silt are deposited in low-lying areas. During road maintenance, the current practice is often to dump this silt after removal, in piles, which can create an eyesore and alter localised drainage systems. Through consultation with lessees regarding the flows of creeks and drainage areas, this practice should be changed so that a natural rehabilitation process can take place.

Air services

There is a daily return jet service from Adelaide to Moomba, servicing the gas field workforce, but no other scheduled passenger services in the District. Augusta Airways, as part of flights for mail delivery, does carry package tour visitors and can carry passengers. The RFDS runs routine clinic visits to stations and distant towns as well as emergency flights. Authorised Landing Airstrips exist at Marree and Innamincka, and most pastoral stations.

Communications

Mail

There is a twice-weekly mail service to Marree and a daily service to Moomba. Stations local to Marree get their mail from Marree. Other stations on the Birdsville Track are served by a once-weekly aerial mail service. A twice-weekly road service operates from Leigh Creek post office to stations on the southern end of the Strzelecki Track. A weekly air service operating out of Leigh Creek delivers mail to Innamincka and there is a road service from Tibooburra to the Corner Country.

Telephone / Facsimile

Two Digital Radio Concentrator Systems (DRCS), allowing normal phone access via a dedicated radio and repeater network, now serve the District. That covering the Strzelecki to Innamincka was installed in 1988, and that covering Marree to Clifton Hills was installed in 1991. While these are actually radio services, they are accessed by phone in the normal manner and are transparent to users. A single DRCS can carry a maximum of 128 subscribers.

The availability of a "normal" phone service opens up the possibilities of DUCT (Diverse Use of Communications Technology), allowing telephone conferencing, Open Access Schooling, normal fax services and computing access (on-line services and the Internet).

The use of satellite phones is increasing in the district and the roll out of the broadband satellite based communication system is expected in 2002. This is predicted to enhance the communication systems within the region.

HF Radio.

HF transceivers are used for contact for personal communication with outlying staff and neighbours. Its importance has reduced significantly with the introduction of the DRCS. In some respects this is unfortunate, since a radio watch may not be kept as much as in the past and problems may arise as tourism increases. The Remote Areas Health Advisory Committee suggests that people travelling through or working in remote areas have HF transceivers fitted to their vehicles. While RFDS will continue to monitor for the foreseeable future, there may be fewer on stations with an "ear out" for the radio.

UHF Radio

UHF radios are used for on-station communication, and increasingly (with VHF) by visitors to the region.

Television

In the Marree township two television channels (SA ABC and Imparja) and FM radio are available via a community owned satellite dish and decoder system. Outside Marree, two television channels, (SA ABC and Imparja) and AM radio can be received via satellite and decoder.

Broadband Internet

The introduction of broadband Internet connection has made a huge difference to communication. It has lead to the use of “CENTRA” by School of the Air students and superseding the HF radio connection supplied through RFDS.

Medical Services

The Royal Flying Doctor Service (RFDS) base at Port Augusta and Broken Hill, and the Royal District Nursing Service provides medical services in the District. The RFDS services all of SA and the southern portion of the Northern Territory. A population of about 50,000 is serviced, in small mining towns, aboriginal communities, and sheep and cattle stations. The RFDS also provides the medical services for visitors and transients in the region.

Medical work covers the same spectrum found in outpatients and casualty departments of metropolitan hospitals. Routine consultations are held via radio three times a day Monday to Friday and daily on weekends and public holidays. Emergency consultation is available 24 hours a day, as is the RFDS aero medical evacuation service. RFDS planes will land on any strip the pilot considers safe.

The RFDS, as well as radio consultation, provides regular medical clinics to isolated communities, where the doctor and nurse fly to the communities. Various specialists may also be flown to communities for clinics. Also, RFDS medics with a fully operational medical centre and Medivac helicopter are permanently stationed at Moomba to service the industry workforce, but have often been called on to provide medical assistance to pastoral workers, tourists and others.

The RFDS day-to-day operational costs are funded by Commonwealth Government (45%), State Government (45%) and direct community fundraising (10%). Community fundraising, with the Commonwealth Government providing a dollar-for-dollar matching grant funds capital items, such as aircraft.

The Royal District Nursing Service (RDNS) has provided a nursing and health service in Marree since 1912. The local community donated the site for this facility in 1916.

Services currently offered by the RDNS include; ambulance services, provision of emergency medications, home visitation, non-medical consultations, child and youth health service, school children health checks, hearing and vision testing, health education information, first aid training, organisation of visiting health services and appointments and short term hospitalisation. The service is also a contact point for Government facilities and services such as Family and Community Services, Commonwealth Employment Service, and Social Security.

Education

The only formal school in the District is the Marree Aboriginal School. This has a school population made up of town children and also caters for itinerant students throughout the year. The school provides directly for years from CPC to Year 12. SACE studies (years 11 - 12) are assisted through the Open Access College. Children on stations in the District do the majority of their schooling, at least at primary level, through the School of the Air, and those close to Marree can use the facilities of the Marree Aboriginal School. Children also catch the bus from Lyndhurst to attend school in Leigh Creek, which has an area school.

Secondary and Tertiary education for children in remote areas is normally sought out of the District.

Water and Power

Marree Township runs a small community power station and water supply. There is major power and water supply infrastructure developed by Santos for Moomba, which also provides power to Gidgealpa Station. Water supply and power generation at all other pastoral stations, and at Innamincka, are run for their own uses by individual lessees and service providers.

Power generation is now generally diesel-powered 240V, with some stations having hydroelectric generation from the pressure head of the Great Artesian Basin. The NPWSA houses at Innamincka use solar/wind with diesel back up – a hybrid system. Records are being kept on usage and this could be considered as one example system for other users in the region to learn from and adapt their own system. This was achieved with assistance from the Green Abatement Subsidy Scheme.

GAS AND OILFIELD DEVELOPMENT

The infrastructure of Moomba and the gas fields has been developed for the extraction and transport of gas and hydrocarbon liquids. The detail of infrastructure and its development is heavily regulated by Acts already discussed in Part I of this District Plan, being largely outside the Board's responsibilities. Development must however conform to provisions of the *Soil Conservation and Land Care Act 1989.*

Areas of infrastructure development, which may affect land care, include:

- The tracks and lines required for continuing exploration seeking new oil and gas resources;
- The routes, development, construction and rehabilitation of pipelines to domestic and export outlets in South Australia and the eastern states;
- Loss of GAB pressures, or usage of GAB water generated as part of the gas extraction;
- Major access roading associated with the gas fields.

These developments may bring land management opportunities and land management problems. Santos has permanent environmental staff and a major environmental protection program to minimise problems arising. Under the *Petroleum Act 2000* there is a requirement to comply with the statement of Environmental Objectives. These apply to all operators working within the SA Cooper Basin.

TOURISM

The northern portion of the Soil Board District both contains some of the largest Reserves in the State and is increasingly a tourist destination. The bulk of tourism at present is based on private vehicles, usually 4WD, but with an increasing component of bus and safari-type commercial tours. Tourism is predicted to be a potential major growth industry within the District. There are strong seasonal fluctuations, pronounced through events such as the filling of Lake Eyre, assisted by stronger publicity of the regions tourism assets.

The level of tourist access into the District via small aircraft is not known but appears to be growing. The Adelaide - Moomba jet service is not normally open to tourists. There are numerous small aircraft flights daily in the District, but again how much of this could be considered tourist traffic is not known. Local charters are available from Marree in peak periods, and from Port Augusta associated with the weekly mail service.

Visitor Types

Small informal groups

The majority of tourists come into the District at present as small groups, usually family and friends and mainly travelling in 4WD vehicles. For many, the 4WD is used for its size and a feeling of security, rather than its all-terrain capabilities. The more adventurous cross the Simpson Desert, for which 4WD capabilities are necessary.

These small groups tend to camp along access tracks in a dispersed manner, with few people at any given site. Their destinations are usually recognised areas such as Coongie, Innamincka, Cooper Creek, Lake Eyre and Muloorina.

Problems arise where there is a specific focus encouraging concentrated camping. Taking the Simpson Desert "crossers" as an example, all are likely to stop at the springs at Dalhousie, and at Purni Bore and Poeppel Corner. The impact of an individual group is low, but the cumulative and concentrated impact may be more than the site is capable of taking without major degradation. As well as simple land degradation, the concentration of use above the carrying capacity reduces the value of the site as a tourist attraction. Sanitation problems arise, firewood resources disappear and the site looks less attractive.

‘Family and friends’ groups also tend to be heavier consumers per head of firewood than larger, organised groups, as campfires serve relatively few people.

Organised tour groups

Organised tour groups may be commercial or private. Commercial groups are dominated at the moment by coach travel, usually as camping tours. Although most coaches are limited to the better access roads, smaller 4WD or 6WD coaches are appearing. As well, 4WD convoy and ‘tag-along’ tours are becoming increasingly popular. These tours tend to be organised commercially and with commercial support vehicles, but with tour members using their own vehicles. 4WD club rallies and tours, though non-commercial, can be considered in this category.

This type of tourist activity has an extremely high impact on the relatively small areas used as overnight campsites, but on the other hand is often more amenable to direction and tends to show more concern for local good relations than is generally the case with small-group tourists.

Nature based tourism

Nature based tourism is defined as tourism with an environmental focus. This focus distinguishes it from the more general "see-the-sights" approach. The level of this sort of tourism at present is low, compared with general tourism, but can be expected to become a major growth industry in the District.

The focus is likely to be on the same areas, which are the present focus, the Simpson Desert, Lake Eyre margins, the Innamincka area and the Coongie Lakes, with a probable extension into more of the mound springs.

The basis of this type of tourism will of necessity remain similar to existing tourism patterns, because of the remote and difficult nature of the country, the limited infrastructure, and reliance on 4WD transport. Management problems and issues will remain the same despite the environmental focus. There will also be business opportunities: provision of services (bases in stockmen's quarters, camping sites) as an adjunct to pastoral management.

Camel safaris deserve a mention also, especially as operations of cameleers are changing from ad hoc, to direct operations. Camels, and horses for that matter, may be less damaging as a cross-country vehicle, but the safaris still represent an increase in tourism use of the area, and other problems will remain.

Backpackers (on foot, hitch-hiking or on bicycle) are likely to remain uncommon, given the nature of the District and the sheer distances involved. The low numbers will mean that impacts also are likely to be insignificant. Nevertheless even backpackers will contribute to tourist pressures on favoured areas, needing campsites and fuel.

Road Access

Main permitted access

The main access routes into the District are the roads maintained by TSA for general public purposes. The major entries are via the three ‘Tracks’; Oodnadatta Track, Birdsville Track, and Strzelecki Track, and the track from Cameron Corner to Innamincka connecting to the Strzelecki Track. There are also more minor roads southeast from Birdsville and west from Nappa Merrie (Q).

- The *Pastoral Land Management and Conservation Act 1989* to defined Public Access Routes, which are primarily the main roads, officially restrict access on pastoral leases. Permission from lessees is required for access on station tracks. Similarly, the “works” roads of the oil and gas fields are not open for public access, nor are the seismic lines and rig roads in the Simpson and Tirari Deserts.
- There is a current Pastoral Board initiative to resolve the Public Access Route issues.

There are also other tracks under lesser use, on seismic lines or old rig roads in the Simpson Desert and in the Innamincka area, as shown on the maps issued with the Desert Parks Pass. Unfortunately many public maps show roads and tracks, which are not open to public access, and this creates many environmental and other management problems.

Use of non-public access

It can be expected that any reasonable track, especially if shown on public road maps or on topographical maps, will be used to some extent by tourists. Use of such tracks can disrupt both station management and the oil and gas industry. Illicit usage can be expected to increase as tourism increases without some education measures, such as attempted with the Desert Parks Pass.

Whatever the formal restrictions might be, at least some people will still use tracks illegally. Increased usage on some tracks may force their acceptance as public thoroughfares, whether declared Public Access Routes or otherwise. This, in effect, has happened both in the Marree SCD and adjoining SCDs, for example the Borefield Road between Bopeechee and Roxby Downs, most of the now main routes through the Simpson Desert, and the initial Public Access Route at Warraweena. Three other examples of increasing use of specifically non-public roads are parties using the Dog Fence track, penetration into the Simpson Desert to the Kallakoopah using old rig roads, and the use of seismic survey lines. The Dog Fence Track is not open to public access and there is a current effort by the Dog Fence Board to actively promote this information.

As tourism increases and the main roads steadily improve, more can be expected to leave the existing public system in their search for remoteness.

Off-road driving

Off-road driving is restricted by both the *Pastoral Land Management and Conservation Act 1989* (pastoral leases) and the *National Parks and Wildlife Act 1972* (Parks and Reserves).

With the ready availability of GPS some people are navigating across country. This may create new tracks, damage vegetation, spread impacts of tourist activity from identified sacrifice areas and create problems associated with people not knowing where they are and getting stuck in inaccessible areas.

PROVIDING FOR VISITATION - DESERT PARKS PASS

A large proportion, if not the majority of present tourism within the District, has its focus on the Simpson Desert reserves or the Innamincka Regional Reserve. An element of both control and education of tourists comes from the requirement under the National Parks and Wildlife Act to hold a Desert Parks Pass.

The Desert Parks Pass is specific to a single vehicle. It provides an access permit system, a booklet and other interpretive information, and maps of the public road and track system. Maps cover off-park and on-park areas in the District, as well as adjoining areas in Queensland, Northern Territory and New South Wales.

The Desert Parks Pass is legally required under the *National Parks and Wildlife Act 1972* for travel through, and camping in all the National Parks, Conservation Parks and Regional Reserves throughout the Far North, including the Marree SCD except on public roads, eg. the Strzelecki Track. It does not give any rights to enter pastoral leases, oil and gas areas, Aboriginal land, or the Fossil Reserves in the southeast of the District. It has also been developed to:

- Promote safe and informed use of the outback with least impact.
- Enhance visitors' experiences when visiting the outback, by providing a highly valuable package of useful information, additional to the entrance and camping permission.
- Allow the collection of at least some Park visitation statistics, an almost impossible task otherwise.

For Innamincka, a Deserts Parks Pass is required for the Reserve but not for camping or staying in the township, on the town common or for travelling on TSA maintained public roads.

Revenue raised from the Desert Parks Passes is spent on management of Parks, and on developing visitor facility infrastructure. Desert Parks Passes are sold through 36 agents throughout Australia: site passes for specific areas, eg. Innamincka and Dalhousie are sold at outlets in Innamincka, Oodnadatta and Mount Dare.

The Desert Parks Pass package provides a way to get further information to prospective visitors. The package contains, as well as the basic booklet, maps and track information:

- A series of one page leaflets on individual Parks;
- A Department of Environment and Heritage leaflet on bush behaviour codes and sharing with other users;
- An advertising leaflet for a (private) bush first aid guide.

There is therefore potential for including District information, such as the Soil Board brochure.

VISITOR NUMBERS

There is no doubt that visitor numbers to the District are considerable, and will steadily increase. Actual statistics however are often vague. For example, Innamincka service providers indicate that some 40 - 45,000 people a year visit Innamincka, (NPWSA, pers com).

This figure does contrast to some extent with the one relatively reliable source of statistics, the Desert Parks Pass. For Innamincka, a Desert Parks Pass is not required for the whole Reserve, but nevertheless a lot of people are not purchasing Desert Parks Passes or site permits, which may well be the case, or the figure is an overestimate.

The uncertainty on numbers is no criticism of the estimators of visitor numbers. It is important to land management generally, and coping with tourism use in particular, to know just how large the challenge is. Overestimation can lead to deploying resources which rightly should be deployed elsewhere, while underestimation can result in land management problems overwhelming unprepared managers. There is no doubt at all that visitor numbers are high for what is still a very remote area and that these numbers will increase. If we take a conservative figure of 40,000 visitors passing through the whole District in a year, of which half or so are simply using the Oodnadatta, Birdsville and Strzelecki Tracks and not needing the Desert Parks Pass, this already puts an enormous load on infrastructure and land management in the District, several orders of magnitude above that imposed by residents only.

USAGE AND ACTIVITIES IN SPECIFIC AREAS

Visitor usage of specific areas is difficult to address, as the Desert Parks Pass is valid throughout the north.

There are individual areas, which have specific appeal and result in concentrations. Areas such as Killalpaninna have the continuing specific appeal of historical significance, and intermittent appeal when Lake Eyre floods. Poeppel Corner has the attraction of a remote but still accessible tri-State corner. Innamincka, Birdsville and Oodnadatta are well-known Australian icons and provide permanent attraction regardless of season. Their remoteness, history, and the bush race meetings provide quite unique recreational opportunities.

Water anywhere is a focus for visits and activities. This poses challenges, which concern the Soil Conservation Board, since natural waters are frequently found in landscapes, which are susceptible to damage from overuse, whether by stock or humans.

Mound springs are an extreme example within the District. There exist spring groups which, while not as spectacular as the Dalhousie springs, have much more to interest tourists than the other well-known and much visited Blanche Cup area, but are far less capable of withstanding more than very light tourist pressures. They are much more extensive than is normally realised: around the south-east margins of Lake Eyre South, on Finniss Creek, along the Oodnadatta Track, north of the Flinders Ranges, and in the Lake Callabonna - Lake Frome area. Soil erosion is inevitable around most of the springs if overused, as their surrounds and approaches are often highly erodible. Local soils are usually salty and very friable, and spring deposit terraces are easily broken.

Aboriginal heritage areas are a special case, outside the immediate responsibilities of the Soil Conservation Board but still requiring mention. These may need exclusion of visitors, protection or interpretation, depending on their nature and the cultural significance attached to them.

Activities will depend on which area is being visited, the reason for the visit, and the seasonal conditions. Taking Cooper Creek as an example, the reason for visiting is often simply to have "been there". The primary activity is simply relaxation in the relative solitude around waterholes with a little fishing, drinking and swimming. Lesser activities would be boating and canoeing coupled with photography, short drives out from base camp, and "going to town" (Innamincka) for a shower, refreshments and stores.

For the Simpson Desert, where camps are transient, main activities are the driving challenge, photography, flora and fauna watching, and the journey itself. The “outback conquest” of the Simpson in general, and Big Red dune in particular, may seem a bit humorous to those who live and work in the District, but it is a very important component of visitors’ experiences, and also a very potent form of advertising, contributing significantly to the increasing levels of visitation.

INTERPRETATION AND EDUCATION OF VISITORS

Interpretation is informing, explaining and educating visitors about the areas they are in or coming to. It has the potential to improve public awareness, behaviour and understanding, as well as increasing the quality of the visitors' stay or passage. The opportunities offered by the Desert Parks Pass have already been mentioned. Other aspects range from on-site or en-route signs, leaflet availability, and in heavily visited areas, interpretation centres.

There is currently a lack of signage throughout the vast Far North, and the Government historically has been slow to provide even basic road signs. Signage has been provided in the past by the Marree Progress Association and the Pink Roadhouse (Oodnadatta) fuel drum lid distance markers on the Oodnadatta track. Signage specific to areas of visitor concentration is still sorely lacking, apart from the signs and track markings associated with the Desert Parks Pass. The Northern Region Tourism Development Strategy has identified lack of signage as a major issue, and has recommended an increase.

Informative or interpretive sign bays associated with the normal “stopping points” (roadhouses and pubs) would assist in spreading both essential information and some interpretative information, particularly to those many travellers who are visiting the area but do not have a Desert Parks Pass. Such signs are planned for Marree, Copley, Oodnadatta, William Creek and Cameron Corner as part of the Desert Parks Pass developments, but signs relating to the whole Soil Conservation District are needed at Lyndhurst, to contact the majority of tourists entering the District.

Signs have greater impact if people stop and read them. Interpretative sign bays are not really enough; ample parking without risk of bogging, shade, water, rubbish disposal and toilet facilities are also needed.

The rebuilt Australian Inland Mission (AIM) building at Innamincka is used as an interpretation centre for the area, housing information and history displays as well as acting as the DEH office. Elsewhere, interpretation may well have to depend on signs and private input. Roadhouses at Birdsville, Cameron Corner, Innamincka, Marree and Mungeranie offer tourist and general information.

LAND SYSTEM DESCRIPTIONS

Landscapes, Land Systems and Land Units

We can classify land at a variety of levels. As outlined above, the District contains the very broad land "types", or landscapes, of the dunefield, gibber country and other hard country, the flooding country, the uplands and the giant salt lakes. This is a convenient thumbnail sketch for rapidly outlining an enormous area, but is far too broad for anything but setting the scene generally. One can subdivide into more detail, as with the Environmental Associations in Laut *et al.* (1977) which is still rather too broad, or reduce to intricate descriptions of small areas, which will swamp the user with an overload of information.

The District Plan is a strategic document, for general planning, and distinction must be made between strategy, the broad approach, and tactics, in this case local lease management. Descriptions here are of Land Systems, which allow a broad view without losing too much necessary information and without cluttering with too much detail. General lease management also is likely to use Land Systems for overall management (hence their use in rangeland assessment manuals). But detailed tactics to cope with pasture improvement, or rehabilitation, or managing the impact of stock or visitors, or monitoring condition, all need knowledge of the basic building blocks of the landscape, the *land unit*.

A *land unit* is a part of the land surface, which has consistent characteristics of landform, soil and to some extent vegetation. Areas of land classed as the same land unit will have properties in common, which are important for determining their condition and for their management. Stability and resilience levels will be the same. The soil will be of a particular basic type, with much the same erosion hazard, nutrient status and so on.

Response to rainfall, to fire and to other influences will also be similar. Vegetative cover will be generally similar, although recent rainfall; fire, grazing or rabbit history may bring differences in detail, hence the ability to track land condition through monitoring vegetation.

A *Land System* is an area or group of areas with a recurring *pattern* of differing landforms, soils and vegetation; a combination of land units. As well as each land unit having its own characteristics, the Land System may have additional characteristics brought about by having differing land units close to each other.

Dunefields with clay soil interdunes give a simple example. The dunes are one land unit. They are steep-sided and have a standard shape. They are sand, with frequent sand movement, poor water retention and usually are only lightly clothed with vegetation. Clay interdunes are a quite different land unit. They are flat (relatively). They have clay soils, which might also have a gibber cover, are likely to be highly stable but not very resilient, and have quite a different vegetation cover.

The dune land unit and the interdune unit will respond quite differently to the same influences. A track over a dune may cause much more initial disturbance than through an interdune, yet have more rapid regrowth. The interdune may have more drought-resisting vegetation cover than the dune, but the growth on the dune may be much more rapid after rain.

The Land System of sandy dune and clay interdune may favour the appearance of high rabbit populations, well above that which either might support by themselves.

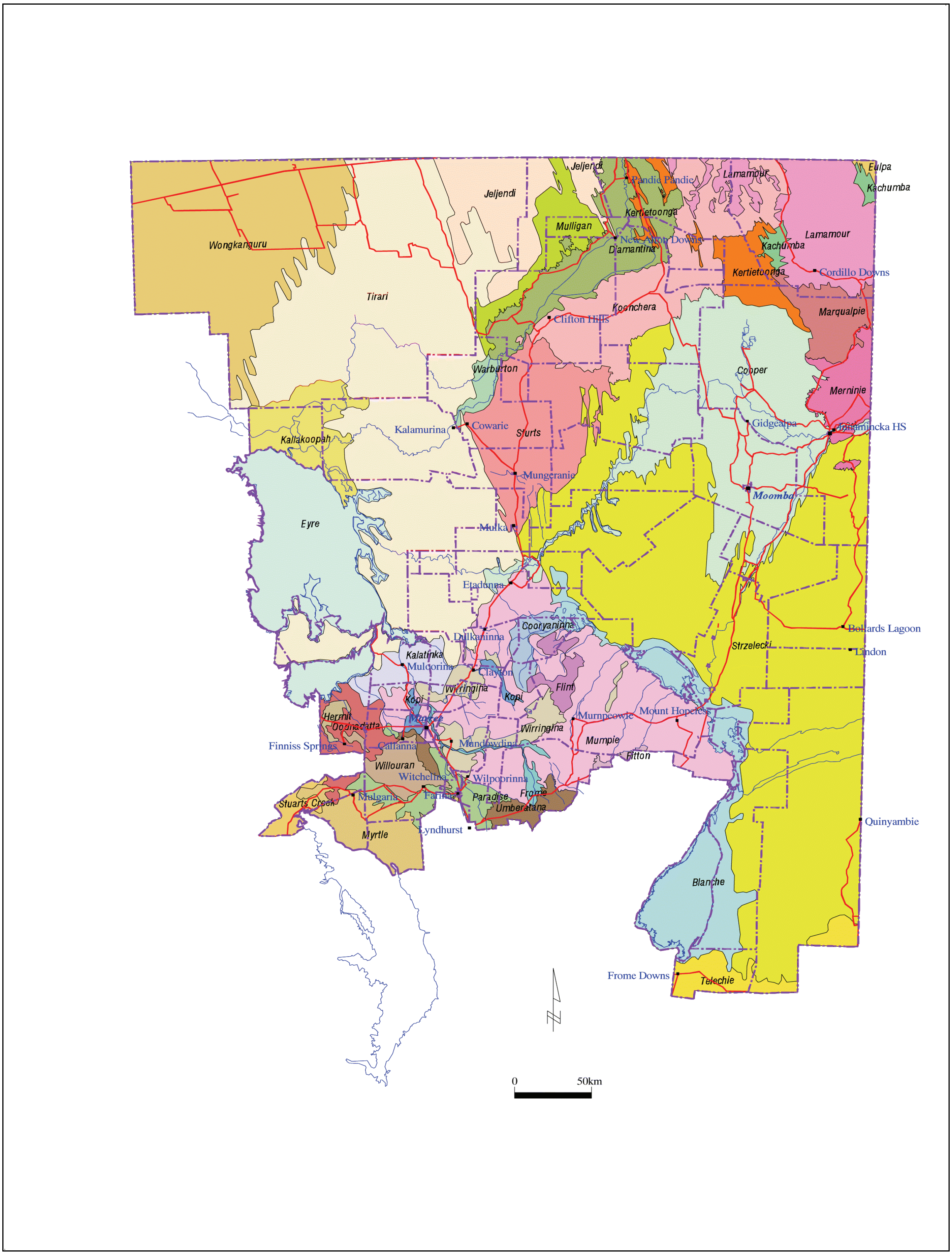


Figure 12 Land Systems in the Marree Soil Conservation District.

The land unit is the basic unit for following land condition. Grazing animals, whether domestic or feral, kangaroo or rabbit have particular preferences for particular land units, which often change with seasonal conditions. Visitors too have preferences. They are far more likely to be camped near a watercourse than in the middle of a gibber plain.

Tactics therefore depend on a knowledge of the nature and performance of a given land unit, and the effective managers will know their country well at this level. For the general strategy, however, Land Systems are simpler and more efficient to work with.

Land Systems in the Marree Soil Conservation District

Thirty-five Land Systems are defined at present for the Marree SCD (Figure 15). Land Systems are divided into broad groupings based on the dominant landforms within each system. These were put together by the board members over a 3 year period, including delineating boundaries and checking these through consultation and travelling around the district. Some assistance was provided by Rick Barratt in ground truthing and Jenny Bourne for facilitating the process.

Sand dunes and sand plains comprise those Land Systems with dunefields as their most common feature. *Watercourses and outwash plains* are dominated by lands, which flood at least occasionally. *Lake country* contains mainly the beds of major salt lakes and their immediate surrounds. *Uplands* contain the relatively limited hilly Land Systems. *Gibber plains, tableland and mesas* are dominated by gibber-paved lands of usually low relief.

Almost all the Land Systems are large to very large (Table 11). Their size alone implies a great deal of variability within individual systems, and some have not been thoroughly documented to date. The descriptions which follow, and the boundaries shown in Figure 15, can be expected to alter in subsequent District Plans as information increases or errors are found. The mapping and descriptions are intended as a first-order description, not as a “last word”.

TABLE 9 - LAND SYSTEMS IN THE MARREE SOIL CONSERVATION DISTRICT

	Land Systems	***Area, km^2***
DUNE SYSTEMS: SANDRIDGES, DUNES AND SAND PLAINS	EULPA	121
	JELJENDI	5,193
	KALLAKOOPAH	3,372
	KERTIETOONGA	2,563
	MARQUALPIE	3,302
	MYRTLE	2,566
	STRZELECKI	43,161
	STUARTS CREEK	679
	TELECHIE	1,949
	TIRARI	34,141
	WIRRINGINA	2,229
	WONGKANGURU	14,769
WATERCOURSES AND OUTWASH PLAINS	COOPER	16,724
	COORYANINNA	924
	DIAMANTINA	5,632
	FROME	471
	KACHUMBA	545
	MULLIGAN	2,510
	PARADISE	1,784
	WARBURTON	623
LAKE COUNTRY	BLANCHE	7,842
	EYRE	10,469
UPLANDS	FITTON	127
	UMBERATANA	1,155
	WILLOURAN	1,367
GIBBER PLAINS, TABLELANDS AND MESAS	FLINT	832
	HERMIT	243
	KALATINKA	1,666
	KOONCHERA	8,240
	KOPI	369
	LAMAMOUR	6,202
	MERNINIE	2,109
	MUMPIE	13,503
	OODNADATTA	1,620
	STURTS	7,072

DUNE SYSTEMS: SANDRIDGES, DUNES AND SAND PLAINS

Eulpa

Dunefield in the northeast corner of the District. Dunes with sandhill canegrass and scattered sandhill wattle; clayey interdune flats with copperburrs, neverfail and annual grasses. This very small system has not been completely described to date.

Jeljendi

Very long, high and widely spaced longitudinal sandridges with a north-north west trend, overlying the ancient (non-active) floodplain of Eyre Creek (Fatchen and Barker 1979a, b; Graetz *et al.* 1982; Purdie 1984). Although the floodplain is classed as non-active waters of Eyre Creek and not believed to reach it, nevertheless some areas may flood following high local rainfall and local runoff. "Local" in this case may be extensive, as local catchments in a broad and long interdune may be in the tens of square kilometres.

Dunes are red siliceous sands, deep, with mobile crests. Vegetation is perennial hummock grassland of sandhill canegrass on crests and upper slopes, with lobed spinifex appearing on lower slopes. Present also on slopes are scattered sandhill wattle, waxy wattle, sandplain wattle, and horse mulga (Purdie 1984).

The ancient floodplain is at least partially exposed between most dunes. Floodplain sediments are brown clays, but the detail of soil and vegetation cover depends on how much is exposed and the depth of overlying sand or other soil deposits. More common varieties are:

- Continuous sand cover over the floodplain clays carrying low open woodland of scattered acacia with either an ephemeral grass understorey or with sparse lobed spinifex;
- Limited sand cover resulting in a surface soil of reddish sandy clay supporting a low open woodland or low shrubland with deadfinish, prickly wattle, needlewood, bloodwood and sennas over ephemeral grasses;
- No sand cover and the alluvial floodplain soils exposed: grey or brown self-mulching cracking clays with vegetation cover depending on the frequency, duration and depth of flooding. Wetter areas carry open shrubland of old man saltbush, lignum and Queensland bluebush, with sparse coolibah. Drier areas carry a sparser shrubland of old man saltbush, lignum or cottonbush, without trees. Some plains may only support ephemeral plants when the seasonal conditions are appropriate;
- Claypan and salina surfaces with saline or gypseous soils, bare of plants where the surface is scalded or supports samphires and bindyis.

Kallakoopah

The lower reaches and saline floodplains of the Macumba, Warburton and Kallakoopah Rivers, and associated dunefields, on the northern margin of Lake Eyre North. It consists of low, irregular shaped dunes of whitish sand, salinas and claypans. The dunes of this system are derived from sand and clay sources in Lake Eyre, the rivers and salinas, and often have consolidated bases, which show evidence of active erosion (Purdie 1984).

The flood plains have grey self-mulching cracking clay soils. Vegetation depends on soil salinity. Less saline soils carry a variety of low chenopod shrublands with grasses. More saline areas have a cover of ephemeral forbs, with growth only when flood or heavy rainfall reduces the surface soil salinity temporarily. (Graetz *et al.* 1982).

Channels, swamps and lagoons have soils ranging from grey siliceous loams to the heavy clays of the floodplains. Again, vegetation cover is dependent on salinity. Tall open chenopod shrubland dominated by old man saltbush occurs along channels where the soil and water are least saline. White Teatree swamps are present in more saline areas, and highly saline areas have a samphire cover (Graetz *et al.* 1982).

Dunes are irregular, mobile or semi-mobile on crests, and are deep, yellow-white loose siliceous sands. Crests support hummock grassland of sandhill canegrass, with lobed spinifex on the flanks. Isolated sandhill wattle and senna occur with increasing frequency towards the northern end of the Land System. Interdune flats are yellow firm siliceous sands, carrying largely ephemeral open grassland with bindyis. Isolated mulga and needlewood also occur. Lunettes (windblown sand and clay mounds on the leeward side of lakes and occasionally river channels) are mainly whitish siliceous sands. They tend to be saline on the immediate fringes of lakes, with a low shrubland cover of samphires giving way to a sparse open hummock grassland of sandhill canegrass and nitrebush as salinity reduces away from the source (Graetz *et al.* 1982).

Kertietoonga

Dunefields, swamps and lakes, overlying the outer floodplains of the Cooper and Diamantina systems, in the northeast of the District.

Dunes are red siliceous sands, with semi-mobile crests in places. Perennial cover is sandhill canegrass and lobed spinifex hummock grassland with scattered sandhill wattle and narrow-leaved hopbush: tall kerosene grass and herbs appear with rain.

Interdunes vary from sands to sandy clays or red sandy clay loams. The sands carry lobed spinifex and tall shrubs as for dune flanks. Clayey flats have perennial shrubland of starbush and blackbush with neverfail.

Internal drainage within interdunes may have sandy clays, with swamp canegrass, or grey cracking clays with lignum and canegrass. Lakes are ephemeral: lakebeds when dry carry copperburrs on silty massive clay. Lakes are bordered by grey clay or clay loam soils with coolibah over a samphire or lignum shrubland.

Marqualpie

A system of low crescent-shaped and irregular dunes with numerous small claypans and lakes in swales (interdunes), sandplain and local drainage lines. Dunefields are associated with the intermittent streams of Montkecleary and Nilpie Creeks draining stony tableland to the north, and not with the Cooper Creek system.

Dunes are red siliceous sands and generally lack the mobile crests of the longitudinal dunes found in other regional dunefields. A major component of the vegetation is lobed spinifex, forming a hummock grassland below a tall open shrubland cover of sandhill wattle, prickly wattle, whitewood, needlewood, colane and hopbush. Sandhill spider-flower and honeysuckle spider-flower appear to the north. Mid- to low shrubs include thorny saltbush, Y cassia, the fuschia-bush *Eremophila obovata* var. *obovata,* and the short-lived loose-flowered rattlepod and regal birdflower. Major groundcover plants are ephemeral or short-lived perennials: kerosene grass, mulga grass, neverfail, grey copperburr, fleshy groundsel and sidas.

Sandhill canegrass is present but its frequency is low, occurring where there is relatively low mobility of the sands.

Interdunes are highly variable. Grey cracking clays are common, with calcareous clay-loams being more common in the east, but the vegetation on them is determined by the frequency of inundation. Those receiving the most water, either from large catchments internal to the dunefield or from tableland creeks, carry low open woodlands of coolibah with a sparse middle layer of the tall shrubs eurah and spotted emubush, and an often relatively dense layer of lignum and Queensland bluebush. Major groundcover species, present in quantity after flooding, are ruby saltbush, neverfail, oatgrass, Mitchell grass, goathead burr, annual saltbush, fleshy groundsel, wild parsnip and buckbush.

Areas enclosed by crescent or circular dunes receive local runoff only, and carry shrubland of lignum, Queensland bluebush or swamp canegrass, or a mixture. Groundcover, which may be absent after a long period without run-on, include bogan flea, grey germander, mulga grass, goathead burr, oatgrass and neverfail. Odd individuals of sandhill wattle or sennas occur on these swale edges.

Claypans are massive grey or brown sandy clays, sealing when wet, and largely devoid of vegetation. Sparse cover of short-lived species may appear after inundation: goathead burr, grey copperburr and Bogan flea.

Drainage lines comprise the channels and waterholes of the Montkecleary Creek and its tributaries. Soils are sandy. Creeks with more frequent inundation support open woodland of river red gum, coolibah, whitewood and bloodwood, over open tall shrubs of spotted emubush, Y cassia, prickly wattle and needlewood. The expansive clay-loam swales often carry more bloodwood. Common groundcover species are neverfail, mulga grass, grey copperburr and forbs and herbs following inundation (or rain). Creeks with less frequent inundation lack river red gum but may have bloodwood and river cooba. Taller shrubs include sandhill wattle, Y cassia, woody cassia and dense cassia. There may be sparse swamp canegrass and Queensland bluebush present with perennial and short-lived perennial grasses, neverfail, native millet, oatgrass and mulga grass. Other groundcover includes grey germander, southern sea-heath, goathead burr, grey copperburr and bottle-tree spurge.

Myrtle

Closely spaced and low dunes overlying plains on the eastern margins of Lake Torrens, with minor drainage and floodplain.

Dunes are low closely spaced sandridges, with groups of dunes alternating with plain areas. Dunes are reddish siliceous sands, with clayey sand cores and footslopes. Although there is always at least some surface sand movement, dunes are not mobile in the sense of those of the Tirari or Strzelecki Land Systems. Vegetation on dunes is low woodland of mulga and horse mulga, less commonly with northern cypress pine, or tall shrubland of narrow-leafed hopbush and blunt-leaf cassia. Where dunes are most closely spaced, the swales are clayey sand or red sandy clay loams with scattered mulga over annual species such as oatgrass and bindyis.

Plain areas and wider interdunes are red or red-brown calcareous earths, with probably some areas of duplex gibber soils. They support a perennial low open shrubland of low bluebush and bladder saltbush. Blackoak groves are present in some areas with brown loam soils.

Minor floodplain areas crossing the dunefield and plain have small areas of duplex soils, without gibber. Very shallow red-brown loams overlie red clays, with an original cover over black bluebush or nitrebush. These areas are prone to scalding. (Playfair pers.comm; Fatchen pers.comm.; Laut *et al.* 1977).

Strzelecki

Note that the following descriptions for Strzelecki and Stuarts Creek Landsystems have been reviewed by Mr Frank Badman, as part of the Marree District Plan review. The boundaries will stay the same but the descriptions and land units within the systems have changed due to the use of a different methodology.

The dune fields of the Strzelecki Desert and its outliers, extending from the south-eastern margins of the Marree SCD north to Innamincka with a tongue extending to Sturt's Stony Desert. Long parallel sandridges with semi-mobile crests, sandy and clayey interdunes and numerous claypans and internal soakages.

Dunes are red siliceous sands, deep, with semi-mobile crests and relatively stable slopes. Lower slopes and narrower interdunes are clayey sands to red sandy clay loams. Dune upper and mid-slopes support a low woodland or tall shrubland of whitewood, narrow-leaf hopbush, needlewood and sandhill wattle in the north, with whitewood becoming infrequent in the south. There is a mid-storey of lobed spinifex and thorny saltbush, or sandhill canegrass where crests are semi-mobile, and a groundcover of ephemerals and short-lived perennials particularly kerosene and mulga grasses, buckbush and grey copperburr.

Narrower (<300 m) interdunes are characteristically massive (non-cracking) red sandy clay loam, usually with a shallow veneer of loamy sand to a maximum of 20 cm depth. Tree cover diminishes on lower dune slopes and in narrower interdunes but species composition remains similar.

Wider interdunes, up to 1 km between crests, have red self-mulching cracking clay soils with frequent areas of claypan and non-cracking massive red earths. Apart from occasional groves of very low senna or needlewood, wide interdunes are treeless. Cover is perennial grass and short-lived perennial copperburrs and similar; curly Mitchell grass, neverfail, mulka, copperburrs and poverty bushes.

Claypan swamps may be present in any interdune but are largest and most frequent in the wider interdunes. Although their soils and vegetation resemble those of Cooper and Strzelecki Creek floodplains, drainage is internal to the particular interdune and has no connection to flood flows. Margins of swamps have massive red earths with little vegetation, with brown or grey cracking self-mulching clays in lower parts of the swamp. The grey clays, at the terminus of drainage, support shrubland of lignum, Queensland bluebush and swamp canegrass, either mixed or in single-species stands, with perennial grasses neverfail and mulka. Following water run-on, ephemeral growth includes tall copperburr, common joyweed, Bogan flea and pop saltbush.

Claypan swamps diminish in size and importance to the south. While claypans remain frequent, the development of the productive grey cracking clays of swamp centres is limited. Also, the Queensland bluebush component of swamp vegetation disappears, with swamp canegrass becoming more important.

Low limestone or kopi rises are present in some interdunes as a minor component. Surface soils remain sandy loams, becoming calcareous at depth. Trees are absent, and the main cover is low shrubland of low bluebush or cottonbush, with grey copperburr, buckbush, pale poverty bush, goathead burr, neverfail and annual grasses. Bladder saltbush appears to the south.

Stuarts Creek

Wide-spaced parallel sandridges with broad clayey and sandy interdunes, superimposed on stony tableland with low downs and jump-ups, and sandplain.

Stony tableland and dunes alternate over much of this Land System. Tableland surfaces are most exposed where dunes are very widely spaced (1-3 km). Sand and clay deposits overlie the tableland where dunes are more closely spaced.

Tableland soils show the common alternation between gibber shelves, (friable shallow loams over clays and dense gibber cover, with poor water penetration and high salinity), and small gilgais with cracking self-mulching clays, little stone, good water penetration and holding, lower salinity but gypseous at depth. Plant cover is low open shrubland of low bluebush, bladder saltbush and samphire.

Where tableland surfaces have a sandy veneer, soils become sandy clay loam, with or without gibber, gilgais are not present, the cover of low bluebush and bladder saltbush increases, and samphire becomes infrequent. Claypan areas within these sandier plains may be massive sandy clays which seal when wet, or cracking clays. The latter carry lignum and swamp canegrass, often dense in larger claypan areas draining surrounding plain and down.

Dunes are yellow-red sands, with some surface mobility but rarely with mobile crests. There is sparse low tree cover of mulga and horse mulga, or a tall open shrubland of sandhill wattle and some hopbush and needlebush, over a grass or herb groundcover of tall kerosene grass and ephemeral herbs. The latter are abundant after major winter rains. Sandhill canegrass may be present in areas of higher sand mobility.

Narrower interdunes are sandy clay loams or sandy clays, usually with a chenopod shrubland of low bluebush and bladder saltbush: bottlewashers may become abundant after summer rains and persist.

Small claypans within the narrower interdunes, with local catchment only, may be massive sandy clays which seal when wet, or cracking clays. Neverfail and swamp canegrass appear on the latter. Sandy dune aprons beside interdune claypans are sometimes fringed by white teatree.

Telechie

Internally draining calcareous plains with scattered low dunes in the extreme southeast of the District.

Soils of the plains are calcareous red earths (sandy clay loams) with sandy surfaces. The main vegetation cover is low open shrubland of low bluebush with or without bladder saltbush. Scattered narrow-leaf hopbush, turpentine and sennas are present in sandier patches or run-on areas, and mulga groves are occasionally present. There is an ephemeral grass cover, particularly bottlewasher and kerosene grasses.

The low dunes are red siliceous clayey sands to sands, with sandhill wattle and some mulga over bottlewashers and kerosene grasses. Blackoak groves are present on brown calcareous loams and along some dunes.

Tirari

Very long parallel sandridges, swales, interdune flats and small to large salinas and playa lakes of the Tirari Desert, the southern and central Simpson Desert, crossed by the narrow floodplains of the Kallakoopah, Warburton and Cooper Creeks. This Land System extends from east of Lake Eyre northwards to the Northern Territory border. It is very similar to the Wattiwarriganna Land System of the Marla-Oodnadatta SCD.

The Land System is dominated by the longitudinal sandridges of the Tirari Desert and the central Simpson Desert. These trend northerly in the southern part of the Land System, veering to north-northwest in the north. Dune spacing is also variable, from 150 m in the south to 1+km in the north. Dunes are large, 10-15m high increasing to 20m in the north. Dunes are pale reddish or brownish quartz sands with carbonate nodules at depth, and some clay in their lower profiles, resulting in lower clayey flanks, which appear to be "hard" sand. Crests are generally mobile or semi-mobile.

Dunefields close to Lake Eyre and between the Warburton and Kallakoopah are denser than elsewhere, and include areas of confused dunes.

The main vegetation cover is very open hummock grassland of sandhill canegrass. Sparse sandhill wattle may be present, and needlebush becomes frequent north of the Warburton. Major ephemerals appearing briefly after rain include kerosene grasses, button grass, buckbush, and desert caltrop and poached-egg daisy. Rabbit populations can be high and the ephemeral cover does not persist.

Narrow interdunes also have sand or clayey sand soils, with similar very sparse vegetation. Where interdunes are wider, soils become sandy loams or sandy clay loams. In the southern half, there is usually a perennial low open shrubland of starbush, a relatively short-lived species, with pockets of nitrebush, low bluebush or bladder saltbush. Bladder saltbush is more frequent in open interdunes in the northern half. Salt and short-winged copperburrs and neverfail are present as short-lived perennials. Common ephemeral species, appearing after rain, include buckbush, spinach, plate grass, common bottlewashers and kerosene grass.

Run-on flats with sandy clay soils are found in longer interdunes. Vegetation is swamp canegrass or old man saltbush shrubland with nitrebush. On the edge of the Land System, and about the major streams, are occasional sandy channels along dune bases with coolibah, sandalwood, sandhill wattle, sandhill canegrass, nitre goosefoot and bladder saltbush.

Stony duplex soils, of brown calcareous loams over calcareous sandy clay, are present in wider interdunes. These support a perennial low open shrubland of low bluebush with cottonbush, and occasionally bladder saltbush. Groves of spotted emubushes and isolated sandhill wattle are frequent north of Warburton Creek, but decrease to the south. Some at least of these soils are gypseous; kopi outcrops appear in places, with a shrubland of sandhill wattle, prickly wattle and desert cassia.

Large playa lakes and some salinas are present throughout, but more frequent north of the Warburton. Soils of the playa surfaces are puffing clays with salt deposits, or thin crusts on the salinas, and unvegetated. Shores are also puffing clays, and are often highly gypseous and / or saline. The blow-off of salt and gypseous material as well as other soil material may extend to over a kilometre northwards. The immediate fringing vegetation is perennial shrubland of samphire.

As the ground rises, additional salinity tolerant perennial species appear in the shrubland, particularly nitrebush and several species of sea-heath. With increasing distance from the lakeshore, and increasing height, this shrubland merges into the sandhill canegrass grassland of sandridges or into the starbush, low bluebush or bladder saltbush shrubland of interdunes.

The floodplains of the Warburton, Kallakoopah and lower Cooper Creeks crossing this Land System are narrow, of the order 2 - 4 km. Floodplains are grey cracking clays nearer the channel, grading to massive sandy clays on the fringes of the surrounding dunefields. There are several points at which the Warburton and Kallakoopah feed nearby playa lakes, but generally the floodouts and extended floodplains found upstream in both the Cooper and Warburton Creeks are missing. Channels and adjacent floodplains have a woodland cover of coolibah, with Broughton willow and river cooba. There is an often-dense middle layer of lignum. Sandy channel margins, particularly about semi-permanent waterholes, have spiny flat-sedge. Although semi-permanent waterholes exist in the Warburton, there is no river red gum. Further from the channels, the coolibah woodland and its lignum understorey thins, with coolibah and prickly wattle remaining as scattered tall shrubs, and the groundcover becoming sparse lignum with a largely ephemeral cover and copperburrs.

Dulkannina Lease Assessment Manual (1986); Purdie, 1984.

Wirringina

Dunefield and sand sheets accumulated against stony hills and rises, salinas and associated lunettes, and some mound springs in the south of the District.

Sandy plains and low dunes are the most extensive unit. Dunes and plains are red siliceous sands. The basic cover is a mixture of sandhill canegrass grassland on dune upper slopes and tall open shrubland on flanks and sand sheets containing needlewood, sandhill wattle, narrow-leaved hopbush and mulga with some Oswald's wattle and deadfinish. Starbush or cottonbush form low open shrubland at the junction of sand and clay or tableland soils.

Stony rises with accumulations of wind blown sand form another unit. The dominant species occurring are blunt-leaf cassia, desert cassia, sandhill wattle, needlewood, sandhill canegrass, shrubby twinleaf, common bottlewasher, grey copperburr and deadfinish.

Salt lake margins and sandy saline flats have saline puffing clay soils, with a sparse low open shrubland of samphire(i), tangled poverty bush, flat-topped saltbush and waterweed.

Kopi lunettes form low rises on the margins of some lakes. Soils are gypseous, white sandy clays. There is a low shrubland cover of bladder saltbush, black bluebush, and slender glasswort, with Tate’s bindyi.

The rare large drainage lines within this Land System have varied soils and cover. Where soils are brown or grey sandy clays, vegetation is shrubland with some or all of; old man saltbush, Oodnadatta saltbush, native myrtle, neverfail, panic, Queensland bluebush, samphire(i) and scattered cottonbush. Cottonbush and Oodnadatta saltbush are present in drainage over hill or tableland surfaces. Rarely, drainage may have some tree cover of river cooba and coolibah.

Mound springs in this Land System may be set within small areas of spring travertine, and in this case do not have any specifically associated vegetation. Areas of local concentrated discharge or former discharge have bright orange clay soils, with a dense shrubland of old man saltbush, ruby saltbush and native myrtle.

Wongkanguru

Extensive regular, linear sandridges of the central Simpson Desert, with sandy interdunes and an absence of playa lakes. Dune density is high and areas of disorganised dunes occur in the central area (Graetz *et al.* 1982, Purdie 1984).

Sandridges are soft, red siliceous sands with mobile crests and stable slopes. The mobile crests have a sparse cover of sandhill canegrass: lobed spinifex dominates dune flanks, with patches of sandhill wattle.

Interdunes are firm red siliceous sands, which merge into dune backslopes and footslopes. Hummock grassland of lobed spinifex dominates where the sand is >50 cm deep, with scattered sandhill wattle, sandplain wattle and narrow-leaved hopbush. Wider-spaced dunes expose reddish sandy clays or clays in the interdunes. Vegetation on these clays is either a very sparse grassland (kerosene grasses) with scattered prickly wattle, Oswald's wattle, sennas and long-leaved eremophila; or infrequently a low open shrubland of bladder saltbush or low bluebush (Graetz *et al.* 1982, Purdie 1984).

WATERCOURSES AND OUTWASH PLAINS

Cooper

The waterholes, channels, floodplains, ephemeral lakes of the Cooper and Strzelecki Creeks, and the field of parallel sandridges with interdune areas connected to and periodically flooded by them. There are multiple floodplain and lake land units, which can be differentiated on the basis of frequency and intensity of flooding.

Dunes vary from red siliceous sands to whitish siliceous sands, and vegetation differs. Red dunes are older, and may have a clayey core. The larger are equivalent to the dunes of the Strzelecki Land System, supporting a low woodland or tall shrubland of whitewood, narrow-leaf hopbush, needlewood and sandhill wattle over kerosene and mulga grasses, buckbush and grey copperburr. The majority of red dunes in this Land System on Innamincka, however, are semi-mobile, with crests and upper slopes carrying sandhill canegrass and ephemeral species. Lobed spinifex may be present.

Pale dunes are recent deposition from the floodplains, and are more mobile. Perennial cover may be sandhill wattle, eurah and occasionally coolibah, with a hummock grassland cover of lobed spinifex, and ephemeral species.

Major waterholes are on the main and northwest channels of the Cooper. They are post-flooding freshwater pockets with salinity varying both in relation to time since flooding and salt input from saline alluvium or local springs. Soils are pale grey sandy to silty clays. Waterholes are effectively permanent, other than in extended drought (as preceding 1945) and tall woodland is supported; river red gum and coolibah, with eurah, bean tree, Broughton willow wattle whitewood and native orange. There is usually an understorey of lignum, with groundcover of short-lived perennials or annuals; cannonball, tangled poverty bush, ruby saltbush and annual saltbushes.

The braided channels and temporary waterholes on both the Cooper and the Strzelecki have similar soils and vegetation. The overstorey is primarily coolibah with occasional river red gum and cooba. Lignum stands are dense, growing on pale grey self-mulching cracking clays. This is also the vegetation of the named "swamps" of the Land System, eg. Tirrawarra swamp.

There are extended flats behind the braided channels, extending to adjoining pale dunes. Flats are typically pale sandy clays with a veneer of pale grey sands. The sandy clay layer is hard setting at a depth of about 25 cm forming a hardpan, preventing deeper water penetration. There are also areas of grey self-mulching cracking clay soils with "crabholes" and deeper water penetration. Coolibah, with whitewood and spotted emubush on sandier patches, forms a woodland to open woodland. There is a shrub layer of old man saltbush, Queensland bluebush and lignum, the first and sometimes the second also absent in areas hard-hit by 19th and early-20th century stocking. Subshrubs include red and other copperburrs and poverty bushes. Annuals include buckbush and onionweed.

Gilgai flats, at a higher level than the preceding and generally beyond the low pale dunes bordering the coolibah woodlands, are flooded less frequently and hence lack the tree cover. Soils again are pale grey self-mulching cracking clays, with gilgai formation, and cover is variable. Chenopod shrubland of Queensland bluebush dominates, but variations depend on frequency of flooding. Swamp canegrass or lignum may appear as single species stands or, mixed with each other and the Queensland bluebush.

Large clay interdune corridors also have the same soils and species, with additional copperburrs in the groundcover.

Responses to rain in all of the proceeding, but particularly in clay swales, may be prolific, with buttongrass, New Zealand spinach, buckbush and pigweed common.

Sandplains are present slightly above the level of the coolibah flats. Soils are sandy loams, with a hard setting layer at about 20 cm. They carry a low open woodland including whitewood, prickly wattle, sandhill wattle, some coolibah, needlewood and beefwood over a mixed grass and subshrub groundcover: mulga grass, oatgrass, katoora, mulka with buckbush, goathead burr, tangled leschenaultia and copperburrs.

The Land System includes the intermittent lakes of the Coongie Lakes system. Some of these lakes receive a regular flow of water from the northwest branch of the Cooper in average flow years, but can dry out almost entirely in extended drought periods. River red gum, which halts at Coongie Lake on the northwest branch but extends further on the main channel, is a reliable indicator of relatively frequent flows. Lakes to the north have coolibah as the dominant tree. Soils again are grey clays, with sediment deposited on lake floors. Surrounds are effectively equivalent to the various floodplain units (above). Lake floors when drying out may contain spiny sedge, but other vegetation is ephemeral although when present may be in large quantities. Species include nardoo, New Zealand spinach, Bogan flea and Cooper clover. Water bodies when present contain mats of duckweed and water primrose.

Innamincka Station Rangeland Assessment Manual, 1986.

Cooryaninna

Creek channels, floodplains, outwash and run-on flats and the surrounding undulating plains of Cooryaninna Creek. Undulating gilgai plains form the most extensive unit.

The plains and downs have a sparse gibber cover, with stone-free gilgais. Soils away from gilgais are red duplex soils (friable loam over clay) with high salinity. Gilgais are self-mulching cracking clays, with lower salinity. Vegetation cover is greatest in gilgais: the vegetation is dominated by salt copperburr, scattered bladder saltbush, satiny bluebush, and Mitchell grass.

Floodplains are brown self-mulching cracking clays. Queensland bluebush occurs in dense patches, and cottonbush and Mitchell grass dominated flats also occur. Other common species include neverfail, samphire(m), Mitchell grass, pop saltbush, bristly sea-heath, jointed poverty-bush, pale poverty-bush, goathead burr, cannonball, tall copperburr, common nardoo, button grass, rat’s tail couch, windmill grass, small Flinders grass, native millet and flat-topped saltbush.

The outwash flats have a denser cover dominated by chenopod low shrubs: bladder saltbush, thorny saltbush, black bluebush, with pop saltbush, Mitchell grass, buttongrass, common bottlewasher, and copperburrs.

Larger creeks are sandy, carrying an open woodland of coolibah, plumbush, river cooba, prickly wattle, lignum, swamp canegrass, samphire and annual forbs. Minor drainage lines have similar species but less tree cover and a greater cover of forbs.

Dulkaninna Station Rangeland Assessment Manual, 1986.

Diamantina and Warburton

The floodplain and channels of the Diamantina River, the channelled swampland and floodout of Goyder's Lagoon, and the floodplain and channels of Warburton Creek.

These two Land Systems are lumped together in this description because of their basic similarities of soil and vegetation. The primary difference lies in the frequency and extent of flooding. The Diamantina floods and reaches the Goyder's Lagoon and Warburton headwaters much more frequently than the Warburton below Goyder's Lagoon. This has major implications for land management, but in terms of a thumbnail sketch of the Land Systems, only minor differences other than the extent of flooding country and the density of vegetation on it. Similar soils and plant species are present in each.

Floodplains have grey self-mulching cracking clay soils with gilgai development. Vegetation is woodland or open woodland of coolibah (Warburton) or river red gum, coolibah, and bean tree (Diamantina) on or near channels, with a mid-storey shrubland of lignum and old man saltbush, and Queensland bluebush (Diamantina). Trees reduce away from channels, with the shrubs remaining relatively dense on grey clays. Although the floodplains are extensive, the spread of the Diamantina-Warburton floodwaters is much more limited than those of the Cooper, and there is not the interweaving of dune and floodplain found in the Cooper Land System.

Channels and terraces (levees) within the Goyder’s Lagoon area and elsewhere are red firm siliceous sands. Channels, depending on the degree and frequency of flooding, may have a cover of rat's tail couch, or a mixture of Queensland bluebush and ephemeral herbs and forbs. Terraces or levees have sparse woodland of coolibah, with or without bean tree in the Diamantina Land System, with elegant wattle, kerosene grasses and ephemeral herbs.

Small dunes are present within the floodplain: these may be pale or red siliceous sands, semi-mobile or in some cases mobile, with hummock grassland of sandhill canegrass and lobed spinifex or ephemeral grassland of very sparse kerosene and mulga grasses.

Frome

Channels and floodplains of the River Frome floodout.

Channels are shallow, with intermittent flows, and sandy or alluvial soils. Vegetation along channels is a linear low open woodland of coolibah and teatree over lemon scented grass and silky brown top. Terraces and floodplains are brown self-mulching cracking clays, supporting dense stands (shrubland) of old man saltbush with scattered prickly wattle.

Kachumba

Alluvial outwash plains and channels of Kachumba and Rainbow Plains on Cordillo Downs.

Soils of outwash plains are either grey self-mulching cracking clays with gilgai development, or along channels, reddish powdery calcareous loams. The clays carry shrubland of swamp canegrass, Queensland bluebush and lignum with native millet and copperburrs. River red gum fringes channels.

Mulligan

The recently and currently active floodplains of the Eyre Creek / Mulligan River drainage system, the main and secondary creek channels, and associated sandridges.

Flood-out flats are grey cracking clays. The usual perennial cover is open shrubland of old man saltbush, cottonbush, and Queensland bluebush. Ephemeral grass, herb and forb cover appears in response to flooding. The occasional clay pan supports clumps of gidgea or samphire low open shrubland (Graetz *et al.* 1977 and Purdie 1984), where salinity is higher.

Main channels have alluvium on channel floors and loamy soils on banks and immediate stream terraces. Secondary channels tend to be similar to their surrounding floodplains, with grey self-mulching clay soils. Major channels are lined with coolibah, river red gum, Broughton willow, river cooba, and bean tree with an understorey of old man saltbush or lignum shrubland, grasses and herbs (Graetz *et al.* 1977 and Purdie 1984). Minor channels share the same species, but are much more sparsely vegetated. Coolibah may extend well beyond channels onto flood flats.

Sandridges are tall, widely spaced red or yellow-red siliceous sands. The sand source for these dunes is the Diamantina (Graetz *et al.* 1982). Dune crests are mobile, with a sparse hummock grassland of sandhill canegrass with or without lobed spinifex. Dune slopes and sandy interdune areas have hummock grassland of lobed spinifex with sandhill canegrass, and scattered sandhill wattle, sandplain wattle, waxy wattle and horse mulga (Graetz *et al.* 1977 and Purdie 1984).

Paradise

Channels, floodplain and floodout flats, plains and low stony hills associated with Paradise Creek, south of Marree. Many soils are saline.

The dominant unit is floodout flats with grey clay loam soils and old man saltbush, samphire, plate grass, swamp canegrass, neverfail and Queensland bluegrass with Australian boxthorn, prickly wattle, tarbush, deadfinish and sandhill wattle scattered throughout.

An extensive cottonbush flat is a major unit occurring in the southeast of the Land System. The characteristic plants are cottonbush and harlequin fuchsia-bush, with scattered desert cassia, deadfinish and black bluebush.

Several types of stony flats commonly occur. Low stony flats may have a mix of the following perennial shrubs; bladder saltbush, old man saltbush, cottonbush, low bluebush and black bluebush, plumbush, silver cassia and desert cassia, with scattered deadfinish, mulga, river cooba, native apricot, harlequin fuchsia-bush and bullock bush. Forbs and grasses include; pale poverty-bush and salt copperburr, kerosene / mulga grass, Mitchell grass, neverfail, and common bottlewasher. Low stony rises are common along the margins of this Land System and are characterised by mulga, long-leaved emubush, cottonbush, desert cassia, and curly windmill grass. Low hills with quartz gibber bands, support bladder saltbush, black bluebush, oatgrass, short-winged copperburr and salt copperburr. Stony low mesas and flats with samphire(m), bristly sea-heath, plate grass, bladder saltbush and thorny lawrencia also form a minor unit.

Drainage lines are generally tree lined and will show a mix of the following trees and shrubs; river red gum, coolibah, prickly wattle, plumbush, river cooba, Broughton willow, lignum and old man saltbush.

Alluvial plains are a common feature of this Land System with old man saltbush, plumbush, prickly wattle and bushy groundsel. Alluvial plains with gilgai are less common, the dominant plants that occur on this unit are; bladder saltbush, pale poverty-bush, salt copperburr, satiny bluebush, neverfail, native millet, stalked plover daisy, barley Mitchell grass, with scattered prickly wattle and old man saltbush.

Low dunes occur along the creek and support sandhill wattle, narrow-leaved hopbush, needlewood, Oswald's wattle and tall kerosene grass.

Warburton

See Diamantina Land System

LAKE COUNTRY

Blanche

A series of interconnected salt lakes with channels, gypseous shorelines and plains, and gypsum dunes on the eastern margins, running from Lake Frome to Lake Blanche.

The major unit comprises the salt lakes themselves. These are true salinas, with salt crusts. Vegetation is limited to saline and gypseous shores, with low open perennial shrubland of samphires and nitrebush. Ephemerals appear when rainfall is sufficient to leach some salt out of the uppermost soil layer on shores.

Dunes are whitish (gypseous) sands, with a high degree of natural mobility. Where the gypsum content allows, sandhill wattle and needlebush tall shrubs are present, with an ephemeral understorey. Elsewhere, ephemeral herbs and grasses are sparsely present.

Interdunes and some plain areas have red earths, some with lime, and a sparse chenopod shrubland cover of low bluebush and bladder saltbush. More saline and heavier soils in interdunes may carry nitrebush, and lignum may be present in run-on areas.

Pans are present: these have either massive red earths or there may be some development of grey self-mulching cracking clays. Cover in pans is samphire shrubland or nitrebush: soil salinity prevents the appearance of lignum.

Eyre

Lake Eyre lake bed, shores, shoreline dunes and lunettes, and saline deltas.

The lakebed is an unvegetated salina (salt crust) in the southern third of the Lake, grading into a playa surface (saline puffing clays with salt deposits) in the northern third.

Immediate lakeshores have saline and gypseous sandy loam soils and sand hummocks. Vegetation is low open shrubland of nitrebush and samphire, with dune fan-flower, neverfail, Tate's bindyi, pop saltbush, buckbush, common bottlewasher, cannonballs and waterweed.

Dunes, large sand mounds and lunettes behind the shoreline are pale to white siliceous or gypseous sands, supporting a low shrubland of nitrebush and samphire, with kerosene and mulga grasses (Laut *et al.* 1977).

Flood-out plains and deltas are saline grey self-mulching clays with low shrubland of nitrebush, samphire species and bristly seaheath (Laut *et al.* 1977).

UPLANDS

Fitton

Hills and rises of carbonaceous and green shales, with a variety of tillites, quartzite and conglomerates. Shallow sandy clay loam soils, skeletal in places, on hills and slopes; fine sandy loam soils along drainage lines. This Land System is primarily within the Northern Flinders Ranges Soil Conservation District. There is a small extension into the southern portion of the Marree SCD.

The dominant plant associations are mulga open scrub with herb and grass understorey and red mallee or red box open woodland with spinifex or bluebush shrubland. Variations include tall shrubland of rock fuchsia-bush and sometimes narrow-leaved hopbush over spinifex and shrubs, or red box and mulga together over a variable shrubby understorey including rock fuchsia-bush, on very shallow to skeletal soils on low stony hills and stony slopes.

The drainage lines support an open woodland of river red gum and white teatree, with lemon scented grass and herb understorey.

Umberatana

Low stony hills and rises with extensive alluvial drainage areas extending from the Flinders Ranges into the southern portion of the Marree SCD.

Hills generally are shallow-soiled (lithosols) with fine red or brown calcareous sandy clay loams with extensive rock outcrop or stone cover. There is a sparse low tree cover, primarily rock fuschia-bush, bullock bush or blackoak. Lower hills have less rock cover and better clay loam development: there is a scattered tree layer of bullock bush, with scattered blackoak, red mallee, deadfinish and mulga over a grassy groundcover (bottlewasher) or in some areas a chenopod shrub cover (bladder saltbush, low bluebush).

Adjoining the Willouran ranges, hills are slate. Soils are skeletal. The vegetation cover is low open woodland or tall shrubland variously of red mallee, deadfinish, tarbush, harlequin fuchsia-bush, brilliant hopbush and plumbush. Perennial groundcover is also sparse, mainly low bluebush. Slatey footslopes support a low shrubland of bladder saltbush, with spotted emubush, plate grass, spear grass and common bottlewasher.

The drainage lines have sandy or clay loam soils. The vegetation is dominated by prickly wattle, teatree, river red gum and red box.

Alluvial plains are sandy clay or light clay. They support a chenopod shrubland of low bluebush and bladder saltbush with streaked poverty-bush. Bottlewasher, Ward's weed and salt copperburr are common ephemerals. Rises on these plains have fine sandy clay loam or light clay soils carrying a sparse tall shrubland of prickly wattle and bullock bush or mulga and red mallee, with limestone copperburr groundcover.

Alluvial outwash fans extend onto the plains from the ranges. Soils are primarily red earths, but may also be clay loams. Vegetation is highly variable: well-drained areas carrying mulga, prickly wattle dominating minor drainage, and harlequin fuchsia-bush forming tall shrubland on alluvial flats. In all cases, chenopod shrublands are present, with black bluebush, low bluebush and bladder saltbush variously dominating or mixed. (This unit is equivalent to Saltia Land System in Northern Flinders Ranges SCD).

Willouran

Slatey strike ridges with small alluvial fans, and small plain areas, of the Willouran Ranges.

Strike ridges have skeletal powdery loams with major rock outcrop. Soils are well drained. There is a low open woodland of mixed red mallee, deadfinish, tarbush, harlequin fuchsia-bush and plumbush. Groundcover is sparse, given the degree of rock outcrop and the skeletal soils: low bluebush is most common, with rock sidas and in some areas brilliant hopbush.

The slopes of the strike ridges have more soil development, although soils remain thin, and carry chenopod shrubland of silver saltbush or bladder saltbush, low bluebush with scattered spotted emubush. Other groundcover is grass: common bottlewasher, plate grass and spear grass.

Small alluvial fans and flats adjoining drainage lines vary from brownish sand and gravel to loamy soils. Vegetation is shrubland of black bluebush with desert cassia, and grasses: flat-awned threeawn and common bottlewasher. Drainage lines themselves have loamy banks and sandy or gravelly beds. Species on drainage include red mallee, river red gum, Broughton willow, black bluebush, and thorny saltbush. Glassworts appear where soils are saline: these areas tend to be near or on springs and soakages, which are believed to be local to the ranges and not connected to the GAB.

Alluvial plains have a fine quartz gibber surface, with crusty red duplex soils, a light shallow friable loam over clay. Soils are subject to deflation, with loss by wind or water of the powdery loam leaving the small quartz gibbers on a clay hardpan. Plant cover is low chenopod shrubland of bladder saltbush and low bluebush with Tate's bindyi and common bottlewasher. Spotted emubush and prickly wattle are present on minor drainage or run-on areas. Glassworts appear on more saline patches, but generally the soil salinity is low.

GIBBER PLAINS, TABLELANDS AND MESAS

Flint

Steep-sided rocky mesas typical of the Flint hills with long undulating gibber-covered slopes and plains. Slopes and plains are similar to those of the Mumpie Land System but slopes are steeper with a denser covering of gibber.

Soils of mesa tops are shallow powdery calcareous loams but the main feature is the dense cover of large silcrete gibber and rock outcrop. There may be pale loams or kaolin, highly erodible and minimally vegetated, on the steepest slopes immediately below the silcrete or other rock outcrops on the edge of mesas. Vegetation is open shrubland or low open shrubland, with fuchsia-bushes, bladder saltbush and Mitchell grass.

The plains and downs have a dense gibber cover, with more-or-less stone-free gilgais. Soils away from gilgais are red duplex soils, very shallow friable loams over red saline clays, with high salinity. Gilgais are self-mulching cracking clays, with lower salinity, which may be gypseous at depth. On steeper slopes, gilgai patches may be linear rather than the more usual circular shape found on level areas. Perennial vegetation cover is greatest in gilgais. The mixture of low open shrubland and perennial grassland is similar to that of Mumpie Land System. Perennials include bladder saltbush, satiny bluebush, cottonbush, black bluebush and thorny saltbush over Mitchell grass, pale poverty-bush, flat topped-saltbush, rat's tail couch and common bottlewasher.

Hermit

The hill massif and plateaus of Hermit Hill and outliers, and the system of springs and spring deposits in surrounding floodplains, with areas of dune deposition; on the south-western margin of the District.

This relatively small Land System is diverse, containing elements of gibber country, ranges, dunefield and spring-created features in close proximity. The steep hills are outliers of the Willouran Land System, gibber areas are similar to the Oodnadatta Land System, and dunes are similar to those of the northern Stuarts Creek Land System. Extensive and numerous springs, and large areas of travertine limestone formed by past spring activity are distinctive.

The steep rounded hills have skeletal soils supporting low bluebush, fuschia-bushes and some mulga, with red mallee on plateau areas. Gibber plateaus are generally highly saline, with limited cover of bladder saltbush. Dune areas carry sandhill canegrass with sandhill wattle and mulga.

There are several hundred individual springs within the Hermit Land System, ranging from active springs with visible flows to dormant and extinct springs. Active springs have bamboo reed and bore drain sedge as the most common species. Also present are the rare salt pipewort, common fringe-rush, cutting-grass, bare twig-rush and sea rush. Limestone areas associated with former springs have sparse white teatree and samphire(i).

Kalatinka

Clay loam alluvial flats with minor occurrences of sandplain and dune to the east of Lake Eyre South.

The clay loams are red calcareous earths, deep and well drained. Small areas of gibber soils, and clay flats, are also present. Plant cover on the clay-loams is a mix of sparse perennial grassland or low shrubland of Mitchell grass, neverfail, bladder saltbush and starbush, with patches of cottonbush or desert cassia. Forbs such as jointed poverty-bush, pale poverty-bush, grey copperburr, short-winged copperburr, flat-topped saltbush, pop saltbush, erect yellow-heads, silvertails and kerosene / mulga grass appear in quantity after rain. Gibber areas have a similar cover. Sandhill wattle and native myrtle occurs in scattered groups where there are minor sand deposits. Clay flats, subject to inundation, have perennial open shrubland of cottonbush and nitrebush with patches of old man saltbush and canegrass: prickly wattle may be sparsely present.

Low dunes and sand plains of brownish, often clayey sands, have a sparse perennial cover of sandhill canegrass, nitrebush, Broughton willow, sandhill wattle and starbush.

Koonchera

Gently undulating gibber plains, crossed by major drainage with run-on depressions and swamps, and limited occurrences of sand dunes.

This Land System, the northern portion of Sturt's Stony Desert, comprises land units as found in Sturts Land System (q.v.). It is separated as a distinct system since, although the land units are equivalent to those of Sturts, their proportion differs.

Kopi

Extended areas of kopi (gypseous) soil country adjoining Mumpie, Flint and Oodnadatta Land Systems. Small pockets of kopi country occur throughout some stony table Land Systems, particularly Mumpie and Oodnadatta, and may be scattered through other tableland and some dune country. Areas mapped as Kopi Land System are dominated by kopi formations.

Soils are grey and puffy clays and loams with a very high gypsum content. They are easily broken and dispersible. Vegetation is very sparse because of the gypsum content, which binds most soil water and makes it unavailable to plants (and also prevents the soil particles from cohering well, hence the "puffiness" of the soil and its ease of erosion). Most plants are therefore annual species, appearing briefly when there is sufficient rain to provide water for growth in excess of the water demands of the gypsum content. Species include Tate's bindyi, cannonball, short-winged copperburr, salt copperburr, tangled poverty-bush, jointed poverty-bush, flat-topped saltbush and softhorns.

Non-kopi areas are stony tableland soils with gilgais. These and run-on areas may carry thorny saltbush, neverfail and Mitchell grass.

Small drainage lines support some perennial vegetation including old man saltbush, thorny saltbush and samphire(m), as well as annuals including bushy groundsel, softhorns, and flat-topped saltbush.

Lamamour

Gibber downs, hills and undulating gibber plains of Lamamour plateau.

Downs and undulating plains have either crusty red duplex soils with dense gibber cover or brown self-mulching cracking clays with limited gibber in gilgai areas. Gilgai development is not as pronounced as on other tableland. Cover is perennial grassland of curly and barley Mitchell grasses, neverfail and bottlewasher, with growth more pronounced in gilgais.

Hills have shallow powdery calcareous loams without gilgai, but with denser stone cover and rock outcrop. There is a sparse low tree cover of dead finish, with a sparse groundcover of silvertails.

Drainage lines crossing the plain are fringed with river red gum or red mulga.

Merninie

Long gradual and gentle silcrete gibber slopes with occasional mesas, alluvial plains and drainage lines with small clayey floodouts, mainly in the northeastern portion of Innamincka Station. Mitchell grass country, with trees limited to channels or run-on areas.

Soils of the gibber slopes are duplex, a shallow fine sandy loam over a light clay, with a dense gibber surface. Vegetation is open perennial grassland of Mitchell grass with neverfail. Other species are ephemeral or short-lived perennials; mulga grass, woolly copperburr, pearl copperburr, grey copperburr, buckbush and goathead burr. In drought, with Mitchell grass grazed to ground level and the copperburrs dead, it may appear unvegetated.

Mesas have fine loam soils, but dense gibber and silcrete outcrop dominates. As with mesa tops in other Land Systems, tall shrubs are present, (emubushes, dead finish and sennas), with a sparse groundcover of bladder saltbush, annual saltbush and ephemeral grasses, kerosene grass and five-minute grass. There are isolated trees, mainly mulga, on mesa tops: red mulga and gidgea may appear on lower slopes where runoff from the mesa top and upper slopes provides local irrigation.

Alluvial plains have a variety of soils. The two most common are red self-mulching uniform soils (sandy clays) and gradational red calcareous earths, the latter a sandy clay loam at the surface grading into sandy clay or medium clay at depth. Both support Mitchell grass perennial grassland, but with few other grasses. The most common secondary species is short-winged copperburr. The self-mulching soils have good water penetration and storage abilities, and large quantities of forage species grow on them after rain.

Drainage channels and creeks are sandy or gravelly, with small clay floodout areas. Creeks are lined with gidgea and red mulga, with whitewood, sandalwood, colane and sennas. On the occasional deeper channels, river red gum is present.

Mumpie

Flat to undulating gibber tablelands and plateaus with numerous gilgais, extensive in the south of the District. Soils and landform are very similar to those of the Oodnadatta Land System, but the latter has Oodnadatta saltbush and bladder saltbush as dominant species of the major land unit. Minor land units include steeper tableland slopes (jump-ups), major and minor drainage lines, mound springs and shallow run-on depressions.

Gilgai formations are present in all tableland soils, but the higher plateau surfaces have much less gilgai development than the much more extensive undulating tableland surfaces. These surfaces, which are remnants of older soil formations, have a dense cover of large silcrete gibbers. Where stone cover is densest and rock outcrop is also present, cover is an open shrubland or low shrubland with fuschia-bush, deadfinish, or mulga with ephemeral herbs and forbs.

Gilgai soils are the usual red to brown self-mulching and cracking clays with gypsum at depth and relatively low salinity, while adjoining gibber shelf soils are red duplex soils of higher salinity with a shallow friable loam over clay. As elsewhere in similar soils, perennial vegetation develops in gilgais.

Gibber tableland with gilgai has a perennial cover dominated by grasses, although seasonal dieback or drought may give the impression of no cover at all. The major species are barley and curly Mitchell grass, neverfail, pale poverty bush, samphire(t&m), flat-topped saltbush, waterweed, plover daisy, bush minuria, katoora and jointed poverty-bush. Scattered cottonbush, bladder saltbush and deadfinish also occur.

Tableland "jump-ups" have powdery loam soils, which may be calcareous or gypseous. Cover is low open chenopod shrubland, with low bluebush, black bluebush and scattered mulga.

Major drainage lines have linear woodland, which may carry river red gum but more frequently, coolibah, Broughton willow, river cooba over lemon scented grass and silky brown-tops. Minor drainage develops a fringing tall shrubland, containing deadfinish, plumbush, harlequin fuchsia-bush and native apricot over low shrubs, cottonbush and black bluebush. Drainage may be bordered by brown loam flats or terraces, with a cottonbush or black bluebush low shrubland cover.

Other brown loams and brown cracking clays appear in shallow run-on depressions. Cover depends on both frequency of inundation and salinity. Swamp canegrass grassland dominates less saline run-ons, with nitrebush and pale poverty-bush on the more saline run-ons.

Mound springs within this Land System appear in topographic "lows", where streams or other long-term erosional processes have cut below the tableland surface. Soils about springs are highly variable, but are usually also highly saline from thousands of years of salt deposition from the springs themselves, and hence are either unvegetated, or vegetated with salt-tolerant species (samphire, nitrebush), or with ephemeral herbs and forbs being present after rains or floods have temporarily leached salts out of the soil surface. Springs themselves support bore-drain sedge, or bamboo reed where grazing (of any sort) is light, and salt couch. One complex of springs in this Land System is reported to be similar in composition to the extensive spring systems in the Hermit Land System, also containing rare and relict species (salt pipewort, cutting grass, bare twig-rush, sea rush).

Oodnadatta

Flat to undulating gibber tableland and plateaus with numerous gilgais. This extremely extensive Land System extends from Dalhousie southward along the western side of Lake Eyre and into the southwest of the Marree SCD.

As for similar table Land Systems, the major soils are the duplex loams over clays of the gibber "shelf" areas, and the self-mulching clays of the gibber-free gilgais. Gibber soils are saline and dispersive, and much of the soil salinity is now thought to have arisen through vertical leakage at the margins of the Great Artesian Basin, which this Land System follows. Gilgais have much lower salinity. Gibber cover may be derived from silcrete or gypcrete, and there are areas with a very high gypseous content south of Lake Eyre South.

Gilgais are the most productive component of this Land System, a result of the combination of water run-on from shelves, cracking clays, which do not seal until much of the profile has been wetted, and the lower salinity. Gilgais may be one or two metres up to several metres across, and may be irregular in shape. They support perennial low shrubs, Oodnadatta saltbush and / or samphire(m) depending on salinity, and perennial grasses particularly native millet, barley Mitchell grass and katoora. Other common species include fairy grass, neverfail, plains lantern-bush, five-minute grass, bladder saltbush and occasionally cottonbush. The irrigation from adjoining shelves results in dense growth of ephemerals after rain; particularly windmill grasses, Australian cup-grass, Flinders grasses and bottlewasher. The edges of gilgais support perennial shrubs such as bladder saltbush and bristly seaheath. Trees and tall shrubs are usually absent, whether because of limited water storage, salinity or excessive gypsum at depth.

Gibber areas between gilgais are by comparison almost unvegetated. Ephemerals appear after major rains, which are sufficiently heavy to leach salts out of the upper soil profile. Such rains have to be major and prolonged, since the gibber soil surface seals rapidly when wet, and most water runs off into gilgais.

Low hills and escarpments, (jump-ups) have gypseous clay loam soils, without gilgai formation. Bladder saltbush, low bluebush, black bluebush, harlequin fuchsia-bush typically occur. Annual species include Tate's bindyi, spear grass, kerosene / mulga grass, and common and jointed bottlewasher.

Mulga grows along creek lines throughout the Land System. Coolibah grows along the larger watercourses, sometimes in association with river red gums.

Sturts

Gibber downs and tablelands overlain by very widely spaced longitudinal dunes, with areas of sandsheets. Internally draining with lakes, claypans and swamps, in the southern half of Sturt's Stony Desert.

The dominant land unit is the gibber down and tableland. Soils have gilgai development; gilgais are red cracking self-mulching clays with little or no stone, while surrounds are duplex soils, a shallow friable loam over red clays, with a dense cover of gibber and higher salinity than the gilgais.

Vegetation is concentrated in and on the margins of gilgais, a result of run-on from surrounding "shelf" areas, better water take-up and penetration in the cracking clays, and lower salinity despite frequent gypsum at depth. Gilgais are generally treeless, with a mixed groundcover of perennial grasses, primarily Mitchell grass and neverfail, and chenopod shrubs, particularly cottonbush. Other species commonly appearing in gilgais are daisy bush, ruby saltbush, tangled poverty bush, goathead burr. Ephemeral species will appear after rain, eg. annual verbine. Larger gilgai areas receiving extended runoff may have a cover of lignum, common nardoo and occasionally swamp canegrass and pale spike-rush.

Vegetation on the gibber shelves is sparse, largely ephemeral and may totally disappear in drought. Short-lived perennials present are copperburrs (tangled, woolly, salt and short-winged copperburrs and goathead burr). Major ephemerals appearing particularly after winter rains are pop saltbush, buckbush and five-minute grass.

Shallow sand sheets and "spreads" over the gibber will support some perennial vegetation away from gilgais, the sand veneer lessening the runoff and permitting more water to enter the heavier gibber soils. Species include cottonbush, bristly seaheath, satiny bluebush, bladder saltbush, woolly variable daisy, Mitchell grass and katoora. The more abundant ephemeral species on these sand "spreads" include annual verbine, grey copperburr, short-winged copperburr, erect yellow-heads, rock-everlasting, and kerosene and mulga grasses. Extended areas of brilliant hopbush may appear where “sand-spreads" are on slopes.

Deeper “sand-spreads" form areas of sandplains rather than simply a veneer of sand on the gibber surface. The deeper spreads have an open tall shrubland of sandhill wattle with Oswald’s wattle. Groundcover is ephemeral other than some short-winged copperburr and ruby saltbush: other species are similar to those of dunes themselves.

The stony tableland plateaus (known as "the gap") have similar soils to the lower areas, but with less gilgai development and increased gibber cover with some gypcrete or silcrete outcropping. The vegetation is a very sparse low open shrubland of low bluebush, shrubby twinleaf and black bluebush, with cotton panic grass and five-minute grass. Scattered deadfinish is present. Drainage lines on the plateaus have sparse mulga with low bluebush, common bottlewasher, velvet potato bush and short-winged copperburr.

The longitudinal sandridges are deep red siliceous sands, the larger with mobile crests and sandhill canegrass, and the lower with surface sand movement but no pronounced mobility and sandhill wattle cover. Vegetation is variable, although sandhill canegrass is always present on upper slopes and crests. Lobed spinifex may be present on lower flanks, but the cover is more usually a tall open shrubland of sandhill wattle and various sennas over an ephemeral groundcover of mulga grass and kerosene grass, with numerous herbs appearing after winter rains. Mulga groves are found on lower dune flanks.

Internally draining lakes and claypans have clay soils. Claypans are massive sandy clays, sealing when wet and supporting little or no vegetation. Other areas have cracking clays, with the best vegetated having grey self-mulching cracking clays similar to those of floodplain elsewhere in the District. Vegetation depends on the depth, duration and frequency of inundation. The best-watered areas have coolibah and river cooba open woodland over lignum shrublands; drier areas have open shrubland of Queensland bluebush and old man saltbush on self-mulching grey clays or cottonbush and swamp canegrass on semi-sealing areas. Samphire shrublands appear where run-off is semi-saline (Purdie 1984).

The banks and sandy levees of minor drainage lines crossing the tablelands are fringed by sparse river cooba and old man saltbush, spiny saltbush, samphire(m), annual verbine and slender glasswort.

PART III

LAND MANAGEMENT ISSUES

LAND CAPABILITY AND LAND DEGRADATION

Land Capability and Use

There are multiple land uses within the Marree Soil Conservation District. Major land-users, in terms of the area of land used are the pastoral industry and the conservation (Park and Reserve) system. In economic terms petroleum use extracts the most value. Petroleum and gas exploration and development, mineral exploration, water extraction and tourism are superimposed over the pastoral and conservation areas. There are other aspects of land use, which are beyond the scope of this plan, particularly Aboriginal usage and questions of title.

Any use of land must be within that land's capability to withstand that use. Land resources cannot be sustained where over-use occurs. Over-use or inappropriate use of land results in *degradation*, the long-term loss of land condition and land resources. It follows that land uses, of whatever sort, need to be managed to stay within land capability, and that restoration measures are needed where the land capability has been exceeded and the land resource degraded.

This District Plan puts particular emphasis on pastoral use as the most extensive land use in the District, and as the primary concern of the Soil Conservation Board. However, all uses and all systems of management have the potential to exceed land capability.

What Constitutes Land Degradation?

The *Soil Conservation and Land Care Act 1989* has an all-inclusive definition of land degradation, 'a decline in the quality of the soil, vegetation, water and other natural resources resulting from either land use activities or failure to take appropriate action'.

For practical and management purposes, some components within this definition need to be separated. The most important in real terms is *soil degradation*, alteration and loss of the soil resource. Its importance is that soil degradation is *not reversible.* Soil degradation in the District comes as a result of *accelerated erosion;* a level of erosion over and above that occurring naturally in what is often a landscape with naturally high erosion rates. Steps can be taken to halt accelerated erosion, or even to rehabilitate degraded soil areas, but the original soil is not restorable.

A major but secondary issue is *pasture degradation,* reduction or loss of the primary resource on which pastoral operation depends, again beyond that occurring naturally, eg. in drought. Pasture degradation is often reversible, provided the basic soil resource remains intact and management approaches are modified to permit rehabilitation.

A change in plant species present within an area may not constitute pasture degradation, but at the same time may still constitute *vegetation* or *habitat degradation.* It is a moot point whether the failure of some tree species to regenerate, particularly mulga can be viewed as pasture degradation, but it certainly points to a loss in local biodiversity, which can still be considered as land degradation.

Other viewpoints may be considered under land degradation, such as a general loss of biodiversity and habitat degradation. The key word here is *viewpoints*. From one viewpoint, the establishment of roads and tracks can be seen as land degradation, from another, infrastructure improvement.

Degradation of natural waters has special implications within the District, as regards the artesian-fed springs on the one hand, and the stream and lake systems of the north-east on the other. Unlike soil, pasture and other habitat quality, water quality is relatively simple to establish and reductions in quality straightforward to demonstrate.

The main issue facing the District is the maintenance and protection of the soil and vegetation resource, on which sustainable use depends. Degradation is a loss in quality of either of these. It is important to focus on exactly what is meant in any given case by degradation, whether the degradation is a consequence of land use or simply a consequence of long-term climatic variation, and the degree of reversibility. For any situation, four key questions should be asked:

- *Is there permanent and irreversible loss of the soil resource taking place, or likely to?* Accelerated erosion of surface soils especially results in loss of soil nutrient and changes in soil characteristics such as the rate of water infiltration. Together, these prevent a return of the landscape to its original level of plant productivity, and are usually accompanied by a loss of plant diversity. Action is needed to reduce erosion rates back to their natural level.
- *Is an observed loss of quality of pasture or vegetation likely to become irreversible?* A loss of quality due to the disappearance of ephemeral species and a reduction in perennial biomass is normal and expected under normal seasonal conditions, and will reverse with subsequent growth. A major reduction in the number of perennial plants present, however, may become effectively irreversible, at least over a term of decades. Action is needed if loss in quality is likely to become irreversible.
- *Is the situation beyond that which could be expected given seasonal circumstances?* Pasture or vegetation quality will deteriorate naturally, as a result of drought. Loss of cover is expected as drought conditions return, as well as ephemeral plants disappearing, perennial species may also lose most of their foliage. It is necessary to distinguish between a loss of quality due to deteriorating season and a loss of quality occurring faster than it should, due to other factors such as feral or plague animals or domestic grazing. Action is needed if observed deterioration is above that expected for seasonal conditions.

- *Are there means available to halt degradation and rehabilitate the land in question?* Where accelerated soil erosion is occurring, or where pasture deterioration is in excess of that expected for the season, the means available for halting the process need to be considered. In some cases, such as rabbit and other plague animal influences, there may be no effective or affordable means available. In other cases, alteration to stock management, or mechanical means in small areas, may be effective.

The impact of any use of the land needs to be managed in line with the threshold of regeneration which will occur when seasonal conditions permit.

RANGELAND CONDITION

Nature of Rangeland Condition

Rangeland condition generally is the 'health' of the combined vegetation and soil resource of an area, relative to its potential. If the soil environment is changed, the plant community will also change. The reverse is also true over much of the District, where the vegetation provides a major part of the protection of the soil surface, but not wholly so over large areas such as gibber "desert" and some dune fields, where the soil resource owes its protection or maintenance to physical factors other than the plant cover.

Especially, the vegetation does not exert a major control over soil conditions in landscapes with major erosion and deposition cycles. These landscapes include the beds of playa lakes, some of the intermittently flooded lakes on the major drainage systems and other flood out areas, and stream deltas about Lake Eyre. In these areas, the soil resource is constantly depleted, and replenished, in the flooding and drying cycles.

Production of sheep and cattle is dependent on native vegetation as the grazing resource. If this resource cannot be sustained, nor can production. Sustainable management must therefore conserve both the density and the diversity of the resource, and also its ability to respond to seasonal influences.

The plants are the base of most food chains and also one of the major limiters of erosion.

There are limits to how much plant material can be removed, whether by native fauna, feral animals, domestic stock, or other activities. If too much is taken off, erosion increases and the long-term productivity is lowered. It was learnt in the 19th and in the first half of the 20th century that too great an off take, by domestic stock, rabbits, or any other herbivore, leads to a rapid loss of plant production, animal production, and income.

The off take of plants, (their conversion into protein by grazing animals) must only be a small fraction of the total plant production, to allow the plant cover to maintain itself. This is particularly important for perennial species, but also applies to some extent to ephemeral plants. Even though ephemerals die off totally between growth seasons, whether grazed or not, too heavy an off take exposes the ground surface earlier than would otherwise have been the case, and limits the seed bank available for the next season's growth, particularly of palatable species.

Plants are therefore used as indicators of rangeland condition. Grazing needs to be managed so that both the species of good pasture value and the species, which provide some erosion protection, are maintained.

Changes in Condition

Changes in rangeland condition, whether as improvement or otherwise, can occur rapidly, or accumulate over long-term. They can be a result of a single event, for example a fire, a brief episode of overstocking or rabbit grazing at the onset of drought conditions, a localised heavy rainfall, or a major flood occurrence.

Longer-term changes can be driven by climate variation. On the one hand, the almost continuous series of droughts from the turn of the century to the late 1940s contributed to loss of rangeland condition over much of arid SA. On the other hand, less arid seasons and a change in management practices since the introduction of the original *Pastoral Act 1936* have assisted improvement in condition.

Major new accessions of perennial shrubs and trees appear during sequences of very wet years or a succession of major floods, as in the mid-1970s. The sequence of wet years allows the development of individuals to the point where they are capable of persisting through a sequence of "normal" years.

Even so, much of the condition gain can be lost in a sufficiently severe drought, whether or not domestic grazing is present. In 1982-1983, a relatively short but very intensive drought period resulted in the death of between 25% and 50% of bladder saltbush in both grazed and ungrazed lands in the Roxby Downs area. Similar losses were recorded in the same period in western NSW. Recovery to pre-drought levels took five to six years.

1992/93 and 2002/03 was considered to be exceptionally dry in this district, but from 1998 – 2000, the seasons have been very good, however with some local variations.

Separating Causes of Change

The two main factors most directly influencing rangeland condition are general seasonal conditions, and the total grazing pressure. This includes domestic stock, native animals, rabbits, feral grazers, and insects. It is important to separate these factors when considering the reasons for a loss, or improvement, in rangeland condition.

Indicators of high grazing pressures are often taken to be:

- Loss of the more palatable perennial species;
- Remaining perennial species in poor condition;
- Changes from perennial pastures to ephemeral or annual pastures;
- Increases in less palatable species;
- Appearance of bare or unstable soil surfaces with associated erosion;
- Grazing shifting to normally unpalatable species.

Indicators involving perennial species are relatively straightforward to use where much of the pasture is perennial, remaining present whatever the seasonal conditions. In the southern portions of the District, ie. along most secondary drainage lines, the indicators can be applied in the denser perennial vegetation and in some of the flooding country associated with the major rivers. The density and condition of perennials in these areas can guide assessment of the general condition of the vegetation.

However, over much of the gibber and tableland country, in the sand ridge areas, and on some floodplains, the bulk of the pasture is ephemeral, and the perennial pasture component is relatively low. Also, many of the perennials may be grasses such as Mitchell grass, which die back in drought. It therefore becomes much more difficult to decide whether the absence of cover is a consequence of the grazing load or of normal seasonal conditions. Such decisions are further complicated by the rapidity with which ephemeral species come and go. For example, light rains in winter will bring up fast-growing but very short-lived herbs, which, regardless of grazing, will have disappeared by summer.

Even in areas with perennial pastures, it remains difficult to decide whether a loss of perennials is a recent or a past event. For example, there are segments of floodplain, which, from their soils, could be expected to carry saltbushes or bluebushes but do not. There is uncertainty whether the species were ever there, or were present but eliminated in the excesses of the 19th and early 20th century.

Rangeland Condition through the District

There is insufficient information at present to give a first-order assessment of land condition for the whole District. It is however, possible at present to indicate resilient and non-resilient Land Systems and land units on the basis of present information.

MANAGING STOCK TO MAINTAIN RANGELAND CONDITION

Basic principles

Pastoralists have no control over the weather, limited control over rabbits and native grazing animals in many areas, and little control over the nature of the basic soil and vegetation resource. What they can control is where their stock graze, at what intensity, and for how long. Control can be applied through movement of stock, paddocking, placement of waters, limiting stock concentrations, and appropriate stocking strategies. The broad principles generally applied in South Australia are:

- *Spreading of grazing loads.* Stock have pasture and forage preferences. A totally open range will result in over-concentration on favoured pastures and under-utilisation of less favoured areas, with the possibilities of pasture and soil degradation occurring in the better, and little productive use in the poorer. Subdivisional fencing and judicious placement of water can achieve spreading of stock loads. The present increasing use of poly-pipe not only improves water conservation, but also has major spin-offs for land care and stock management. Stock waters can be shifted away from the source to where they are needed, or to harder, or less erodible landscapes. More waters provide pastoralists with additional options for stock management. Grazing pressure can be spread more evenly across the country, reducing the severe pressures, which can develop where large mobs are reliant on fewer waters. Increasing the number of water points also permits rotational systems, where stock can be moved from area to area as the condition of both pasture and stock dictates.
- Poly-pipe is still not a cheap management technique. Costs for purchase and construction are in the range of $2,500 - $4,500 per km, depending on the type of pipe and the nature of the terrain it crosses. There has not been a full inventory taken of existing pastoral reticulation systems in the District. However, some 20+ major bores supply pipe systems ranging from several kilometres to 90 km long.

  However any development of new watering points needs to consider the implications of the Native Vegetation Act 1991.

- *Avoiding local concentrations on non-resilient areas .*The choice of placement of artificial waters (dams, bore outlets, troughs) is crucial. Dams inevitably are in locations, which either is not highly resilient to major local concentrations of stock or, if resilient, tend to be in the most productive pastures. Modern poly-pipe permits an economical and practical means of shifting the actual point of stock concentration onto a "harder" area or into less valuable pasturage. Similarly, other points of heavy concentration, (holding paddocks, yards, mustering areas), are best sited on "hard" land of low pasture quality.
- *Overall conservative stocking.* Grazing is matched to the climate, where drought is the normal case.

Strategies, which follow from these principles, are:

- Maintain drought-resistant soil surface cover to prevent accelerated erosion and maintain as far as possible the vegetative cover generally. The cover may be perennial plants in which case maintenance of palatable species is preferred. It may also be gibber or gibber pavements, where disturbance or disruption by tracks should be kept to a minimum.
- Keep maximum stocking rates at a level allowing both perennials and ephemerals to seed, to ensure future recruitment.
- Monitor land condition and apply the information to modify land management methods.

Local variation in the Marree SCD

The preceding basic principles and strategies are generally applied throughout the South Australian rangelands. However, the ways in which they are applied differ in various parts of the rangelands, depending on local Land Systems, pastures and climatic characteristics.

The Marree SCD has some special characteristics: primarily, the extensive flooding country of the northeast, and to a lesser extent the division between sheep and cattle husbandry, which partially coincides with the flooding areas. Because of these differences, it is not realistic to apply guidelines, which have been developed for other circumstances, for example the set stocking at or near drought levels which is common in the southern sheep country.

In the case of the floodplains and lakes, episodic flooding provides an irregular natural irrigation and nutrient input largely independent of the local climate, while growth also follows local rains. The major part of the productivity of these areas is ephemeral, with very rapid growth and also rapid die-off.

Set stocking based on drought levels is simply not appropriate in these circumstances, which favour opportunistic rather than continuous use. Local drought conditions, and the pasture available, often relate more to when and how extensive the last flood was, rather than absence of local rainfall. Under drought conditions, there is usually insufficient forage available for maintaining stock, while under growth conditions, ephemeral pasture growth generally outstrips both the rate at which stock can be brought in to the area and the rate at which stock can be bred.

Long-term set stocking is also not appropriate on much of the gibber country north of the Dog Fence. These lands also carry primarily ephemeral pasture, with even perennial grasses rapidly losing much of their nutritive value and dying back at the onset of drought. Again, a degree of opportunism in stocking is necessary.

Management of the ephemeral pastures, and strategies for retaining their long-term productivity, requires a careful following of both pasture and stock condition, and a readiness to remove stock as pasture condition deteriorates with the "haying off" of ephemerals.

Basic differences between sheep and cattle production

There are also major and real differences between the ways sheep and cattle are run, a consequence of both the animals' differing physiology and of the economics of the animal product. Differences again favour a more opportunistic form of grazing in "cattle country" rather than the more common set stocking of sheep country. Table 12 lists some of the more important differences.

In physiological terms, cattle are not as efficient as merino sheep in their metabolic water relations, and are less able to remain productive with increased salt loads in water or diet. Hence sheep are better able to utilise the relatively salty drought-resisting perennial forage species, particularly chenopod shrubs.

Sheep flocks can therefore be maintained continuously, and productively, where sufficient perennial shrub pastures exist, in circumstances where cattle would significantly lose condition, or not survive. Perennial shrub pastures are found in most Land Systems within the Marree SCD, but the most extensive occurrences are generally within the Dog Fence, and under sheep husbandry.

TABLE 10 DIFFERENCES IN REQUIREMENTS AND HUSBANDRY OF SHEEP AND CATTLE

Sheep	***Cattle***
Water requirements 7 - 8 *litres* per day	Water requirements 60 *litres* per day
Water quality tolerance of dry stock is higher (13,000 ppm TDS)	Water quality tolerance of dry stock is Lower (10,000 ppm TDS)
Lactating ewes and cows, together with calves and lambs, have much lower water Quality tolerances which are roughly equivalent between stock types (5 - 6,000 ppm)	
High tolerance to saline feed. Ephemeral (non-saline) pasture preferred but perennial shrub (saline) pasture readily utilised.	Low tolerance to saline feed, maximum utilisation of ephemeral (non-saline) pasture needed.
Can be run productively through drought.	Lose condition and productivity in drought.
Income generated throughout productive life (to 6 years) through wool, with a final income from sales.	Income generated only when stock are sold.
Flocks generally maintained at a consistent level with usually minor variation in response to season.	Breeding herds maintained for suitable bloodlines and to permit restocking when seasons permit, but overall herds vary greatly depending on seasonal conditions.

The continuous stocking of sheep means that flock levels must be kept to a level consistent with long-term conditions. Numbers above drought-sustainable levels must be sold on early indications of an extended dry period. Damage to vegetation and soil resources can be great if too many stock are held into dry seasons.

In contrast, cattle necessarily are run in an opportunistic way, with herds built up to make use of ephemeral growth bursts (or over much of the cattle country, the regrowth of perennial pasture grasses), and cut back as ephemeral pastures die off and rapidly lose their nutritive value. Cattle condition falls off rapidly with poor forage and declining water quality, and the loss in condition represents a major economic loss. Holding cattle in drought, in excess of breeding requirements, even assuming all survive, may not recoup the economic loss because of the age of cattle when their condition improves. It is a very different situation from sheep, where condition losses in drought are reflected in reduced quality and quantity of the wool clip, but may be recouped with improved seasonal conditions from an increased wool clip.

This is not to say that cattle are automatically "kinder" to the country than sheep, simply because numbers are reduced with drought, but rather that the detail of management and utilisation differs. Over-stocking, whether by cattle or sheep, still runs the risk of depleting pasture resources by limiting the capacity of the plants to provide for the next growth burst, by eliminating what perennial component there may be present, by reducing palatable pasture species, and by creating conditions favouring accelerated erosion. In the final analysis, too many of any herbivore, (sheep, cattle, rabbit, or kangaroo), concentrated in too limited an area will result in land degradation. In a drought total grazing pressure must be reduced to prevent stock mortality and land degradation.

Special roles of fencing and water location

Major pressures on vegetation and soil resources can arise where stock are dependent on point water sources such as dams and troughs. The most effective strategy for spreading the stock grazing load and limiting these pressures lies with the selection and distribution of watering point locations. Modern poly-pipe provides the means for shifting permanent stock waters from where they are found, to land or pasture types which can cope with local stock concentrations, and for multiplying waters to permit a more even spread of grazing with reduced pressures at each point.

Moving stock around can also reduce grazing loads around permanent waters. Shrub species in perennial pastures will benefit from reduced grazing following drought, particularly where they have been the main source of drought feed. Perennials and other plants near the permanent waters can be given a period of stock-free regeneration after effective rains by shifting stock away from the permanent waters, onto temporary surface waters such as swamps and claypans. At this stage, soil moisture conditions are most favourable for both rapid regrowth and the establishment of seedlings.

Care in location of stock-accessible waters can minimise the inevitable damage arising from stock concentration immediately near the water. Similarly, careful placement of subdivisional fencing can reduce the over-utilisation or concentration of stock on their preferred pasture types and increase the use of otherwise under-utilised pasture types.

It is a fallacy that paddocks should contain a multiple of pasture types, since inevitably there will be stock concentration on relatively small proportions of the paddocks. While they will favour one pasture type at a certain stage of forage growth and another at other stages, this simply means that all pasture types within a paddock will at some stage suffer relatively intensive grazing.

The ideal is to fence individual pasture types, but this implies an intensity of fencing, which simply cannot be economically achieved. Low-intensity grazing will always entail large paddock units, which inevitably will contain a mixture of pasture types. However, separation at least at the level of gibber country, flooding country and dunes is possible. Possibilities of relocation of fences can be included in planning for future development or for the upgrading of existing fences.

Intensive activities

Any activity requiring mustering and holding stock in a limited area is likely to lead to both loss of vegetation and soil disturbance in the holding area. Holding areas (major yards, home paddocks and shearing sheds) tend to be in their present locations for ease of working or as a historical accident, and not for considerations of disturbance. For most properties, shifting facilities to less damage-prone areas is not a reasonable short-term option, although it should be considered in any long-term redevelopment planning.

The heavy concentrations of stock and their movement have the potential for considerable impact on vegetation and soil, and activities should be planned to minimise this. Strategies for avoiding damage include:

- Muster in time, not too early, so that stock are concentrated for the minimum possible time;
- Hold large numbers in large paddocks and spread the load;
- Keep holding paddocks as holding paddocks, not for general stocking, so that feed reserves are high prior to stock being held;
- Use mobile yards for crutching, or other temporary stock holding techniques / methods.

Regional Kangaroo Management Strategies

Regional kangaroo management strategies are developed for each region through a consultative process involving the District Soil Conservation Boards or other regional bodies where relevant. The process is ongoing and involves extensive consultation.

Population counts are available from 1978 for trend estimations, relating only to the part of the District south of the Dog Fence (approx. 13,000 km^2) where kangaroo management is a real issue. During this period, Red Kangaroo population density estimates have ranged from about 1 per km^2 in 1983 after a severe drought to about 15 per km^2 in 1990. In 2003, another very dry year, the density was about 4 per km^2.

ISSUES IN ASSESSING RANGELAND CONDITION

Monitoring

Monitoring is an essential part of rangeland management. A successful land manager is constantly monitoring the condition of both land and stock; the state of the pasture, indications of increased or lowered productivity, the physical condition and development of stock, the presence and extent of feral animals and so on, adjusting management, and planning future operations accordingly.

All this is a product of learnt skills and experience. It is also subjective, dependent on the observer and dependent on memory. Stock information may be recorded, but rangeland condition information is generally not.

A more objective monitoring of rangeland condition can be achieved by a system of records, which do not depend wholly on the observer. At its simplest, this system can be a series of photographs taken repeatedly at representative points, together with written comments. More detailed pasture information (cover, composition) can be included.

A monitoring installation and a baseline assessment is needed to start with. The installation is needed for repeated recording and measurement. The baseline assessment is needed for establishing current condition and for detecting changes and judging trends in subsequent observations. Both rely on having observations and monitoring sites, which are a representative sample of the area (ie. they include the major land types and encompass the variety of grazing loads) and are checked on a regular and ongoing basis, ie annually.

Monitoring installations are being established as part of the Rangeland Assessment Program. There are real advantages in lessees utilising these installations directly, and expanding them as an objective means of following land condition and providing input to lease management.

The Marree SCB in conjunction with lessees is monitoring sets of exclosures to measure the grazing impact of stock and feral animals on the vegetation resource. Three sets of exclosures have been built and vegetation monitored over five years in the major land types, flood out, sand dune and gibber. The Marree SCB also monitors the population of the rare species *Acacia pickardii* protected by an exclosure near Mt. Gason. The board has encouraged self-monitoring where possible.

Condition assessments

On pastoral leases within the District, rangeland condition is assessed in terms of the effects of total grazing pressure, through the Rangeland Assessment Program required under the *Pastoral Land Management and Conservation Act 1989.* These assessments also cover the Innamincka and Strzelecki Regional Reserves, in which grazing is one of the land uses. There is a Land Condition Assessment Program being established within other Regional Reserves, Conservation or National Parks, although these also come under the Marree Soil Conservation Board's responsibilities. These areas may be useful for comparison purposes to differentiate the grazing impacts of domestic stock as compared to rabbits and native herbivores.

Rangeland condition at present is usually determined by comparing sites under different grazing pressures on otherwise similar land units where, landform, soils, plant species present, climate effects, and vegetation are, or would be equivalent if domestic grazing were not a factor. Baseline assessment provides a starting point for further monitoring, a description of the Land Systems on each lease, and an initial assessment of the perceived rangeland condition.

Initial approaches to rangeland assessment, and especially the initial determination of rangeland condition, were derived from experience in lands south of the Dog Fence and usually characterised by a high proportion of perennial shrub pastures, with shrub densities being high and relatively evenly distributed. In these circumstances, a measure of condition relatively independent of season can be gained by comparing the relative abundance of perennial shrub species. This is done using the Land Condition Index (LCI), which makes it possible, and justifiable, to provide a relative estimate of condition whether observations are taken in drought or in growth seasons.

However, the less the perennial shrub component, the more unreliable the LCI becomes. The LCI was not used over majority of the Marree SCD because for much of the district perennial shrubs are only a small component of pastures, not the dominant component. Ephemeral plants, or perennial grasses which dieback in drought, become much more important in arriving at a condition assessment. The base rangeland condition is largely or wholly dependent on erratic climatic events; frequency and intensity of rainfall, or on some of the landscapes subject to irregular and intermittent flooding. In both cases, rangeland condition may change dramatically from area to area, and year-to-year, depending on rain and flood events and largely independent of grazing effects.

Within much of the District, therefore, a full assessment of condition will rely on trends observed over the course of monitoring rather than on initial observations. The assessment procedure, which has received some criticism, has been modified to apply to cattle production areas in particular and is now being reviewed to determine methodologies to be used in the next round of assessments.

Options

There is little option to the present assessment. Legal requirements aside, there simply does not exist the long-term objective information to apply different approaches, and some assessment of rangeland condition is a major improvement on no assessment. It is clear that the condition assessment techniques, as initially applied, need modification to cope with the largely ephemeral pastures.

Assessment of condition, however, should not be regarded simply as something imposed by Government. Ideally, lessees should be maintaining their own continuous assessment, with the required Government assessment as an independent check. Assessment procedures, land condition monitoring and feedback to management are all open for improvement. Some approaches are:

- Encourage rangeland condition monitoring by landholders themselves, to provide the long-term objective information which is lacking at present, but which is necessary to improve rangeland condition assessment.
- Encourage the sharing of experience and information among land users of the District as another means of assessing rangeland condition.
- Encourage further research into assessment procedures.
- Increase landholder input and assistance to the current Government monitoring.
- Facilitate landholder monitoring by providing for assistance through monitoring "kits" and guidelines.

PEST ANIMALS AND PLANTS

Rabbits

Major issues

Rabbits present the most intractable problem for both pastoral and conservation managers.

Rabbits are present throughout the District. After their appearance in the District in 1887, rabbit plagues were frequent until the introduction of myxomatosis in the early 1950s. The spread of myxomatosis is dependent on mosquitoes, which are inadequate as vectors in this District, and as a consequence, rabbit populations can remain at high levels. Myxomatosis, however, has eliminated rabbit plagues as such. The conditions favouring extended breeding of rabbits also favour the spread of the virus, but do not stop local population booms.

Rabbit impacts are numerous and important.

- Rabbits suppress regeneration of perennials, particularly tree and tall shrub species. Even low rabbit numbers can prevent tree regeneration.
- Their local overgrazing results in an increase in unpalatable or undesirable plants.
- Denudation of soil surfaces at warrens and favoured feeding grounds leads to accelerated erosion.
- Rabbits directly compete with domestic stock for forage. 12 to 14 rabbits equate to one dry sheep equivalent (DSE), and the stocking equivalent of rabbits in a population boom may be several times the maximum domestic stocking rates. (Pastoral Program, DWLBC)
- Rabbits compete with other wildlife for habitat. There are indications that rabbits were a primary agent in displacing native species with similar habitat requirements, particularly bandicoots.
- Rabbits are a major food source for dingoes, cats and foxes with consequent higher populations that impact on wildlife and stock. Predators do not exert major control on rabbit populations.

In good seasons, the rabbit's population growth capabilities can be achieved, resulting in huge local populations being present at the onset of drought conditions. The majority then die, but not before damaging or destroying mature perennial plants and often eliminating the perennial regeneration which occurred during growth conditions.

Base rabbit populations remain high to very high in areas, which mimic the rabbits' natural habitat, light soils for warrens and heavier soils nearby for feeding. Within the District, the Land Systems with an alternation of dune and flat are ideal. Numbers are least in Land Systems lacking good warren-building soils, particularly the gibber country.

Survival of breeding populations during drought is dependent on refuge warrens, warrens in areas with enough forage and sufficient forage moisture content (or water available) to maintain at least a breeding nucleus. Populations rapidly build up from these refuges with the onset of good seasons, with rabbits expanding to re-open warrens, which lost their local populations in the drought. On "hard" country and gibber lands, refuge warrens may be identifiable. In dune fields, the pattern of dune and interdune itself creates refuge conditions. Warrens near permanent waters, whether waterholes, dams or stock watering points, will serve as refuges.

Limitations on control

Rabbit control by direct means is difficult and expensive. It is unlikely to be justifiable on purely economic grounds other than for the protection of high-productivity areas, or areas of high ecological and conservation significance, and is unlikely to be successful unless applied in drought when rabbit numbers are low. In most dune areas, this will mean that active control is simply not feasible.

However, there may be a case for control in areas where the refuge warrens are both well defined and limited in number, and the improvement in productivity balance the costs.

For example, it may be worth targeting rabbits along a narrow floodplain with bush and shrub cover running across stony tableland. The floodplain is the most productive unit, the most heavily affected by rabbits, and the site of the drought refuge warrens for the area generally. Similarly, total-grazing pressures around dams and homesteads can be reduced by local control of rabbits.

Any active control program needs to be planned if any benefit is to come from it:

- Control is most effective combined with extreme seasonal conditions eg drought or major floods, when populations are stressed and less likely to recover.
- Warren locations should be mapped to assist any follow up treatments.
- Active control should be aimed at protection of high productivity areas (or "special" areas, eg. the encouragement of regeneration of a particular tree species).
- Control should seek especially to eliminate refuge warrens.
- Control programs should be kept to a manageable and achievable size.
- Follow-up control, particularly destruction of re-opened warrens, must be included in programs.

Warren destruction is the most important and effective means for active control, as it destroys the breeding site. Ripping of warrens may not always be possible in sandy country because it may lead to accelerated drift. Poisoning with 1080 can be used as a backup, but involves major effort for a questionable return in arid country, and its success is likely to be limited if breeding populations still remain and warrens are still available for use.

Biological control is still the best hope for reducing rabbit populations. Strains of the myxoma virus are still being developed, and it is hoped that the Spanish rabbit flea will prove to be a more effective dry country vector than the mosquito in spreading the myxoma virus. Trials with Rabbit Calicivirus Disease (RCD), under quarantine, have indicated its effectiveness, a point further amplified by the accidental release to parts of SA. There is also the possibility of the myxoma virus being modified to create infertility among rabbits.

Since this release in 1995, RCD has had a significant impact on rabbit populations in the arid zone, with recurrent outbreaks occurring in many areas. Whilst this does dramatically assist in the process of regional rabbit control, it does not replace or even diminish the need to maintain programs of warren destruction, baiting, and fumigating.

Given public fears regarding biological agents, such as new viruses, and the increasing political profile of animal welfare, it is vital that efforts continue to be made to educate the public on the damage rabbits cause, and to support and assist research efforts into rabbit control.

Other Feral Animals

The District contains patches of feral animals in moderate to high numbers. Feral pigs have established through the Cooper Creek and Diamantina River systems and on Cordillo Downs. Camels and donkeys are present in low to moderate numbers in the district and some brumby herds exist. Feral goats are present in the Willouran Ranges and on the fringes of the Flinders Ranges.

Feral species may compete directly with livestock or native wildlife for forage, or may impact on areas, which livestock do not utilise. Their effects when uncontrolled are similar to the effects of uncontrolled domestic grazing, overgrazing resulting in land degradation. They also carry human and stock diseases.

Management strategies for feral goats, brumbies, camels and donkeys are shooting, mustering and trapping. Populations, while considerable, do not pose the same problem as the rabbit. The extent of inaccessible areas in the District means that core populations cannot be totally eliminated; hence management has to be on going.

Landholders generally control the species on pastoral leases. Control through helicopter shooting has been started in Park areas. The Marree SCB provides assistance for feral animal control.

A feral Pig control strategy is being developed for the regional reserves and will provide a methodology that can be applied across the Soil Board District.

Pest Plants

Although alien plant species form only a small percentage of the District flora, they can be common in some floodplain and watercourse areas. Some of these, such as the group of species known generally as Bathurst and Noogoora burrs, are a direct liability to wool production. These are also undesirable in terms of sustaining native ecosystems.

Some native species may pose particular problems for pastoral management. The desert rice-flower (*Pimelea simplex*) contains a toxin, which is poisonous to cattle. Poisoning occurs when the plant is present in quantity, as after rains in April - May, but more in dry seasons when the Pimelea flower has degraded to fine powder and is inhaled by grazing cattle. The direct stock losses, particularly cattle, can be serious. The presence of the species reduces management options in two ways. First, direct stock losses reduce station income margins and so limit management options requiring capital. Second, the presence of the plant may force the removal of stock from the affected area, with increased pressures resulting on other parts of the lease.

The Lake Eyre Basin and the associated Catchment Committees have developed a Weed Management Strategy. A weed control and management program has been developed by these groups in conjunction with the board and the South Australian Animal and Plant Control Commission and is focussing on weeds of national significance such as Parkinsonia and prickly Acacia.

VISITORS, TOURISM AND RELATED INFRASTRUCTURE

Expanding Visitor Use

Tourism visitation in the District is increasing. The impact in the District is most pronounced at present in the Innamincka - Coongie Lakes - Birdsville area, Lake Eyre when water levels are high, other seasonal wetlands and waterholes and across the Simpson Desert. As tourism gains a higher profile, other desert areas for example, the lower reaches of the Warburton, and the mound springs within the District, are impacted.

There is simply not enough yet known on visitor patterns, activities, duration of stay or other factors to make more than general comment. Visitors appear to focus on specific areas, which may not be capable of handling increasing visitor loads under the current level of visitor management. In particular, there is a general desire to concentrate on water bodies; Cooper's Creek at Innamincka, bores and springs on the edge of the Simpson Desert, which are as little able to withstand intensive human use as intensive animal use. Intensive camping and vehicle use itself removes vegetation, compacts soil surfaces, and accelerates erosion.

Concentration on permanent waterholes can lead to problems of water quality and public health. Concentration of visitors may also create rubbish disposal problems, with simple burning potentially conflicting with clean air regulations designed for metropolitan areas. This aspect is only becoming pronounced at Innamincka at present, but may occur at other sites with increased future visitation.

Visitors also create a demand for firewood well in excess of the rate of timber growth within the area. Dead timber is already at a premium along commonly travelled routes and at favoured destinations. Constant removal of dead timber for fuel reduces faunal habitat and also long-term soil protection. Where dead wood is depleted, living trees and shrubs are often cut for firewood.

Tourism has the potential to allow some diversification opportunities for landholders of the District, through provision of camping or accommodation, and involvement in tour organisation or local interpretation.

Under the *Pastoral and Land Management Act 1989*, pastoral lessees have the right to refuse access in certain circumstances. This potentially can cause conflict, the resolution of which currently involves case-by-case negotiation. There may be some need for some formalised guidelines to address this issue.

These issues did not exist a few years ago. They are now at crisis point. There is no doubt that they will become major as visitor use, word-of-mouth, media reporting and improved access feed on each other. The process is similar to that which has been experienced in the Flinders Ranges over the last thirty years.

Whilst the Marree SCB has no effective control over visitors themselves, the board has been involved in an extensive education program and supported a range of projects over the last 5 years. It has achieved the following: -

- Public education of visitors into the nature and limitations of the land they visit, and how to treat it, through brochures, books and information signs at specific sites.
- Directing landholders with specific visitor problems, or with intentions of diversifying into tourism-related activities, to the relevant authorities.
- Facilitating a workshop for local landholders on tourism issues and possible management options.
- Educating government agencies, committees and locals on issues and promoting collaborative solving of problems eg Tourism Workshop held in Marree.

Tourism-oriented Road Development

The increasing focus on the Innamincka / Birdsville area and the lake and river systems has led to upgrading of road access. New road construction uses forming rather than simply grading for; safety reasons, reduced maintenance costs, reduced environmental damage, and for a most-weather surface route.

The board has been involved in inspections and consultations on road construction, specifically the Borefield B road, also the rehabilitation of borrow pits. The board still has some concerns regarding development of windrows and the lack of commitment in using effective wet maintenance, especially in regard to large truck usage on all roads within the district.

Formed roads are general good practice for the arid country, including most of the District. They minimise erosion and especially avoid the subsequent development of the multiple track braiding and bypassing associated with the old cut roads. They do require significant amounts of borrow material, but soil damage associated with borrow areas can be both minimised and rehabilitated.

Special problems arise where roads have to be constructed on floodplain units of the Cooper, Diamantina and Warburton Land Systems and cannot be diverted to non-flooding units. On floodplain areas, built up roads do avoid the problems of channelling (the road becoming the creek), but create problems of damming or redirecting water flows. This may have major consequences on down-stream production, particularly where overland flood flows are slow and shallow, as in the lower reaches of the Cooper Creek. The situation is similar to the effect of windrows on graded seismic lines or other tracks, but can be more permanent given the nature of the road construction.

The current standards for construction, using low-level floodways and phasing-out existing culverting, should mitigate the problems.

OTHER IMMEDIATE AND LONGER-TERM TOURISM MANAGEMENT CHALLENGES

Present numbers of people concentrating in some areas, and in transit along access, are already giving rise to three problems: depletion of firewood, rubbish disposal, and health. The last is minor as yet, but can be expected to increase, particularly where increasing numbers concentrate on semi-permanent waterholes in drought. None of these are the direct responsibility of the Soil Conservation Board, but they are issues where the Board may be able to make a contribution to management.

Firewood is dependent on dead standing timber. Timber replenishment rates are extremely slow in the District away from the major watercourses and their immediate floodplains, and, over gibber landscapes in particular, trees are uncommon. Slow replenishment rates are a function of slow growth rates of tree species in the arid zone, and also of slowed regeneration rates of many species. Regeneration can be directly affected by overgrazing, but rabbits appear to be the major factor in removal of tree seedlings away from frequently flooding areas.

Red gums lining major drainage channels, and to a lesser extent coolibahs on floodplains, are capable of relatively rapid growth and regeneration, as limited by frequency and extent of flooding. In these circumstances, the absence of sapling growth and major regeneration on waterhole edges and river levees is likely to be one consequence of domestic stock concentration on, and access to, waterholes and major stream courses, as is the case on the Murray - Darling system. There is potential for increasing the future supply of firewood as a spin-off from protection of these areas. Another possibility is the development of woodlots where water is available. Nevertheless, it is unlikely that supply can cope with demand in the long-term.

Firewood along Public Access Routes is being used faster than the replenishment rate. Railway sleepers along the Oodnadatta track still provide a considerable firewood resource, but other areas do not have this advantage.

Rubbish disposal is a real and ever increasing problem. The *Environment Protection Act 1993* already restricts rubbish burning throughout the State, and “greenhouse" legislation is likely in the future to do the same. With these restrictions, the cheap and efficient disposal days are over. Rubbish disposal becomes more difficult, and more expensive, as now someone has to do the work of disposal.

The impact of human wastes has already started appearing in the debates surrounding Coongie Lakes. It is potentially a real problem, particularly as it concerns the spread of parasites and diseases. For example, the human parasite *Giardia*, which causes gastric problems, is now present in most streams in the Snowy Mountains as a result of increased visitation. Human waste will continue to have increasing impact on the integrity of the Marree district’s natural resources, especially the water.

PETROLEUM AND MINERAL EXPLORATION

The District overlies major oil and gas reserves. The existing infrastructure associated with oil and gas is outside the Board's responsibilities. There may however be concerns with future exploration, in particular the construction of the necessary seismic lines and rig roads, and their subsequent rehabilitation or use for other purposes.

Legally, environmental management is covered by the relevant Mining and Petroleum Acts (see Part I), the *Environmental Protection Act 1993*, occasionally the *Development Act 1993* in the case of a major development, and the special case of the *Cooper Basin (Ratification) Act 1975*. Santos Ltd, as the main explorer and producer within the District has an environmental management group, including a present soil board member, to oversee both general environmental and land conservation issues. The level of communication and direct assistance to the Soil Board is good.

Santos is cognisant of its environmental responsibilities and has developed a comprehensive Environmental Management System (EMS) covering all aspects of the Company's petroleum exploration and production activities both in Australia and overseas.

Key elements of the Santos EMS include:

- A Corporate Environment Policy;
- Codes of Environmental Practice and Environmental Guidelines for all aspects of the Company's activities. Codes of Environmental Practice were initiated by Santos in 1983 and have since become a legal requirement under the *Petroleum Act 2000*. Not only Santos, but also other explorers in the District are required to follow the Codes.
- Environmental inductions and education programs for all personnel;
- Environmental monitoring and research; and
- Comprehensive environmental auditing of the Company's activities.

In implementing the EMS, Santos has become an industry leader in environmental management, receiving numerous awards for their pro-active efforts.

Other companies are also exploring for gas or petroleum reserves within the District. There is a requirement under the *Petroleum Act 2000* to liaise with landholders, and where pastoral lease improvements are altered, the landholder must be compensated. None of this directly affects the Board. Santos is in regular communication with the Board, but smaller explorers without an existing major investment in the District are less likely to contact the Board, as this is outside strict legal obligations.

In all cases, explorers are required to provide a Declaration of Environmental Factors (DEF) to PIRSA for approval of proposed Programs. They are also required to rehabilitate areas to the levels specified by PIRSA once the exploration Program has been completed. The DEFs are effectively a miniature Environmental Impact Statement, but provided to PIRSA rather than for general circulation. In the present process, the Board legally does not have to be informed nor need its advice be asked. However it has been involved in the inspection of the rehabilitation of seismic lines and the use of the rubber tyre bulldozer for construction of seismic lines to minimise erosion.

NATURAL RESOURCE AND WILDLIFE MANAGEMENT

Park and Reserve Management

The Board has some input and responsibility for management in areas reserved under the NPW Act 1972, such as involvement in district wide feral animal control and pest plant programs and impacts associated with visitor and tourism use. It represents resources knowledge and information, which could be particularly useful as, input in the early of stages of planning. The board has and will continue to support NPWSA staff in their management of the park and reserve system in the district. The board also recognises that there is a need for very clear and specific guidelines for managing multiple use areas eg Regional reserves. As a multi-use reserve, the Innamincka Regional Reserve has a review and coordination committee comprising pastoral and petroleum lessees, PIRSA and NPWSA.
Input to Park management and planning can be formalised through the Far North Consultative Committee, which advises the Minister on both Park and off-Park conservation issues The Consultative Committee is the most appropriate point for directing this input, as well as the most appropriate forum for addressing general concerns.

The Board perceives a major need for up-to-date management planning for the Reserves within the District. Plans exist for the Simpson Desert Conservation Park (1983) and the Innamincka Regional Reserve (1993). Strategies outlined in these Plans are implemented even though there may be significant limits of staff and volunteers or other resources. Successful outcomes in the Simpson Desert and at Innamincka have been the Desert Parks Pass system, the rationalisation and marking of visitor access and camping, together with improvements in safety, and in the case of Innamincka the existence of the Innamincka Working Group and management committee.

Where plans do not exist, there is no specified strategy and the impression is one of little directed activity. The Board strongly supports the development of management plans for Reserves, and especially urges improvement in an allocation of resources to cope with the increasing demands on Park management.

Off-Park Conservation

Biological conservation on pastoral leases depends on two considerations; first, an application of good land care principles, and second, knowledge of the existence, location and significance of special features.

The Board through its required activities promotes responsible land care, recognising that the sustainability of pastoral and other uses hinges on this. Where special features are known, individual lessees, or the Board, can and do, modify management to protect them. These features may include:

- Localised stands of uncommon or rare plant species, as in the case of the plant *Acacia pickardii* where protective exclosures are locally maintained and managed by the Board;
- Habitat of special interest or significance, as in the case of some lakes on the Cooper floodplain and in Innamincka Regional Reserve where pastoral management has been modified;
- Local habitat for fauna species;
- Special archaeological or geological sites.

The challenge lies in knowledge of what special features there are, where they are, and what management modifications are needed to conserve them. Not everything is known within the District, and communication and cooperation is needed. Pastoral management within the District has demonstrated a readiness to modify operations where special features genuinely require special management, but there can be no real basis for rational decision and planning where no reliable information exists, or where information is not communicated.

Continuing survey of all the District's conservation resources is needed and should be encouraged. However, survey should not be undertaken in isolation, but rather in close consultation and cooperation with landholders. The success and implementation of the knowledge gained is reliant on a regional and community approach backed up by rigorous science. A cooperative approach is needed to ensure that:

- The information gained is communicated to land managers;
- Landholders themselves can contribute their local knowledge and experience;
- All management options are canvassed; and
- Information and options can be incorporated into individual property management plans.

Resource surveys which fail to inform of their findings, or to make use of local, long-term experience, or to point toward possible management options, are of no help to pastoral management.

"Continuing" survey is stressed. One-shot surveys, properly designed, can provide a great deal of basic resource information, but rarely can they provide a full documentation of the dynamics of the systems under investigation. Single surveys undertaken in wet seasons may return quite different information when compared with the results of single surveys undertaken in drought conditions, yet both sets of information are relevant. A single survey can only suggest trends, which may be occurring. Monitoring or repeated survey is necessary to test the suggestions. In effect, single surveys result in a snapshot, where often what is needed is a moving picture.

The Board is also involved in other resource management planning such as the Rangelands Regional Strategy, the Lake Eyre Basin Strategic Plans, GAB plan, the Catchment Water Management Plan, the Integrated Natural Resource Management Plan and the Coongie Lakes (RAMSAR) Management Plan.

Information on permanent and intermittent wetlands, which can assist pastoral management, is particularly needed for areas within the RAMSAR listed portion of the District. Broad-brush approaches are simply not sufficient. Managers need to know specifics to be able to plan accordingly; what are the relative values and extent of areas, which intermittent wetland types require particular types of management, what stocking regimes maximise use of flooding areas for both production and conservation. The development of effective property plans is hindered where the information available is only broadly descriptive.

EROSION ISSUES, HAZARDS AND RESPONSES

Introduction

Most of the District has a high natural rate of erosion, a consequence of high aridity (see Part II). The concern is to avoid *accelerating* the naturally high erosion rates, and to distinguish between the natural and accelerated processes. This becomes particularly difficult during major drought when all trace of ephemeral vegetation has gone and the rate of soil movement is naturally very high.

The two agencies of erosion are wind and water. The primary protection against both is vegetation and stone cover.

Wind Erosion

Processes

Wind erosion occurs where there is little soil surface protection, and soil particles are light enough to be moved directly by the wind. This may result in dusting of finer soil particles, or in drift of heavier soil particles. The extreme examples of drift are the naturally mobile crests of the sand ridge systems of the Simpson, Strzelecki and Tirari Deserts, and drift is most pronounced on sandy-soiled land units generally.

Soil nutrients are concentrated in the top few centimetres of the soil, either as organic material or attached to fine soil particles. Loss of soil through wind erosion means loss of nutrients also and a subsequent lowered productivity of the pasture.

Increased wind erosion leads to an increase in the amount of "sand-blasting" faced by pasture plants. Blowouts and other wind-eroded areas can expand because of this as well as the more obvious burying of surrounding land under drift.

Generally, accelerated wind erosion is most likely to occur where vegetation or gibber cover has been removed. Removal of vegetation may be due to domestic grazing, feral grazing, plague animals (eg. the plague rat, locusts) or fire. Disturbance of gibber is almost always a consequence of earthworks associated with track- and road-making, fence line clearing or pipe laying.

On clayey sands, wind sheeting may also occur. Continued compaction of blown sand particles, cemented with clay particles, forms a clayey sand crust on the surface. Although the crust limits drift, it also lowers the rate at which water can enter the soil. This in turn both limits the re-establishment of plants and increases the possibility of local water erosion.

Some bare soil surfaces, such as the heavy clays of floodplains, are not prone to wind erosion if undisturbed because the clay surface is cemented. This "cement" however can easily be broken by heavy stock concentration, extended vehicle use or other disturbance. Dust is generated, and there may be some loss of soil nutrients in the dust.

Duplex or texture-contrast soils, where the shallow topsoil is a fine loam overlying heavy clay or other hardpan, is prone to scalding. If surface vegetation or other protection is lost, wind erosion can remove the topsoil and expose the hardpan. Hardpans, especially clays, have poor water infiltration and seal rapidly when wet. Rainfall on a hardpan is lost either through runoff or later evaporation. Scalding also results in loss of most soil nutrients, and the scald itself is a poor seedbed. No nutrients, a poor seedbed, a lack of water penetrating the scald and water run-off together make scalds largely self-sustaining, and in some cases self-extending.

Natural scalds are present throughout the District, especially in interdune areas. Scalds may be initiated following loss of vegetation cover, whether through high grazing pressure, drought, fire or even hailstorms. The presence of scalding is not of itself an indication of poor management practices. Without monitoring information, it is difficult to determine what has caused the scalding, natural events and processes, or accelerated erosion.

Management to limit wind erosion

The District is arid to highly arid, and wind erosion rates are naturally high. There is no point in attempting management or rehabilitation to bring erosion rates below those, which naturally occur. An obvious example is the naturally high mobility of dune crests in sand ridge areas.

There is however considerable reason for managing lands to reduce accelerated erosion or to rehabilitate lands, which are suffering accelerated erosion. The soil resource is the ultimate base for plant production and diversity, and its degradation or loss is reflected in lowered diversity and production.

There are limits to which accelerated erosion can be reduced, in particular the inability to limit rabbit populations. Very high rabbit populations in dune fields, both in and beyond pastoral areas, are undoubtedly accelerating rates by limiting ephemeral plant growth and rapidly removing ephemeral cover after growth bursts, but without an effective control of rabbits there is no means for reducing this impact.

Soil protection needs to be maintained or increased to minimise accelerated wind erosion or to rehabilitate eroded areas. The following are factors, which can be managed.

- The density of perennial vegetation, (tree and shrub).
- As much standing dead grass, herbage, and soil litter cover as possible, needs to be retained into dry seasons. This cover will not persist indefinitely through an extended dry period, since natural decay, rabbits and local plague species will eventually remove it. However, wind erosion will commence later, and be less severe, where a high proportion of the total forage is left.
- Controlling stock numbers, larger feral and native grazers, should reduce the total grazing pressure and where feasible, controlling rabbits.
- New stock water points and access tracks should be placed in areas least prone to wind erosion. Relocation of existing facilities out of erosion-prone areas should be planned. In the first place, this may mean avoiding sandy land units. There will be cases, however, where the alternative site is a land unit with less resilience and worse water erosion risks, and locally increased wind erosion is the lesser problem.
- Burnt areas on erosion-prone soils should be completely destocked or at most have very light stocking only. Especially in chenopod shrublands, fires kill most perennial shrubs, trees and all of the ephemeral cover, deplete the seed store and totally expose the soil surface. Even light winds can result in major erosion, which will not halt until the next growth burst.
- In areas needing rehabilitation, a revegetation program should be planned and implemented. The soil type, slope and seed source are all factors, which need to be considered. The primary aim is to re-establish perennial cover, or to increase the existing density. This may need construction of seed and nutrient traps by spreading dead timber or roughening the soil surface by furrowing or pitting. In the case of scalded areas, extensive mechanical preparation may be needed.

Water Erosion

Processes

Water erosion occurs to some extent on all Land Systems. Creek systems are naturally subject to water erosion, and most other land units have at least some susceptibility to accelerated water erosion. In many respects, it can be of more concern than wind erosion because of the ability of water to transport large quantities of soil in a single event. The two main forms are gully erosion on sloping ground and sheet erosion on level ground. Both are limited by the degree of soil protection. Gullying is not reversible and is difficult to halt once started. Sheet erosion is simpler to halt, and in some cases rehabilitation to a productive soil is possible through means such as pitting, contour banking or water ponding.

Hill systems (eg. Willouran Land System), characterised by skeletal soils, rock outcrops, often quite steep slopes and low vegetation cover, are still quite susceptible to gullying, though the gullies formed may be shallow due to the minimal soil depth. Rehabilitation and regeneration can be difficult in this land type.

Gully erosion

Gibber downs and tablelands are particularly susceptible to gully erosion. The saline or gypseous clay soils are very dispersible, and even gentle slopes will gully if the gibber surface is disturbed. Gullying is further accelerated since most of the rainfall runs off gibber surfaces. Under normal circumstances, runoff is into gilgais or existing drainage lines, but damaged gibber itself will form a new drainage line. Hence gullying will start, even under mild rainfall conditions, (it does not have to be a major rainfall event). Once initiated, gullying spreads both down-slope and up-slope.

Gullying will also occur on other "hard" country, where soils are also clay-based and where there is some slope. Here, the plant cover is the main protection. Minor gullying can occur in dunefields where dune bases have a clay component. Infiltration of water into the soil is limited by the clay, where there is insufficient vegetation to retard runoff, heavy rainfall events will lead to local gullying at the base.

Gullying can also occur as a result of unusual climatic events such as a localised very heavy downpour, or seasons of extreme rainfall. In the exceptional 1974 rains, severe local gullying eliminated some former swamp areas in the District. Swamps filled beyond their normal capacity and overflows gullied out their rims.

Poorly made or poorly sited tracks can start gully erosion in most land units. A track is effectively a sealed catchment, with most water running off. Past practices in track construction did not provide sufficiently for shedding water, hence the common sight on sloping ground of two or more "generations" of tracks, the earlier gullied out. Current practices increasingly provide for limiting the possibilities of water erosion by simple and minor alterations to traditional approaches.

Stream banks

The banks of any drainage line will erode naturally. The extent of the erosion is partly determined by the amount of perennial vegetation. Hence in a major stream, the presence of trees and large bushes such as lignum will limit bank erosion. At the other extreme, a small drainage line in bladder saltbush may have almost no natural bank protection.

Sheet erosion

Erosion by sheets of relatively fast moving water is a natural feature of most floodplains, and can also occur on outwash areas with sufficient slope to keep water velocities high. The extent to which soil is removed is dependent on the vegetation cover. A well-vegetated floodplain will not erode significantly, and is more likely to trap and hold sediment carried by the stream flow. A poorly vegetated floodplain will both lose part of its soil and fail to trap the sediment and nutrient bonus carried by the floodwaters.

Management to limit water erosion

On Land Systems dominated by gibber country, the most important management tool for limiting water erosion is the retention of the gibber cover itself. Damage to the gibber cover at a level, which can result in accelerated erosion, is almost always associated with installation of facilities (tracks, fences, pipelines), and active management is needed in these cases.

- Stone cover removed for purposes such as fence line clearing or pipe laying should be kept to a minimum, and stone replaced where possible. The inevitable windrows or pipe depressions should have breaks or bars (small mounds) to divert water from the line and spread it on surrounding gibber.

- Tracks need to be constructed near the contour, or at least kept to a gentle grade to minimise gullying. Where there is a slope, water bars should be included in the track construction, to divert flows off the track and across the slope. Water barring need be little more than graded "speed humps" at intervals. Trackside drains should have frequent shallow cuts to the side, to spread water across the slope. Deep drain cuts will simply extend and accelerate the gullying.
- There are alternatives to the simple graded track cut below ground level, which unfortunately acts as both a water catchment and a channelling device. Is a track actually needed at all? Much gibber country is capable of taking occasional vehicle movement when dry, wheel tracks remain visible but the gibber cover remains intact. Will rolled gibber, rather than a cut track; serve the amount of traffic expected? Rolled tracks are now used for temporary seismic operations, being less damaging than the cut lines used in the past.

On non-gibber surfaces, the vegetation cover, particularly perennial species, is the main protection against gullying and sheet erosion. Management principles are much the same as for protection against accelerated wind erosion:

- The perennial plant cover needs to be maintained.
- In ephemeral pastures, standing dead grass and herbage needs to be retained into dry seasons.
- Controlling non-domestic grazers, as well as stock numbers should reduce the total grazing pressure.
- Stock concentrations, which reduce vegetation cover, should be avoided. Where concentrations cannot be avoided, for example around point waters or yard areas, these facilities should be sited on flat rather than sloping ground.

For creek lines, bank erosion can be limited to some extent by maintaining or increasing bank vegetation. Where major streams or waterholes are concerned, this is not simply a question of limiting stock access, as these areas are also a focus for feral animals and humans, which denude banks and damage vegetation.

The possibilities of sheet erosion on floodplains depend to a great extent on the velocity of floodwaters, which varies greatly within the District. The Cooper Creek floodplains are very extensive, and water velocities are low. Floods may take some weeks to rise and subside. Soil deposition rather than erosion is the usual case here.

At the other extreme, the small floodplains associated with secondary rivers such as the Frome, or the numerous small drainage lines particularly in the southern sector of the District, can be subject to major flooding with relatively high water velocity, with floods literally arising overnight and subsiding in a day or two. Sheet erosion on these courses and floodplains can be managed to some extent by maintaining or rehabilitating the perennial shrub cover, particularly the major forage species of old man saltbush and Queensland bluebush. The extensive ephemeral growth, which appears after floods, does not usually provide erosion protection, as it is unlikely to persist to the next flood event.

Stocking at a level, which permits survival and recruitment of perennials, can be supplemented by mechanical methods for reducing water velocity, for trapping sediment, nutrient and seed, and for raising the productivity of areas badly affected by sheet erosion. These are pitting or ripping on sealing (non-cracking) clays, and contour banking or water ponding on both cracking and non-cracking clays. None have been applied to any great extent in the District, and are mentioned here simply as future possibilities.

Water ponding is cost-effective on extensive almost level areas (slope less than 0.2%). It involves the construction of low, broad-based banks no more than 40 - 50cm high to partially block or limit flows and pond water. Provided the ponding is less than about 10 cm deep, The build-up of water and sediment behind banks increases the soil water store, increases the available nutrients and provides an excellent seed bed. Deeper water encourages less useful water-loving species. Normally accepted scales for ponding are banks no more than 250 m long, arranged so that up-slope ponds can spill into down-slope ponds.

Ponding has the major disadvantage that any interference with flood flows may adversely affect downstream areas. Proposals to water-pond should be discussed through the Soil Board with all affected parties.

Natural Direct Seeding to Increase Erosion Protection

Lack of a seed supply will limit plant regeneration, particularly of perennials. Seed collection in bulk for species such as bladder saltbush, low bluebush and old man saltbush is fast and simple if the occasional large seed drop is utilised. Other than for rehabilitation of mineral exploration areas, direct seeding has hardly been attempted in the District.

Collection and spreading the seed of common perennials does not require a major time cost or very specialised equipment. When seed is freely lying in vegetated areas, one or two people with a vacuum cleaner, generator, vehicle and some bags can collect hundreds of kilograms in two or three days for seeding rehabilitation areas, or simply for enrichment seeding of thinned pastures.

WATER MANAGEMENT

Artesian Water

Usage of water and artesian pressure

Much of the pastoral use in the District is dependent on water from the Great Artesian Basin (GAB). Other uses of the GAB are associated with gas and hydrocarbon extraction in the northeast, and the Olympic Dam water supply in the southwest. The main issue is the extent of draw down, the pressure reduction, which accompanies any local extraction, and which can affect other bores and spring flows within a local area.

Where pastoral bores, gas wells and well fields for industrial and township supply remove large quantities of artesian water, pressures in the aquifer drop. Although water itself moves only very slowly through the aquifer, pressure changes move rapidly, and a major outflow at one point can directly reduce pressures, and so artesian flows, at some distances over a very short period of time.

For distant bores with high pressures, the reduction in pressure and flow caused by drawdowns elsewhere may be negligible, or only of minor concern. But for closer bores, or bores and springs on the edge of the GAB where the pressure head is already low, additional drawdowns may mean the difference between some flow and none at all. Hence unnecessary use of artesian water in any given area is not only a waste of a valuable resource, but also affects use and availability of the water in other areas.

Near the margins of the GAB, drawdowns can result in changes in water quality (which may already be marginal) by changing the balance between supply from the main body of the GAB and supply from relatively local recharge. The main source of GAB water in the District comes from recharge in Queensland and there is also minor recharge along the southern and western margins of the basin. The latter is of poorer quality, and may pass through local sediments, which further reduce the water quality. Generally, drawdowns at the edge of the basin result in a deterioration of bore water quality.

Soil and vegetation conservation, stock management, and artesian water conservation all dovetail and are interdependent. The effectiveness of a bore as a stock water supply is multiplied by the use of reticulation systems. Reticulated waters can be used to control stock regardless of the location of the initial supply, and use of a reticulation system rather than the traditional open drains minimises water losses associated with provision of stock water.

Approaches to artesian water conservation

As artesian water is a key component in sustainable use of the rangelands, the Board necessarily has an interest in any operations affecting the artesian water resource and supports the Arid Areas Catchment Water Board in their role as the water resource management body in the district.

There are legitimate concerns regarding potential drawdowns from large-scale existing or proposed extraction. Reduction in the availability of artesian water can limit the options available for sustainable rangeland management by reducing the ability of properties to manage stocking through their watering systems.

Possible actions on these issues include:

- The promotion of conservative use of artesian water on pastoral properties:
  - Encouraging the installation and use of low-loss stock water reticulation.
  - Encouraging the further reduction of open bore drain flows by education and discussion of the imbalance between benefits and drawbacks of open drains.
- Seeking landholders' support and assistance in pastoral bore capping and control Programs both in South Australia and interstate where GAB water utilisation occurs;
- Including artesian resource and management components in land care activities such as field days;

- The encouragement of investigations into uses for waters currently produced in hydrocarbon extraction;
- Informing the broader public of the necessity for artesian water conservation;
- Input to large-scale extraction proposals in relation to effects on pastoral bores, springs, and flexibility of water management;
- Request and disseminate information relating to management of the GAB through the District.

Mound Springs

Special values

Mound springs are the most uncommon habitat and formation in the entire District, occupying a minuscule total area. They contain genuinely unique aquatic fauna, including a group of species found only in the springs and in some cases limited to only a few springs, and one endangered plant species (salt pipewort). Springs maintain local populations of plants, which were once widespread in past, wetter ages but now are limited to higher rainfall regions of Australia. The formation of mounds, where present, may preserve a record of fluctuations in the GAB, and the spring sediments may preserve a pollen record, both of which may shed light on past climatic changes once fully investigated.

Springs were central to survival and movement of Aboriginal people, and were the main support for initial pastoral use of much of the southern part of the District. They determined the route of the Overland Telegraph and subsequently the Central Australian Railway. They are still used as a source of stock water, and are increasingly a tourism drawcard. In the District, their biology is quite different from that of other water bodies, and also from that of bore drains.

Primary issues

There are three main issues:

- The effect on springs of direct access by stock and feral animals;
- The effect of increasing visitor pressures;
- Possibilities of reduced spring flows due to water extraction from bores.

Direct access of stock and feral grazing animals onto springs degrades at least some of the values of the springs:

- The intense trampling and grazing of the springs, which occurs in drought, changes the vegetation cover. Although the existing evidence suggests that this has not resulted in the actual extinction of any species, this is by no means certain, and there is no doubt that protection of springs from direct grazing and trampling results in a very different combination of plant cover from that present under open access.
- Trampling and bogging of stock on springs mixes the upper spring sediments and may destroy not only the pollen deposits themselves, but their sequence in the sediments from which past climatic information can be gained.
- The physical mound structure itself can be broken.
- Visitors to the area will see the physical appearance of a heavily grazed and trampled spring as a lack of care.

Increased visitor access to springs may result in similar effects, with the added damage caused by vehicles to spring surrounds, as well as potentially interfering with stock use. At present, heaviest visitor use of spring areas takes place outside the District, with the springs at Blanche Cup and at Dalhousie (both now conservation reserves) under heaviest pressures. However, the number and extent of springs close to main visitor routes within the District is not yet widely realised. As knowledge of the District grows, increasing visitor pressures may be expected.

Spring flow reductions, and local extinctions, have occurred in the past due to local draw down. Shallow bores or wells were sunk in or near springs to increase the off take of artesian water, with a consequent artesian pressure drop. Often, pumping further reduced pressures to the point where springs ceased to flow. The large and deep artesian bores away from the area of springs were previously thought to have also seriously affected springs. However, their effects are now less certain, given the findings of recent research into the GAB, and particularly the identification of vertical leakage losses (Part II). Increasing utilisation of artesian waters from the margins of the GAB does however have the potential to reduce spring flows significantly.

Spring management

A frequent 19th Century station practice was to fence or wall spring vents, denying stock access to the vents themselves while still permitting access to the spring water. Stock-proof fencing is still maintained on some stations. DEH has a program for partial fencing of some of the more important springs. Encouraging stations with springs to return to the 19th Century practice and fence the vents off would be a particularly visible demonstration of commitment to land care principles. Increasing numbers of people visiting springs are likely to have similar effects to stock utilisation, and protection is needed for this reason also.

The influence of existing and new water extraction schemes on spring flows depends on a series of factors: how large the extraction will be, how far draw down effects will extend, what the subsurface "shape" of the GAB may be and how far distant is the proposed extraction. Distance in this sense is distance via the aquifers: a bore and a spring may be only a few kilometres apart on the surface, yet 40-50 km apart if the aquifer is followed. The situation requires extended hydrogeological study and testing, modelling to predict effects, and monitoring to check and modify the modelling. For major new developments, as with the borefields associated with the Olympic Dam water supply, the studies, modelling and monitoring are major requirements of the water license.

There is no consistent management strategy for the springs generally, however a comprehensive report was written by Tim Fatchen in 2000 for DEH and would provide the basis for an integrated management strategy. Monitoring of springs over the last decade or more, as part of the Olympic Dam development, has also provided sufficient information for the development of an integrated management strategy.

Lakes and Streams

Special values

The ephemeral lakes and permanent waterholes associated with the Cooper and to a lesser extent the Diamantina systems are currently under discussion. Issues are associated with a range of sometimes conflicting land and water uses, including recreational use of land and water, beef production, commercial fishing, biological conservation, oil and gas exploration, and management of listed areas consistent with the Convention on Wetlands of International Importance Especially as Waterfowl Habitat (RAMSAR). Not all uses come within the Soil Conservation Board's ambit. Also, much of the area in question is within the Innamincka Regional Reserve, subject to specific management planning, and this limits the role of the Board.

In terms of the biology of the river and lake systems, the permanent and semi-permanent waterholes are refuges for fish and some other aquatic species, and the source of replenishment of fish populations in the intermittent lakes and lagoons. The waterholes maintain local fish populations until the next flood. The species, which appear in the temporary lakes, and the initial growth of fish populations, depend to a large extent on the species maintained between floods in the major waterholes. Between floods, waterholes are a focus both for stock and for recreational use.

The shallow ephemeral lakes are highly productive when water is present, supporting at the top of food chains very high numbers of waterfowl (which prompted the original RAMSAR listing) and very large populations of fish. The level of biological production when these lakes initially fill is likely to be affected by the amount of plant material and general litter and detritus submerged by the water.

However, maximum biological production comes after filling, at the diffuse boundary between lake and dry land in these shallow lakes.

Primary issues

The interface between dry land and the main water body, which can be "water meadow" or simply a strip of shallow water and mud, provides a food supply for most of the lake food chain. Particularly, the mixture of high vegetable and invertebrate animal production which supports the very high concentrations of wading and dabbling waterfowl, as well as providing food resources for juvenile fish. Large numbers of waterfowl and extended breeding can be supported because the food resources are not depleted over most of the shallow lake's "life". As the waters shrink, new areas of shallow water and exposed flat are uncovered, and production of food species is thus kept high.

At and above this interface is the most productive ephemeral pasture, utilised by stock. The primary issue here is that use of the interface by waterfowl and the organisms they depend on, and use by domestic stock, may be competitive rather than complementary to at least some extent. Both the wildlife and the stock are physically utilising the same area. The specific resources they are using may differ but there must be some form of interaction occurring. The extent of this interaction has not been clarified. It is unlikely to be simple and certainly will not be uniform throughout all floodplains and lakes. Also, given the long and sometimes intensive pastoral use of the resource and the continuing high quality of the landscape as intermittent waterfowl habitat, it would appear unlikely that the system is in imminent danger of collapse.

Nevertheless, a clearer picture of the interaction is needed for long-term refinement of management. It should be noted that the alterations which pastoral use may have introduced are minor when compared with wetland alteration in other arid and semi-arid areas. The following comments, regarding the upstream "channel country" in Queensland, also apply to the SA portions of the streams and floodplains:

> "Although the great majority of these wetlands are unprotected, most remain relatively undisturbed by pastoral development. Disturbance due to grazing, namely vegetation removal, silting, water fouling and stream bank erosion, occurs over most of the Channel Country's wetlands, but is of only moderate concern for the long-term security of habitats. Continued improvements in pastoral management through appropriate property management planning, and programs such as Integrated Catchment Management, should further secure the future of these vital habitats. This is in stark contrast to wetlands in other arid areas (eg. Murray - Darling Basin New South Wales) which have suffered significant alterations to flooding regimes and vegetation, at the hands of irrigated agriculture, resulting in permanent damage to, and loss of numerous wetlands."(Ford, 1995).

Management investigations and approaches needed

Topics needing further investigation or clarification include:

- *Delineation of floodplain types, particularly in terms of the variety in frequency and intensity of flooding.* There is enormous variety in the areas which can be classified as floodplain, ranging from extensive areas which are flooded only in extreme events such as the 1974 floods, to areas flooded during most stream flows. Management needs may be quite different across this spectrum. Most present information does not distinguish between the frequently flooded and the rarely flooded.
- *Objective assessment of effects of all land uses on water quality within the flooding systems, including appraisal of the relative significance of effects.* For example, floodwaters are turbid. Stock on margins may increase the turbidity, but it is an open question whether this increase in turbidity makes any significant difference given an already highly turbid water body.
- *Relative significance of erosion and sedimentation inputs and outputs.* Concentration of

visitors and stock on channels and waterholes may increase bank erosion, but there is potentially a high natural erosion rate. Again, the question is whether the increase is significant given the background natural erosion rates and the extent to which new sediment is imported during floods.

- *Following trends in productivity and diversity within floodplain ecosystems.* "Single-shot" surveys and investigations give a snapshot view, which may mislead if trends over time are being sought. There is a need for continued monitoring, as feedback to management.
- *Contributions of visitors, stock, other animals and water transport to the spread of alien plant species.* Waterways are the main avenue for the spread of alien plants, including weed species, in the Marree SCD. Control of established species is difficult or impossible given the limited population base. There may be management alterations, which could at least limit future invasions.

Specific management of the intermittent wetlands or wetlands system may be more appropriate in individual Property Management Plans.

Cooperative planning involving landholders, oil and gas interests, and conservation authorities, is in progress for the Innamincka Regional Reserve, which in the present context is equivalent to a single pastoral lease. The Innamincka Regional Reserve represents the first real attempt in Australia to manage for biological conservation, pastoral use and resource industry use within a single area. As the first attempt, there will inevitably be problems and alterations to management needed, and there certainly will be pressures to exclude one or more of the main uses. Success in achieving a blend of uses needs genuine cooperation, unbiased investigation and monitoring of management outcomes, provision of adequate resources, and time above all else. Successful planning, and management based on clear guidelines to provide for continued multiple uses, may provide a model for use on other leases.

FIRE

Major fires on pastoral lands in the District are rare by comparison with fires in the mulga lands or the Flinders Ranges to the south. Nevertheless, a significant proportion of the District, primarily within the Wongkanguru, Tirari, Jeljendi and Strzelecki Land Systems, is prone to very occasional major fires. Fire is only a minor consideration in most gibber landscapes; it can occur, but fuel loads between gilgais are rarely high enough to maintain a fire front. With increased visitor use, particularly of sand ridge areas, fires started by vehicles or careless camping can be expected.

Major fires generally require a relatively dense cover of flammable grasses, particularly kerosene grasses, mulga grasses and other grass species which stand when dead leaving high "flash fuel" loads. These conditions arise after a sequence of well-above-average rainfalls. Some plant cover, lobed spinifex particularly, is highly flammable at any time, but the dry ephemeral cover is needed for fires to spread to any significant extent.

We do not know what the previous fire regime was. Explorers' diaries and other early reports, together with more recent information from central Australia, strongly suggest that Aboriginal practice was to patch-burn, ie. frequent, small fires, the present fire regime are one of major fires at very infrequent intervals. The most recent major fires followed extreme rainfall and growth in 1974, with large areas burnt along the Queensland border and in the Simpson Desert.

Fires when they do occur are "hot". In other than the sand ridge deserts, much of the vegetation can be killed outright, including chenopod shrubs and many of the tree and tall shrub species. The soil surface is bared, the likelihood of wind and water erosion is greatly increased, and the soil seed store is reduced. Stabilisation may take several years because of the erratic climate. Re-establishment of any former perennial shrub cover may take longer, and at least some tree species, mulga in particular, may not re-establish at all.

"Woody weeds" can establish at high density after fire. They will be a greater problem if grazing on fire-affected areas is not carefully managed in the early stages of recovery especially. The woody weed seedlings are not palatable to stock or rabbits, and reduction of the more palatable species through grazing will reduce competition and benefit the woody weeds.

Fire protection and prevention is rarely a priority on pastoral land because of the infrequency of fires. However, some contingency planning for fires is necessary, to cover:

- Equipment and manpower availability
- Strategies for fire suppression
- Shifting and agisting stock
- Protecting not only built assets but also the more valuable pasture types
- Educating visitors to the risks, hazards and costs of fire.

There is also a need for fire management policies and guidelines to be developed for regional reserves in the district.

Lobed spinifex and sand ridge country regenerates after fire, and fires may favour the spread of spinifex in the long-term even though pastures may be improved in the short-term. Burnt areas in most other Land Systems need to be treated similarly to areas subject to accelerated erosion.

STOCKING STRATEGIES

Principles

Adaptive stocking systems

Pastoral use in most of the Marree SCD is governed by the combination of low and unreliable rainfall and high ephemeral pasture components. The perennial pasture component, where present, is sparse compared with the less arid sheep lands south of the SCD. As a result, most of the SCD is not suited to set stocking of either sheep or cattle, where stock numbers are sustained at or near the level which can be permanently carried, even in drought. Rather, stocking is adaptive.

Stock numbers will fluctuate in response to the wide range of seasonal conditions, from small breeding herds during prolonged drought, through normal sustainable levels, to larger herds in growth periods following major rain or flooding. Fluctuations are most pronounced in cattle areas, where perennial shrub pastures are least, but also apply within sheep lands with a higher perennial shrub component in pastures.

Within an adaptive system, both the condition of the largely ephemeral pastures and the condition of the stock have to be considered. Key questions, which must be considered in adaptive stocking, include:

- How many stock are to be held as a breeding core through drought;
- Which Land Systems are capable of sustaining the breeding core through drought without degradation of the Land System and without loss of stock;
- At what stage in a pasture growth period should stock numbers be built up;
- Where and in what quantity are stock to be carried;
- At what stage of pasture quality or season should stock numbers be reduced?

Other factors limit operations. Some are economic. For example, although pasture condition may be suitable for increasing stock, stock to supplement the base-breeding herds may not be available or their purchase may not be economically sound. Other factors can be "once-off" or occasional. For example, the tuberculosis and brucellosis eradication campaigns (BTEC) resulted in effective destocking of most cattle leases in the District in the early 1980s. Occasional rat plagues in the north of the District (native plague rat, *Rattus villosissimus*) can severely reduce ephemeral pastures on some properties, to the extent that stock have to be removed, and usually sold, before stock condition is lost. Strong pasture growth may be accompanied by the growth of plants poisonous to stock (eg. *Pimelea simplex* in 1995), which prevent grazing of the ephemeral pasture.

Adaptive stocking has been aided, and can be carried out economically, because of the availability of transport and roads which allow stock to be both removed for sale or brought in for herd increases relatively rapidly. With the disappearance of long distance droving, has also gone the holding of stock for too long into a prolonged drought, as well as the pasture damage once caused by large concentrated herds being slowly moved through the countryside.

Absolute stocking levels and stocking rates

Because of the adaptive stocking, absolute stocking rates (numbers per unit area) and the number of stock per water vary with the state and type of pasture, the availability and location in paddocks of stock waters, and the condition and class of stock. Stocking rates also vary with the stocking regimes enforced by the nature of the land and the stock water supply, discussed later in Stocking Limits and Strategies. Leases, particularly cattle stations, may be almost entirely destocked in prolonged drought conditions.

Use of fencing

Concentration of stock in limited areas results in damage to soil and vegetation. There are both broad-scale and local-scale aspects of over-concentration. On a broad-scale, stock themselves may concentrate on preferred pastures, with the attendant risk of pasture degradation, while under-utilising less preferred areas. On a local-scale, there is inevitably a concentration of stocking pressure about waters, increasing with proximity to the water point. Yards and holding paddocks can be subject to very high pressures on soil and vegetation while in use.

Fencing can control tendencies of stock to over-concentrate in particular land units. For the control to be successful, however, fencing must provide at least a general separation of pasture types. At a minimum, Land Systems or large land unit areas with different growth responses and other capabilities or limitations should be separated. For example, fencing may be able to separate major floodplain from dune field. Pasture growth bursts on the floodplain after floods can be utilised while dune field pastures are spelled. The dune field pasture provides a drought reserve for breeding herds once the floodplain pasture has reduced. Internal subdivision in both dune field and floodplain will prevent over-concentration of stock on particularly favoured areas within each Land System.

Fencing should be done with regard to the Land Systems, pasture types, and the location of waters.

There are differences of opinion and practice in the District regarding the extent of fencing. It can also be argued that relatively intense patterns of fencing are appropriate where waters are permanent, but are not appropriate where waters are impermanent. The argument is that fencing is needed with permanent or semi-permanent waters, to prevent long-term stock concentrations on particular water or to allow spelling of areas about individual waters. With impermanent waters, however, it is argued that stock concentrations are of short-term duration in any case, and that fencing unduly limits the ability of stock to move when local water dries out. This possibility has not been well tested in the rangeland research literature, much of which concerns set stocking associated with permanent waters, and future monitoring may be able to shed some light on it.

The extent of fencing has economic limits. As well as the high capital cost of establishment, maintenance of fences represents a major and ongoing cost, both in labour and materials. Appropriate fencing provides increased possibilities for stock management, but it also requires labour to monitor and move stock, and to maintain the fencing. For example, fencing off water may be an effective way of spelling an area. Fencing itself does not substitute for active management. Pasture and stock condition still need to be monitored, and management intervention is still needed to maintain the land resource.

Stock water development and placement

Sheep and cattle are not true arid-zone animals, and the single most important aspect of their grazing behaviour is their need to drink frequently. The effects of this on land condition overrides differences in their forage preferences. Daily movement into and away from point water sources (such as troughs) creates the "piosphere", a roughly circular grazing zone centred on the water, in which grazing and trampling pressures are greatest near the water and least away from it. Where waters are linear, as with long open bore drains and extensive waterholes, similar zonation occurs although there is usually not the intensive concentration found about point water sources.

High pressures immediately about waterpoints cannot be totally avoided, and there will necessarily be a "sacrifice" area of land in degraded condition. Whether the loss of land condition is limited to a few tens of metres about the water as it should be, or extends to cover a significant proportion of the paddock, depends on the nature of the land unit the water is in and the number of stock using the water.

Surface waters (waterholes / earth dams and tanks), are rarely set in landscapes which are tolerant of continuous heavy stock use. These landscapes may be unstable or erosion-prone. The logical means for protecting land condition have always been either moving the waters to more robust areas, or increasing the numbers of waters so that fewer stock concentrate on each one.

Subdivisional fencing increases the effectiveness of spreading the grazing load. Simple provision of more waters, without associated fencing, may still result in concentration of stock on one water, due to stock preferences for particular pasture types or water qualities.

Use of poly-pipe allows affordable construction of stock-water pipelines. Pipelines need not always be extensive to be effective: piping water from a bore or dam sunk in a floodcourse to a trough on "harder" ground a few hundred metres away may be sufficient to minimise loss of condition of the valuable, and limited, floodcourse pasture. On the other hand, extended pipeline systems can create a spread of stock waters in an area of limited or no natural surface waters, and maximise the return on investment (both as pastoral productivity and in terms of overall land condition) from the cost of artesian well-drilling. Additional research is required to determine if the provision of additional water points reduces available habitat for native wildlife populations in areas that were previously utilised infrequently by livestock.

With a combination of well-designed and located fencing and waters, it becomes practical to fine-tune stocking levels to maintain land condition. Development of this sort, however, does require very careful planning, economic as well as directed to maintenance of the land resource. Circumstances vary throughout the District, and paddock sizes and layouts, and the detail of water placement and management will also vary. What is appropriate for a sheep station on the southern margins of the District may not be appropriate for a cattle station on the Cooper floodplains. Working out the future fencing, water placement and operation is a vital part of individual property management planning.

Stocking Limits and Strategies

Three broad stocking regimes, each involving different strategies can be recognised in the Marree SCD. The regimes are found in both sheep and cattle areas, and are determined in the first instance by the limits set by the land itself, and particularly the nature and reliability of its water supply (Table 13). Most leases work on a combination of the broad strategies, for example where part of a lease is watered through artesian bore (Type I, see Table 13) but other parts are reliant on surface catches (Type II) or on river country (Type III).

TABLE 11 LIMITS ON STOCKING STRATEGIES

Country with permanent fixed waters	
TYPE I	
Stock water is non-limiting.	Water supply is artesian and permanent. Large, almost permanent dams. Permanent sub-artesian water. Condition of pasture, combined with condition of stock determine stock levels.
Country with non-permanent or moving waters	
TYPE II	
Stock water is limiting.	Water supply is from seasonal dams, soaks or semi-permanent shallow bores. Water availability is dependent on season. Water and forage appear together. Amount of water determines whether or not land is stocked. Condition of pasture and availability of stock determines stocking levels.
TYPE III	
Stock water is limiting.	Water supply is dependent on floods. Forage growth can follow either flooding or local rain, the latter out of phase with the river or flood water supply. Amount of water, amount of forage and availability of stock together determines whether land is stocked and stocking levels.

Strategies on Type I country (stock water non-limiting)

Areas served with artesian bores or other fully permanent waters require that a careful watch is kept on both pasture condition and stock condition. The advantage of the assured water supply in terms of maintaining land condition is the scope for reticulating water. A reticulated system in combination with fencing lends itself to moving stock around the lease, depending on pasture condition.

Stock can be shifted to utilise growth from isolated storm areas, and paddocks / waterpoints can be spelled when necessary, or when Type II or Type III waters are available.

However, the permanency of the water supply creates the danger of holding too many stock for too long in one area, with a consequent loss of land condition. In other regimes, the impermanence of stock water supplies sets a final limit on the potential for over-utilisation of pastures, as stock cannot be held without water. Stocking on Type I country cannot be self-regulating in this way, and so requires active management of stock, conservatism in stocking rates, and a close watch kept on pasture conditions.

Stock movement on Type I country is regular, with off take, culling and shifting of stock in response to both pasture changes and stock condition. An example of factors and management responses is given in Figure 16.

The actual number of stock per water has to be determined by taking into account the type of country around the water, the land condition, the quality of the water, the condition and class of the stock (eg. steers or cows with calves) historical use, and the duration of concentrated stock use at that particular water.

Accepted stocking rates in the Marree SCD are generally in the range of 50 - 200 cattle per water (bore and trough combinations) or 300 - 1000 sheep per water. The lower end of the range is for dry season levels, but not major drought, and the upper end for major growth periods. Long bore drains may handle more in favourable seasons.

There can be considerable variation due to local circumstances. Temporary holding for transport, shearing or other activities requiring musters, may incur much higher numbers for short periods.

Strategies on Type II country (surface catches or shallow bores, stock water limiting)

Strategies for areas dependent on surface catches are based on utilising pastures around short-duration waters (2 - 3 months maximum) when water is available, and "falling back" to pastures around longer-duration waters (6 - 12 months duration) with increasing dryness. Short-duration waters include claypans, natural swamps and small catches. Longer duration waters are usually dams. The ultimate drought fallback is to the few dams or wells, which are almost permanent, but are capable of supporting only the core breeding stock without damage to the land condition. On Type II country, pasture growth and water availability is in phase: a rainfall event which results in major pasture growth will also provide the short-duration waters needed for stock.

The stocking strategy is summarised in Figure 17. After major rainfall, stock are driven to "outside" country with short-duration waters, while the "inside" country about the long-duration waters is largely spelled, with as many troughs and major dams as possible closed to stock. (The longer-duration waters will still have some stock present, as ready for trucking and sale depending on markets.) The stock movement allows recovery of lands which have carried stock through drought, while utilising pastures which cannot be reached by stock other than in pasture growth periods and which are not under domestic grazing pressure in drought. Stock numbers are initially low, with increases limited by breeding rates and by the economics of buying in additional stock.

As claypans and limited catches start to dry out, there is progressive culling and selling, as well as the shifting of stock into longer-duration waters. Stock numbers on longer-duration waters are continually assessed in terms of pasture condition and stock condition. Culling is regular, although market values will determine which class of stock (eg. store, fat cattle, wethers or lambs) is reduced at any given time.

As stock are moved in, stocking levels on particular areas may be temporarily high because of the need to concentrate stock for a short period for culling and sale. Culling is progressive as conditions continue to dry.

If pasture growth conditions return, stock are again moved to the "outside" country and the cycle is repeated. If drought conditions continue, stock are eventually reduced to the core breeders and moved to the almost permanent waters. Operations in effect equate to those of Type I country in prolonged drought circumstances.

The regime is largely self-regulating. Water becomes limiting before the pastures do, and over Type II country, stock should not be held into prolonged drought.

Strategies on Type III country (river and floodplain)

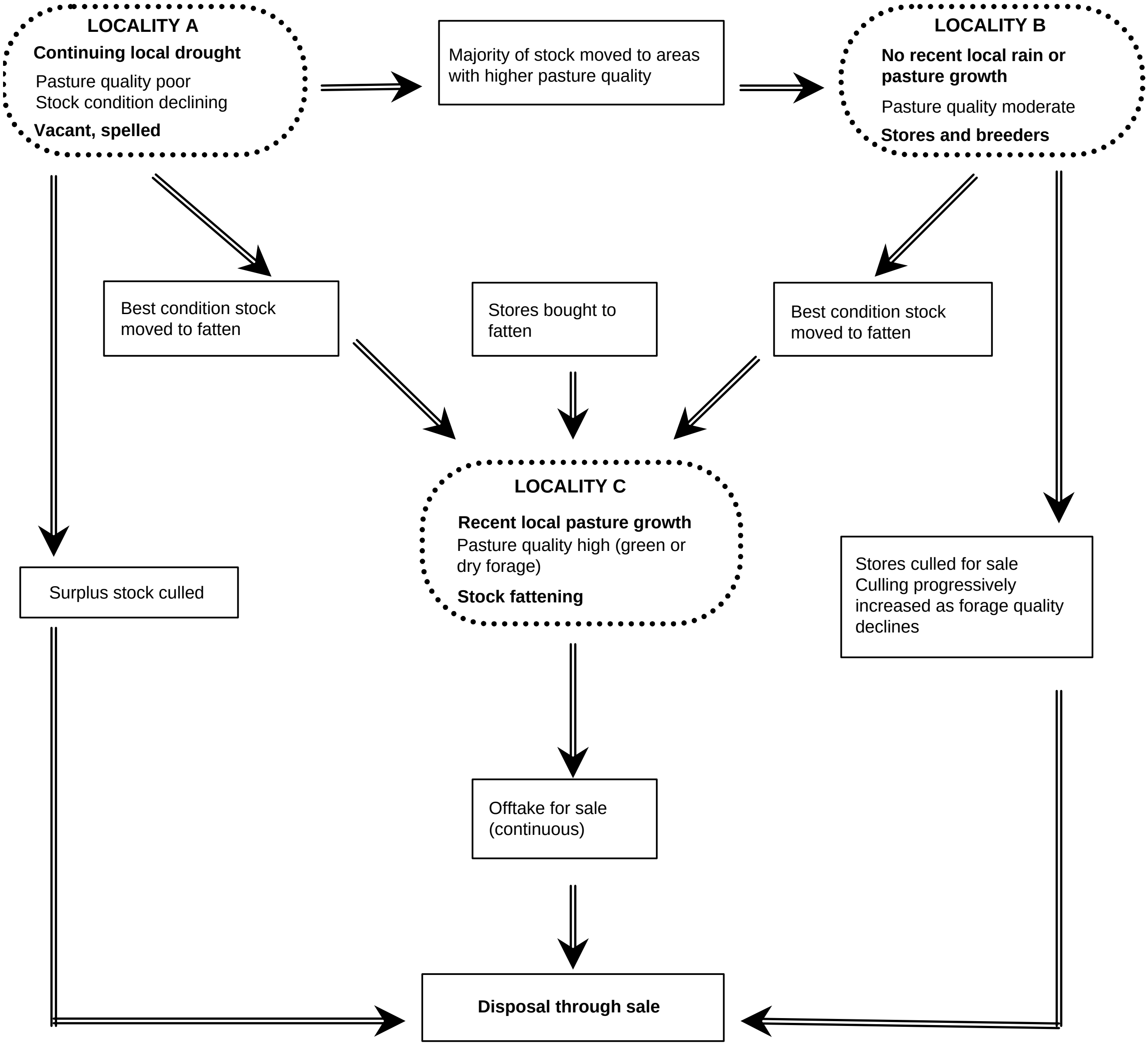
Major ephemeral growth bursts on floodplains, follow flooding. The stocking regime is necessarily highly opportunistic, since pasture growth is rapid and pasture die-off is also rapid. Water is usually not limiting while flood-driven growth is present. Lesser growth bursts of ephemerals may follow local rains, with water limited to small surface catches only. Strategies in this latter case are equivalent to those applied to "outside" areas in Type II country.

With the growth of ephemerals following flooding, cattle are transferred from Type I country and are also purchased and turned onto the floodplain.

Stock off takes are progressive as cattle fatten. Forage quality drops and water supplies dry or reduce in quality as the floodplain soils dry; this is reflected in cattle condition, and off takes increase, both through sale and shifting to swamp areas with high quality forage still present. As forage quality and quantity deteriorates further, stock are culled to pre-flood levels and returned to the "dry" Type I country (Figure 16).

On ephemeral floodplain vegetation, stock management is partly self-regulating, as is the case in Type II systems. Cattle numbers start from drought levels, the ephemeral growth is not sufficiently long lasting for cattle breeding alone to match pasture growth rates, and the bringing in of additional cattle is limited by economics. As ephemeral growth diminishes in both quantity and quality, cattle condition also falls, and again the economics require that cattle in good condition be culled before their condition declines.

There is no basis at present for arguing for a specific stocking intensity, and the long-term effect of varying individual management approaches to floodplain grazing needs research. At present, there is no agreed means for assessing floodplain condition. In areas where perennial forage is also present (old man saltbush, Queensland bluebush), there is a danger that stocking at a rate supportable by ephemeral growth may reduce the perennial component.



Localities vary with local conditions (eg. passage of storms)

Extended drought conditions:	No equivalents to Locality C
	Stores and breeders still carried
	Progressive culling and disposal
Extreme drought conditions:	No equivalents to Localities B and C
	Destocked or minimal breeding herd

Figure 13 Stocking strategy on Type I country - cattle on unlimited permanent waters.

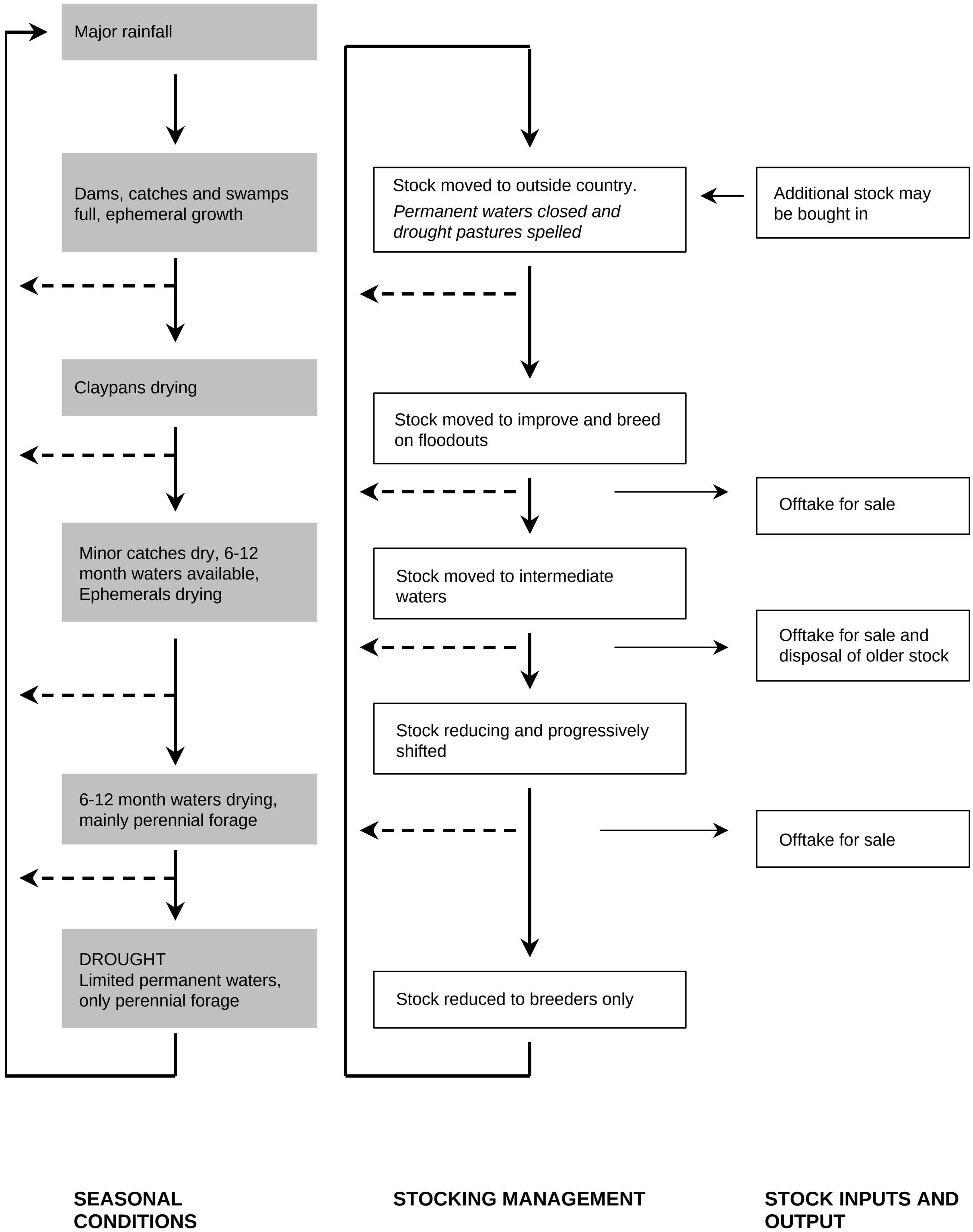


Figure 14 Stocking strategy on Type II country - limited permanent waters.

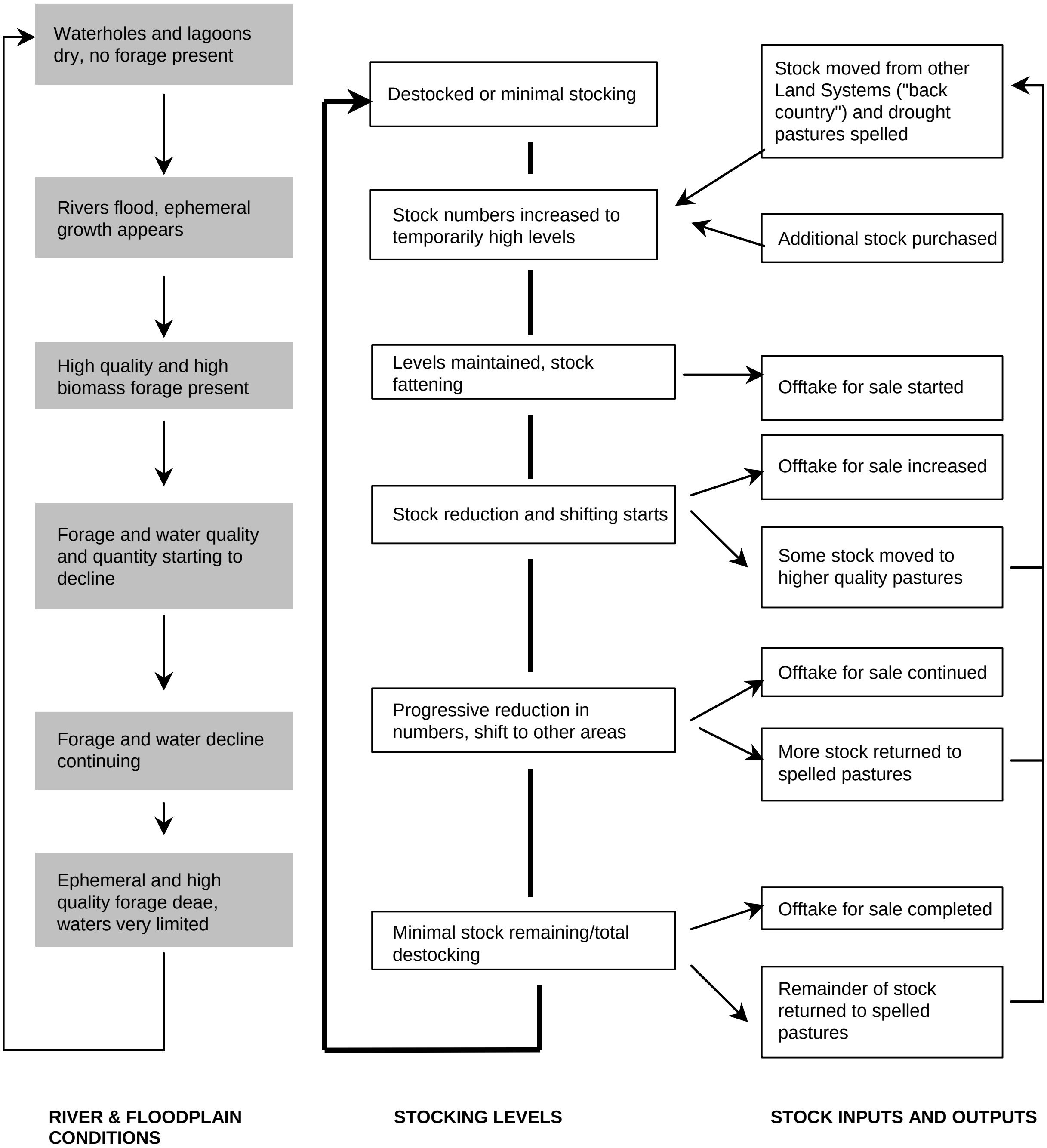


Figure 15 Stocking strategy on Type III country – river and floodplain.

PROPERTY MANAGEMENT PLANNING

Sustainable Use Aims

Pastoral management planning must aim at long-term sustainable use. Economic sustainability is a major part of this, but in terms of the *Soil Conservation and Land Care Act 1989*, and the Board's responsibilities, it is secondary to sustaining the basic soil and vegetation resource.

Basic Land Resource and Management Information Needed

The first step should be knowing the country, its variety, its possibilities and its limitations. For property planning, the starting point is a detailed assessment of the land and pastures types, the climatic variation to be expected, the existing utilisation, the appropriate stocking regime, and existing and potential land degradation issues.

One of the purposes of Land System description and mapping, as in this District Plan, is to provide a framework, which can assist both the communication and application of knowledge. At the level of an individual property, the mapping and description of pastures and soil types, the documenting of their response to changing conditions, and an assessment of their capability for use is basic to subsequent planning of pasture and stock management. For those properties, which have a Pastoral lease assessment report, much of this basic information exists at least in outline, and can be enlarged to assist detailed future planning.

Given the knowledge, pastoral activities can be altered and pastoral development can be planned to help maintain sustainable operations and to increase efficiency of use. Well-planned development leads to effective placement of fences, water and other future facilities, identification of potential "trouble spots" and knowing how the "trouble" can be avoided, and getting the best use out of potential high production areas. The results are both higher levels of land care and better production.

Experience, "Outside" Information and Documentation

The most effective property management plans will be a blend of local experience and "outside" specialist information, with the information and the plan written down. Knowledge alone is not sufficient. It has to be both applied and communicated. An effective and experienced property manager may manage well on the basis of experience only, but that experience only comes with time. Properties may change managers, or move to totally new landholders, and without a documented plan, the hard-won experience is lost to the new managers.

Evolving Management Plans

Property management plans cannot be static, once-off creations. New information becomes available, technologies change, animal husbandry practices may alter, and new land uses may appear. The initial property management plan should be considered as both a guide and a foundation, but not as the "final word". The initial plan will require fine-tuning, modification, or even major revision as circumstances change, as less successful approaches are abandoned and new approaches incorporated.

Land Care Components in Property Management Planning

Property management planning needs to consider a series of environmental and management factors which relate to soil and pasture conservation, land care and sustainable use generally. These include:

- *Local climate.* The erratic climate is the single most important control on all the systems within the District. Individual properties need to consider their local climatic "mix":
  - Local climatic and short-term seasonal variability,
  - Frequency of drought,
  - Frequency of major rainfall events and / or flooding,

- Differing responses of pastures to the patterns and timing of rainfall.

- *Soils and pasture types.* Understanding the capabilities of the various soils and pasture types, and a knowledge of their distribution across the property, is central to planning operations and utilising the country efficiently and with care
- *Soil erosion hazards.* Individual areas, which have particular soil erosion hazards, need to be identified, and management adjusted to minimise risks of accelerating existing erosion.
- *Areas where stock concentrate.* All properties will have existing areas where major stock concentrations occur, not only around waters but also in holding paddocks, yards and similar areas. Such concentrations may be unavoidable, but their location can be shifted. The significance of the existing concentrations needs to be considered in terms of soil conservation and pasture productivity. In some cases, existing points of concentration may be best left where they are (for example, yards on a low productivity tableland pasture with minimal erosion hazard). In other cases, soil conservation and pasture productivity will be better served if the cause of the concentration is moved to another, more stable and less productive land unit.
- *Areas over- or under-utilised.* Stock grazing preferences may result in one pasture type being relatively heavily utilised while other types in the same paddock are only infrequently grazed. Knowing the location and extent of such areas allows a realistic consideration of options for modifying the patterns of utilisation; fencing or water re-arrangements, active stock management, or no action.
- *Existing paddock layouts and possible subdivision or fence re-alignment.* Existing paddocks may not adequately separate land and pasture types of greatly differing capabilities, may cause stock bottlenecks, or may hinder efficient stock husbandry (for example the separation of bloodlines). Some paddocks may be appropriate for future subdivision; others may require future boundary re-alignments. Alternative fencing schemes may improve the spread of stock pressure.
- *Existing stock waters and possible future water development.* The location, quality, supply rate and permanency of existing waters are a major factor in sustainable utilisation of pastures and in maintaining stock condition. Possibilities of relocating permanent waters to more stable or resilient landscapes, of establishing reticulation systems, and of increasing the number of waters while reducing the stocking pressure around each water all should be evaluated, in conjunction with paddock design and systems of station operation.
- *Stocking strategies.* The property management plan should also lay out the basic stocking strategies to be followed. While individual strategies are likely to be generally similar to those outlined in this District Plan, no two properties are identical in the land they occupy and in the details of their pastoral enterprise. Individual properties inevitably will have significant differences in their detailed stocking strategies.
- *Special problems.* Individual properties may have local "spot" problems, for example local rabbit concentrations, difficult-to-handle feral animal problems, or a locally high tourist use. The property management plan needs to highlight such problems and assess their present and future significance.
- *Areas of special significance.* Some parts of properties may contain areas, which have special ecological and cultural significance or require special management. Some examples are springs, fossil deposits and significant mythological and archaeological sites. Specialist input may be needed to assist with management planning for these areas.

REFERENCES

Armstrong, D. (1990) Hydrology. Ch 5 in Tyler, M.J., Twidale, C.R., Davies, M. & Wells, C.B. (eds) *Natural History of the North East Deserts.* Royal Society of South Australia (Inc.), Adelaide.

Allan, R.J. (1990) Climate. Ch 6 in Tyler, M.J., Twidale, C.R., Davies, M. & Wells, C.B. (eds) *Natural History of the North East Deserts.* Royal Society of South Australia (Inc.), Adelaide.

Badman, F.J. (1989) *The Birds of Middle and Lower Cooper Creek in South Australia.* Nature Conservation Society of South Australia.

Badman, F.J., Arnold, B.K. and Bell, S.L. (1991) *A Natural History of the Lake Eyre Region.* The National Parks and Wildlife Service's Northern Consultative Committee.

Badman, F.J. (1991) Mound Springs. Ch 7 in Badman F.J., Arnold, B.K. and Bell, S.L. *A Natural History of the Lake Eyre Region.* The National Parks and Wildlife Service's Northern Consultative Committee.

Badman, F.J. (1991) Vegetation. Ch 3 in Badman F.J., Arnold, B.K. and Bell, S.L. *A Natural History of the Lake Eyre Region*. National Parks and Wildlife Northern Consultative Committee.

Badman, F.J. (1994) *Provisional List of Plants Recorded in the Marree and Marla-Oodnadatta Soil Conservation Districts, South Australia, with Common Names.* unpublished.

Bureau of Meteorology (1994) *Climate of the Marree Soil Conservation District.* Bureau report prepared for the Marree Soil Conservation Board.

Cigler, M. (1986) *Afghans in Australia.* Australian Ethnic Heritage Series.

Dulhunty, J.A. (1990) Lake Eyre. Ch 8 in Tyler, M.J., Twidale, C.R., Davies, M. & Wells, C.B. (eds) *Natural History of the North East Deserts.* Royal Society of South Australia (Inc.), Adelaide.

Fatchen, T.J. (1978) Change in grazed *Atriplex vesicaria* and *Kochia astrotricha* populations, 1929-1974. *Transactions of the Royal Society of South Australia* **102**, 39-42.

Fatchen, T.J. and Barker, S. (1979a) Cyclic vegetation pattern in the southern Simpson Desert. *Transactions of the Royal Society of South Australia* **103**, 113-121.

Fatchen, T.J. and Barker, S. (1979b) Gradients in plant species distributions in the southern Simpson Desert. *Australian Journal of Botany* **27**, 643-655.

Ford, G. (1995) *A survey and inventory of wetlands in the Channel Country, south-western Queensland.* Report to Australian Nature Conservation Agency. Department of Environment and Heritage, Toowoomba, Queensland.

Gibbs, W.J. and Maher, J.V. (1967) *Rainfall Deciles as Drought Indicators.* Bulletin No. 48, Australian Government Printing Service, Canberra.

Gibson, A.L. (1987) *Northern South Australia Cattle Industry Survey 1986.* Department of Agriculture Northern Region, South Australia.

Gillen, J.S. and Drewien, G.N. (1993) A vegetation survey of the Kanowana wetlands, Cooper Creek, South Australia. SA Department of Environment and Land Management, Adelaide.

Graetz, R.D. Tongway, D.L. and Pech, R.P. (1982) *An Ecological Classification of the Lands Comprising the Southern Simpson Desert and its Margins.* CSIRO Rangelands Research Centre Deniliquin Technical Memorandum 82 / 2.

Hercus, L.A. (1990) Aboriginal people. Ch 12 in Tyler, M.J., Twidale, C.R., Davies, M. & Wells, C.B. (eds) *Natural History of the North East Deserts.* Royal Society of South Australia (Inc.), Adelaide.

Lange, R.T. and Fatchen, T.J. (1990) Vegetation. Ch 11 in Tyler, M.J., Twidale, C.R., Davies, M. & Wells, C.B. (eds) *Natural History of the North East Deserts.* Royal Society of South Australia (Inc.), Adelaide.

Laut, P., Keig, G., Lazarides, M., Loffler, E., Margules, C., Scott, R.M. and Sullivan, M.E. (1977) *Environments of South Australia: Province 8, Northern Arid.* CSIRO Division of Land Use Research, Canberra.

Litchfield, L. (1983) *Marree and the tracks beyond in black and white - Commemorating the Centenary of Marree 1883-1983.* The author, Marree.

Meinig, D.W. (1970) *On the Margins of the Good Earth - the South Australian Wheat Frontier 1869 - 1884.* Rigby Ltd, Adelaide.

Morton, S.R. (1990) The impact of European settlement on the vertebrate animals of arid Australia: a conceptual model. *Proceedings of the Ecological Society of Australia* ***16:*** 201-213.

Playfair, R. (1992) *Flinders Ranges Integrated Resource Survey.* Pastoral Management Branch Department of Environment and Planning Internal Report.

Purdie, R. (1984) *Land Systems of the Simpson Desert Region*. CSIRO Division of Water and Land Resources Natural Resources Series No 2.

Rangeland Assessment Manual, Dulkaninna Station (1986) Edwina Faithfull (author), Land Assessment Branch, Department of Lands, Adelaide.

Rangeland Assessment Manual, Innamincka Station (1986) Edwina Faithfull (author), Land Assessment Branch, Department of Lands, Adelaide.

Ratcliffe, F.N. (1948) *Flying Fox and Drifting Sand.* Angus and Robertson, Sydney.

SANTOS (1991a) *Arid Zone Field Environmental Handbook.* 4th edn (1993 reprint). SANTOS Ltd and Delhi Petroleum Pty Ltd, Adelaide.

SANTOS (1991b) *Field Guide to the Common Plants of the Cooper Basin (South Australia and Queensland).* 2nd edn (1993 reprint). SANTOS Ltd, Adelaide.

SANTOS (1991c) *Code of Environmental Practice, Seismic.* SANTOS Ltd, Adelaide.

Tyler, M.J., Twidale, C.R., Davies, M. and Wells, C.B. (eds) (1990) *Natural History of the North East Deserts.* Royal Society of South Australia (Inc.), Adelaide.

Walsh, F.J. (1990) An ecological study of traditional Aboriginal use of "country": Martu in the Great and Little Sandy Deserts, Western Australia. *Proceedings of the Ecological Society of Australia* ***16:*** 23-37.

Williams, W.D. (1990) Salt lakes: the limnology of Lake Eyre. Ch 7 in Tyler, M.J., Twidale, C.R., Davies, M. & Wells, C.B. (eds) *Natural History of the North East Deserts.* Royal Society of South Australia (Inc.), Adelaide.

Wopfner, H. (1990) Subsurface geology and hydrocarbon deposits. Ch 2 in Tyler, M.J., Twidale, C.R., Davies, M. & Wells, C.B. (eds) *Natural History of the North East Deserts.* Royal Society of South Australia (Inc.), Adelaide.

Wright, M.J., Fitzpatrick, R.W. and Wells, C.B. (1990) Soils. Ch 4 in Tyler, M.J., Twidale, C.R., Davies, M. & Wells, C.B. (eds) *Natural History of the North East Deserts.* Royal Society of South Australia (Inc.), Adelaide.

PART IV

A GUIDE TO THE FIVE-YEAR WORK PROGRAM

WHAT IS THE FIVE-YEAR WORK PROGRAM?

The Marree Soil Conservation Board, as part of its duties under the *Soil Conservation and Land Care Act 1989*, is required to develop a program of works . "Works" within the program may be a range of activities, from direct physical soil conservation or land rehabilitation activities, to assisting community land care efforts, to community and landholder awareness programs. **A review of the previous year work program contained in the 1997 District Plan is contained in Appendix F**

A guide for the activities proposed for the **next 5-year period (2002 – 2007)** are considered priorities which are an extension of the previous program and are also in keeping with the Board's Vision Statement:

A shared conservation and land care ethic will be built for community benefit and survival.

The work program is tied to individual aims of the Board (see below). A large part of the program concerns communication and the accessing of skills and information rather than physical soil conservation works. The Board sees the exchange of local knowledge and skills, the addition of specialist information from other sources, and the direct involvement of individual landholders, and the District's community generally as the major means for improving land care in the District. The Board also has taken into account the constraints within the Marree SCD; its sheer size, its minimal infrastructure, and its very small and widely dispersed resident population. Co-ordination, communication and skills-sharing, and other activities aimed at enhancing land management, can be achieved and are practicable, and are therefore given a much higher priority than direct physical works.

AIMS OF THE MARREE SOIL CONSERVATION BOARD

1. *To encourage and promote the effective control of pest plants and animal species.*

2. *To encourage and provide for communication between the local community, the wider community and agencies and organisations involved with natural resource management.*

a. To raise awareness in the local and wider community regarding landcare in the district.
b. To provide a forum for resolving land use and land management conflicts
c. To establish and maintain broad networks of people within and outside the district, for communicating and sharing
d. To maintain the current profile and awareness of the Soil Board and its responsibilities.

3. *To share and transfer land care skills and knowledge.*

a. To share and transfer skills and knowledge of local managers
b. To share and transfer skills, knowledge and technology developed through industry and scientific activity
c. To encourage and assist land holders seeking to undertake special land care projects

4. *To promote the maintenance of viable industries through sustained health of the land and improved quality of production.*

5. *To encourage, promote and support ongoing inventory of the district's natural resources.*

6. *To encourage and promote an improvement in land condition monitoring.*

7. *To encourage and support other research which focuses on natural resource management within the district.*

8. *To maintain and improve the Board's effectiveness.*

a. To establish Soil Board offices for the repository of resources eg computers, records, maps, books, library texts, photocopier, fax etc.
b. To develop an ongoing training program, including an Induction Program for new board members, with courses on conflict/negotiation, media, working in groups etc
c. To employ a treasurer and secretarial support and budget for all activities.

9. *To seek support and funding from alternatives sources eg SANTOS, WMC and Pastoral companies.*

10. *To seek to change the Soil Conservation and Landcare Act 1989, to ensure that membership turnover is based on half on, half off at each membership term (split system) and seek to change the gender requirements so that inability to fulfil this requirement does not jeopardise the Board's ability to function and progress..*

11. *To influence the SCC to become more flexible in its dealings with Rangeland Soil Boards eg the Board should have more delegation over implementing the Board's succession planning, especially in regard to new membership, this may include attendance at meetings as part of a training program.*

THE NEXT FIVE -YEAR WORK PROGRAM ACTIVITIES – 2002 TO 2007

Aim 1: encouraging and promoting the effective control of pest plants and animal species

The Board will facilitate and lobby for greater human and physical resources to be allocated and committed to this area for pest plant and animal control and initiate research into stock poisoning.

PEST PLANTS

The Board requires full time officers to develop a strategy for the area and to function as field officers to implement and monitor the strategy with some assistance from landholders.
The components of the strategy would include:-

- Following on from a preliminary survey done in 2001/02, develop an inventory and distribution of pest plant threats – within the district and outside and adjacent to the district, including any vectors
- Identifying “hot spots” and relevant actions needed for management
- Obtaining funding for “hot spots” including on – ground works. APCC is expected to be the major funder but alternative sources will be investigated.
- Developing advanced warning and monitoring programs for pest plants encroaching from outside the district
- Monitoring known pest plants in the district as well as any treated areas
- Education and awareness programs for local communities and visitors, including though field days.
- Impact of poisoning on stock ie impact of Pimelea poisoning on stock and ongoing management practices.

This is an ongoing program.

FERAL PIGS

Based on the Management Plan developed for Innamincka Regional reserve, the Board will:-

- Work with relevant groups including NPWSA to get funding to achieve feral pig control
- Co-ordinate action and support for NPWSA, APCC, industry, other agencies and landholders involved in the program
- Promote awareness of landholder responsibilities and opportunities in controlling feral pigs, ie through field days, information brochures, survey work etc.

OTHER PEST ANIMALS – CAMELS, DONKEYS, FERAL GOATS, RABBITS, FOXES, HORSES, CATS EMUS ETC.

The Board will:-

- Survey all landholders in the district and collate information to give an overview regarding their awareness of pest animal impact and their responsibilities in control pest animals
- Assist landholders to control pest animals by promoting a co-ordinated district approach and disseminating information on the most efficient methods etc.

Aim 2: Providing for Communication

The work program associated with this aim, each dealing with a different facet of communication: general community awareness of land care in the District, resolution of conflict, sourcing people with experience and information, and explaining the special role of the Soil Board.

Raising community awareness of land care

The Board aims:-

To continue to raise awareness in the local and wider community regarding land care in the Marree Soil Conservation District.

The following activities are proposed for the next five-year program:

1. Promotion and distribution of this edition of the Marree Soil Board District Plan both locally and regionally.

The District Plan provides a summary of the environment of the District, and of land care issues within it. The District Plan is intended to be a document which is used, and which will become increasingly useful with successive revisions, *provided* it is read and commented on, and individuals contribute to future revisions from their own experience.

How will this be achieved

This will be achieved by providing a copy of the reviewed plan to all landholders in the district and putting it on the internet. Other individuals and groups may purchase a printed copy.

2. Development and presentation of talks or more formal addresses, with associated project materials, for schools and community groups generally ie Speakers Kit on CD

Talks to schools and groups can be highly effective in raising awareness of land care and land management both within and outside the District. Such talks need not only be presented by Soil Board members. However, presentations need to be well designed, both to help the individuals actually giving talks, and to avoid accidental misinformation. Supporting material is also needed, and can form the basis of project kits for schools.

How will this be achieved?

An approach is to be made to industry to assist with the development of a Speakers Kit.
Individuals from the District prepared to deliver occasional talks in their own time; production of a basic address and of supporting material (slides, videos, hand-outs). Some travel and accommodation costs to individuals; preparation and production costs of supporting material.
The Board will work with other Soil Boards to promote Landcare and the Soil Boards at local field days eg Lyndhurst, race meetings, shows etc.

Resolving land use and land management conflicts

The Board aims:-

To provide a forum for resolving land use and land management conflicts.

Landcare and land management conflicts will arise and will need resolution. While the Soil Conservation Board has direct statutory responsibilities and powers under the *Soil Conservation and Land Care Act 1989,* the preferred course of action will always be resolution of conflict rather than a resort to formal powers. There is however a need for some training in handling what potentially can be emotive and divisive problems. Apart from the Board's regular meetings, the specific activities proposed are:

- *Identification and recognition of the skills of the board members to ensure that the most appropriate people are allocated the most appropriate tasks.*

- *Training and building on current skills of all Soil Conservation Board members, in mediation and conflict resolution .*

How will this be achieved?

Soil Board support staff will work with Board members to identify strengths and weaknesses and work together to build on skills. Former soil board members may be available to support this process.

Establishing and maintaining information networks

The Board aims:-

To continue to establish and maintain existing broad networks of people, within and outside the Soil Conservation District, for communicating and sharing information eg Australian Disease Surveillance Team.

Informal networks not only promote communication but also can provide a means for maintaining contact with individuals who have special interests or can provide special expertise related to Landcare in the District. Networks can be established and maintained through several means, for example through phone and fax; by occasional newsletters; through meeting people attending relevant conferences, field days and workshops; and via the Internet. With the establishment of reliable phone, fax and dataline communications, the District is no longer isolated.

How will this be achieved?

Maintenance and updating of existing mailing list, database of names, contacts and interests; production and circulation of an occasional newsletter; Board member or nominee attendances at relevant conferences or meetings.. Newsletter reproduction and postage costs; travel assistance for conference attendances will be needed.

Maintaining the current Soil Conservation Board profile

The Board aims: -

To continue to make known the existence, responsibilities and abilities of the Soil Board

The effectiveness of the Board's operation, and the promotion of land care in the District, will be aided if all landholders have a clear knowledge of the Board's existence, purposes and responsibilities. Soil conservation and land care activities are likely to be hindered if the Board is thought to be irrelevant to land management, or to be concerned with only part of the District. The following activities are intended to ensure that the role of the Board is properly understood by land managers:

- *Circulation of information on the Soil Conservation Board.* Information may be circulated through a direct letter which provides the Soil Board's charter, responsibilities and goals, together with membership and contact information. Additional information such as the proposed brochure may be included. Distribution would be to pastoral landholders, townships, industry, Government agencies, conservation bodies and other non-government organisations.
- *Talks to local community groups.* The emphasis here is on *local* communities, as part of the Soil Conservation District, as distinct from the more general talks already discussed. However, both aspects can use the same resource materials.
- *Varying the location of formal meetings of the Soil Conservation Board.* The area of the District is approximately equivalent to that of the State of Victoria. The board has been undertaking a district tour and shifting the location of Board meetings around the District. This has given land managers in different areas the opportunity to speak to the Board, or simply observe open meetings, and has demonstrated that the concerns of the Board are not limited to any single portion of the District. This very successful initiative should be maintained.

- *Working collaboratively and supporting neighbouring Soil boards.*

Aim 3: Sharing Landcare Skills and Information

Local land management skills

The Board aims:-

To share and transfer skills and knowledge of local land managers Land managers in the Soil Conservation District collectively possess an enormous store of skill, knowledge and experience beyond that available to any single individual. Increased communication within and outside the District will assist in sharing skills and experience, specifically with Government agencies, other interest groups, media and conservation groups, to develop an understanding and respect for local knowledge and ability.

Encouragement to landholders to participate as members of the Soil Conservation Board. The Board's charter provides for changing membership. Changes in Board membership provide opportunities for bringing different experiences, different individual viewpoints and new ideas into play. It also avoids the work of the Board becoming identified with a particular set of Board members.

Utilisation of the media to spread local and topical land management information, experience and comment. More use could be made of local media, particularly local radio, as a means for sharing local management skills and promoting and recognising landholders for their good land management practices.

"Outside" information and knowledge

The Board aims:-

To share and transfer skills, knowledge and technology developed through industry and scientific activity.

This is achievable as part of communications generally, networking, field days and workshops proposed elsewhere. The aim is included as a specific recognition of the importance of accessing external skills and advances in knowledge beyond that of local land managers. However, it is important that local land managers are included and asked to comment on specific projects, to make suggestions on improving methodology based on their skills and knowledge eg biosurveys.

Land Care projects

The Board aims:-

To encourage and assist landholders seeking to undertake special land care projects.

There are numerous small and large scale land care projects possible on individual properties, eg rabbit control. Assisting individual landholders to undertake projects has the joint benefits of improving local land care and increasing information and skills exchanges. The Board will help individuals by providing access to expertise, and further links and contacts to appropriate government departments or other sources of help with the project.

How will this be achieved?
Word of mouth or informal encouragement from the Board, either directly or through circulated material.

Aim 4: Promoting Viable Industry

The Board aims:-

To promote the maintenance of viable industries through sustained health of the land and improved quality of production.

The following activities are proposed for the next five-year period.

- *A workshop will be run, focussing on review and follow up on property management planning.* One PMP workshop was held within the first three-year period. It is now timely for a review of the plans and a movement onto the next step of a detailed Business Plan. The Board can have a role in encouraging and supporting preliminary interest and then facilitating the development of a Business Planning group.
- *A* ***Marketing*** *workshop may be a suitable option for the Board to facilitate and assist in gaining funding ie through Farm Bis.* This could be extended to include working with industry bodies to do breeding trials, sustainablity trials and maximisation of feed use and efficiency.
- *A trial and evaluation of new land uses on the resource could also be undertaken, based on the outcomes and issues outlined in the Diversification workshop, held in May 2000.*
- *Existing local field days will be supported and utilised to spread new information.* In the first instance, Board materials such as leaflets, land condition booklets and the District Plan will be available at Field Days. The possibility of staging information evenings, whether at Field Days or at other community functions, should be explored.

How will this be achieved?
In partnership with agribusiness and Government agencies, particularly for gaining access to industry and scientific contributions to the workshops, and for Field Day and related promotions. A range of funding options should be sought to cover costs.

The Board also intends to educate on the impacts and management of tourism within the district. The Board will liaise with appropriate bodies and groups, in particular SA Tourism Commission, NPWSA, the Far North Consultative Committee, and the Flinders Ranges Outback Tourism Association.

Aim 5: Promoting Resource Inventory

The Board aims:-

To encourage, promote and support ongoing inventory of the District's natural resources

The Board's does not have a direct role in resource inventory, and so specific activities are similarly limited. As regards general inventory by other organisations, the Board will:

- *Provide support to agencies and other groups involved with inventory of District resources.* The Board recognises that continued inventory of the District's natural resources, particularly ongoing inventory over a range of seasons and years, will provide information for more effective management and land care. Other organisations such as PIRSA, DEH, Environment Australia, and the Australian Heritage Commission (for National Estate areas) have specific roles in resource inventory. The Board can assist indirectly as an initial point of contact between District land managers and organisations. However, the Board does not propose to contribute to costs of inventories performed by other organisations.

  Specific activities concern inventory at the individual property level. For the initial three-year period, improving land managers' skills in recognition of plants is considered a priority. Activities proposed are:

- *Continuation of the Board's plant herbarium project.* This project was completed under the previous 3 year plan, however it is being extended into a Ute Guide for Plants of the SA Rangelands. The Board is working in collaboration with other rangeland soil boards and DWLBC.

How will this be achieved?

The Board will be directly involved in monitoring the progress of this project and ensuring that the outcomes satisfy their requirements. This will involve monitoring timelines, ensuring that two way communication is maintained between the board and DWLBC and that the project is kept on target. It is important that for all collaborative projects that the board is involved in, that there is a contract which states clear timelines, agreed reporting and responsibilities and itemises accounting requirements to ensure accountability. A standard contract proforma is to be developed in conjunction with the Soil Board Liaison officer.

Aim 6: Promoting Land Condition Monitoring

The Board aims:-

To continue to encourage and promote research and improvement of land condition monitoring methods.

To continue to encourage and assist landholders to do their own land condition monitoring.

The following activities are proposed for the next five-year program:

- *Supporting landholders involved in monitoring to develop systems suitable for landholder use and analysis.*
- *Maintenance of the existing exclosure and the monitoring program*. Stock and vermin-proof exclosures allow direct comparisons of grazed and ungrazed land condition. Comparisons can be simply visual, or monitoring observations can be made. The Board has already established pilot exclosures in cooperation with some landholders, and a monitoring manual is available. The Board will been encouraging and facilitating the ongoing assessment of these exclosures. Alternative funding sources will be sought to continue this program.

Aim 7: Encouraging Natural Resource Management Research

The Board aims:-

To encourage and support other research which focuses on natural resource management within the District.

There is no specific work program proposed for this aim. Research into various aspects of the Soil Conservation District is undertaken by various Government departments and other research organisations, industry groups, universities, groups and individuals. The Board can provide encouragement and support for research with a bearing on land management, by acting as **a point of contact** between intending researchers and landholders, as an initial source of local information, and in identifying problem areas where research is particularly needed. eg there is a specific need for research into the management of fire as a management tool. There is currently a national review into the management of fire and this may give some guidance in the area.

PART V

APPENDICES

APPENDIX A

Names of previous members of the Marree Soil Conservation Board.

Bob Gaffney	Pastoralist
Lois Litchfield	Pastoralist & Historian
Gordon Litchfield	Pastoralist
Malcolm Mitchell	Pastoralist
Kevin Oldfield	Pastoralist
Grant Oldfield	Pastoralist
Daryl Bell	Pastoralist
Sharon Bell	Pastoralist
Trevor Mitchell	Pastoralist
Grant Rieck	Pastoralist
Andrew Pym ,Trevor Whitelaw	Santos Ltd, Moomba
Dean Newell, Robin Young, Trevor Naismith	National Parks & Wildlife, Hawker

APPENDIX B

PLANT SPECIES OF THE MARREE SOIL CONSERVATION DISTRICT

From Badman, F.J. (1994) *Provisional list of plants recorded in the Marree and Marla - Oodnadatta Soil Conservation Board Districts, SA, with common names.*

*Introduced species

Family	Scientific Name	Common Name
ISOETACEAE		
	Isoetes muelleri	rock quillwort
OPHIOGLOSSACEAE		
	Ophioglossum lusitanicum	austral adder's-tongue
	Ophioglossum polyphyllum	large adder's-tongue
ADIANTACEAE		
	Cheilanthes lasiophylla	woolly cloak-fern
	Cheilanthes sieberi ssp. *sieberi*	mulga fern
ASPLENIACEAE		
	Pleurosorus rutifolius	blanket fern
MARSILEACEAE		
	Marsilea costulifera	Narrow-leaved nardoo
	Marsilea drummondii	common nardoo
	Marsilea hirsuta	short-fruit nardoo
AZOLLACEAE		
	Azolla filiculoides	Red azolla
CUPRESSACEAE		
	Callitris glaucophylla	northern cypress-pine
CASUARINACEAE		
	Casuarina pauper	black oak
MORACEAE		
	Ficus platypoda	Native fig
URTICACEAE		
	Parietaria cardiostegia	mallee smooth-nettle
	Parietaria debilis	smooth-nettle
	** Urtica urens*	stinging nettle
PROTEACEAE		
	Grevillea huegelii	comb grevillea
	Grevillea juncifolia	Honeysuckle spider-flower
	Grevillea nematophylla	water bush
	Grevillea stenobotrya	Sandhill spider-flower
	Grevillea striata	beefwood
	Hakea divaricata	corkbark
	Hakea ednieana	corkbark
	Hakea eyreana	corkbark
	Hakea leucoptera	needle bush
	Hakea suberea	corkbark
SANTALACEAE		
	Exocarpos aphyllus	leafless ballart
	Santalum acuminatum	quandong
	Santalum lanceolatum	plumbush
LORANTHACEAE		
	Amyema gibberulum	
	Amyema maidenii ssp. *maidenii*	pale-leaf mistletoe
	Amyema miquelii	box mistletoe
	Amyema miraculosum ssp. *boormanii*	fleshy mistletoe
	Amyema preissii	wire-leaf mistletoe
	Diplatia grandibractea	Coolibah mistletoe
	Lysiana exocarpi ssp. *exocarpi*	harlequin mistletoe
	Lysiana murrayi	Mulga mistletoe
	Lysiana subfalcata	
POLYGONACEAE		
	** Acetosa vesicaria*	wild hops
	** Emex australis*	three-corner jack
	Muehlenbeckia adpressa	Climbing lignum
	Muehlenbeckia coccoloboides	
	Muehlenbeckia diclina ssp. *diclina*	weeping lignum
	Muehlenbeckia florulenta	lignum
	Persicaria decipiens	
	Persicaria lapathifolia	pale knotweed

Family	**Scientific Name**	**Common Name**
	* *Polygonum aviculare*	wireweed
	Polygonum plebeium	small knotweed
	Rumex crystallinus	shiny dock
GYROSTEMONACEAE		
	Codonocarpus cotinifolius	Desert poplar
GYROSTEMONACEAE	*Gyrostemon ramulosus*	Camel poison bush
	Gyrostemon tepperi	
NYCTAGINACEAE		
	Boerhavia coccinea	tar-vine
	Boerhavia dominii	tar-vine
	Boerhavia schomburgkiana	Schomburgk's tar-vine
	Commicarpus australis	pink gum-fruit
	* *Mirabilis jalapa*	Marvel-of-Peru
AIZOACEAE		
	* *Aptenia cordifolia*	Heart-leaved iceplant
	* *Galenia pubescens*	Coastal galenia
	Glinus lotoides	hairy carpet-weed
	Glinus oppositifolia	Slender carpet-weed
	Glinus orygioides	Desert carpet-weed
	Gunniopsis kochii	pigface
	Gunniopsis papillata	Twin-leaved pigface
	Gunniopsis quadrifida	Sturt's pigface
	Gunniopsis septifraga	Green pigface
	Gunniopsis tenuifolia	pigface
	Gunniopsis zygophylloides	Twin-leaved pigface
	Mollugo cerviana	wire-stem chickweed
	Sarcozona praecox	sarcozona
	Tetragonia eremaea	desert spinach
	Tetragonia tetragonioides	Warragul cabbage
	Trianthema pilosa	
	Trianthema triquetra	red spinach
	Zaleya galericulata	hogweed
PORTULACACEAE		
	Anacampseros australiana	
	Calandrinia balonensis	Broad-leaved parakeelya
	Calandrinia calyptrata	Small-leaved parakeelya
	Calandrinia corrigioloides	Strap purslane
	Calandrinia eremaea	small purslane
	* *Calandrinia menziesii*	Small purslane
	Calandrinia polyandra	parakeelya
	Calandrinia ptychosperma	creeping parakeelya
	Calandrinia pumila	Tiny purslane
	Calandrinia remota	Round-leaved parakeelya
	Calandrinia reticulata	parakeelya
	Calandrinia stagnensis	
	Calandrinia volubilis	Twining purslane
	Portulaca filifolia	Slender pigweed
	Portulaca intraterranea	Large pigweed
	Portulaca oleracea	common pigweed
CARYOPHYLLACEAE		
	* *Gypsophila tubulosa*	annual chalkwort
	* *Herniaria cinerea*	rupturewort
	Polycarpaea arida	
	Polycarpaea spirostylis ssp. *glabra*	
	* *Spergularia diandra*	lesser sand-spurrey
	* *Spergularia marina*	salt sand-spurrey
	* *Spergularia rubra*	red-spurrey
CHENOPODACEAE		
	Atriplex acutibractea ssp. *acutibractea*	pointed saltbush
	Atriplex acutiloba	
	Atriplex angulata	fan saltbush
	Atriplex cordifolia	
	Atriplex crassipes	
	Atriplex eardleyae	small saltbush
	Atriplex eichleri	Eichler's saltbush
	Atriplex elachophylla	
	Atriplex fissivalvis	Gibber saltbush
	Atriplex holocarpa	pop saltbush
	Atriplex incrassata	
	Atriplex intermedia	
	Atriplex kochiana	

Family	Scientific Name	Common Name
	Atriplex leptocarpa	Slender-fruited saltbush
	Atriplex limbata	spreading saltbush
	Atriplex lindleyi ssp.	baldoo
	Atriplex lindleyi ssp. *inflata*	corky saltbush
	Atriplex lindleyi ssp. *lindleyi*	baldoo
	Atriplex lindleyi ssp. *quadripartita*	baldoo
	Atriplex lobativalvis	
	Atriplex macropterocarpa	
	Atriplex morrisii	
CHENOPODACEAE	*Atriplex muelleri*	Muellers saltbush
	Atriplex nummularia ssp. *nummularia*	old-man saltbush
	Atriplex nummularia ssp. *omissa*	Oodnadatta saltbush
	Atriplex obconica	
	Atriplex pseudocampanulata	mealy saltbush
	Atriplex quadrivalvata var. *quadrivalvata*	
	Atriplex quadrivalvata var. *sessilifolia*	
	Atriplex quinii	
	Atriplex spongiosa	pop saltbush
	Atriplex stipitata	bitter saltbush
	Atriplex suberecta	Lagoon saltbush
	Atriplex turbinata	
	Atriplex velutinella	sandhill saltbush
	Atriplex vesicaria ssp.	bladder saltbush
	Atriplex vesicaria ssp. *calcicola*	bladder saltbush
	Atriplex vesicaria ssp. *variabilis*	bladder saltbush
	Chenopodium album	Fat hen
	Chenopodium auricomum	golden goosefoot
	Chenopodium cristatum	crested goosefoot
	Chenopodium desertorum ssp.	desert goosefoot
	Chenopodium desertorum ssp. *anidiophyllum*	mallee goosefoot
	Chenopodium desertorum ssp. *desertorum*	desert goosefoot
	Chenopodium gaudichaudianum	Cottony saltbush
	Chenopodium melanocarpum	black crumbweed
	Chenopodium melanocarpum forma *leucoparum*	
	* *Chenopodium murale*	nettle-leaf goosefoot
	Chenopodium nitrariaceum	nitre goosefoot
	Chenopodium pumilio	small crumbweed
	Chenopodium truncatum	
	Dissocarpus biflorus var. *biflorus*	twin-horned copperburr
	Dissocarpus fontinalis	
	Dissocarpus latifolius	
	Dissocarpus paradoxus	ball bindyi
	Dysphania glomulifera ssp. *eremaea*	globular pigweed
	Dysphania kalpari	kalpari
	Dysphania plantaginella	plantain crumbweed
	Dysphania platycarpa	flat-fruit crumbweed
	Dysphania rhadinostachya	Green crumbweed
	Dysphania simulans	erect crumbweed
	Einadia nutans ssp.	climbing saltbush
	Einadia nutans ssp. *eremaea*	climbing saltbush
	Einadia nutans ssp. *nutans*	climbing saltbush
	Enchylaena tomentosa var. *glabra*	ruby saltbush
	Enchylaena tomentosa var. *tomentosa*	ruby saltbush
	Eremophea spinosa	
	Eriochiton sclerolaenoides	woolly-fruit bluebush
	Halosarcia cupuliformis	samphire
	Halosarcia fontinalis	samphire
	Halosarcia halocnemoides	Grey samphire
	Halosarcia halocnemoides ssp. *halocnemoides*	grey glasswort
	Halosarcia halocnemoides ssp. *longispicata*	grey glasswort
	Halosarcia halocnemoides ssp. *tenuis*	Grey samphire
	Halosarcia indica ssp. *bidens*	brown-head samphire
	Halosarcia indica ssp. *leiostachya*	brown-head samphire
	Halosarcia lylei	
	Halosarcia nitida	shining glasswort
	Halosarcia pergranulata ssp.	black-seed samphire
	Halosarcia pergranulata ssp. *divaricata*	black-seed samphire
	Halosarcia pergranulata ssp. *elongata*	
	Halosarcia pergranulata ssp. *pergranulata*	black-seed samphire
	Halosarcia pluriflora	
	Halosarcia pruinosa	

Family	Scientific Name	Common Name
	Halosarcia pterygosperma ssp. *pterygosperma*	green samphire
	Halosarcia undulata	
	Maireana aphylla	cotton-bush
	Maireana appressa	grey bluebush
	Maireana astrotricha	grey bluebush
	Maireana campanulata	bell-fruit bluebush
	Maireana cannonii	
	Maireana carnosa	cottony bluebush
	Maireana ciliata	hairy bluebush
	Maireana coronata	crown fissure-weed
	Maireana eriantha	woolly bluebush
	Maireana erioclada	rosy bluebush
	Maireana georgei	slit-wing bluebush
CHENOPODACEAE	*Maireana integra*	entire-wing bluebush
	Maireana lanosa	
	Maireana lobiflora	lobed bluebush
	Maireana luehmannii	bluebush
	Maireana melanocarpa	Black-fruited bluebush
	Maireana microcarpa	swamp bluebush
	Maireana ovata	
	Maireana pentagona	hairy bluebush
	Maireana pentatropis	erect bluebush
	Maireana planifolia	Low bluebush
	Maireana pyramidata	black bluebush
	Maireana schistocarpa	
	Maireana scleroptera	
	Maireana sedifolia	bluebush
	Maireana spongiocarpa	spongy-fruit bluebush
	Maireana tomentosa ssp. *urceolata*	
	Maireana trichoptera	mallee bluebush
	Maireana triptera	three-wing bluebush
	Maireana turbinata	top-fruit bluebush
	Maireana villosa	Silky bluebush
	Malacocera albolanata	woolly soft-horns
	Malacocera biflora	
	Malacocera tricornis	goat-head soft-horns
	* *Monolepis spathulata*	
	Neobassia proceriflora	Soda bush
	Osteocarpum acropterum var. *acropterum*	water weed
	Osteocarpum acropterum var. *diminutum*	wingless bonefruit
	Osteocarpum dipterocarpum	two-wing bonefruit
	Rhagodia eremaea	Tall saltbush
	Rhagodia spinescens	spiny saltbush
	Rhagodia ulicina	spiny saltbush
	Salsola kali	roly-poly
	Sarcocornia blackiana	Thick-leaved glasswort
	Scleroblitum atriplicinum	purple goosefoot
	Sclerolaena articulata	Jointed poverty bush
	Sclerolaena bicornis var. *bicornis*	Goathead burr
	Sclerolaena bicuspis	
	Sclerolaena birchii	galvanised burr
	Sclerolaena blackiana	Blacks copperburr
	Sclerolaena brachyptera	short-wing bindyi
	Sclerolaena calcarata	redburr
	Sclerolaena clelandii	
	Sclerolaena constricta	
	Sclerolaena convexula	tall bindyi
	Sclerolaena cornishiana	Cartwheel burr
	Sclerolaena cuneata	poverty-bush
	Sclerolaena decurrens	green copperburr
	Sclerolaena deserticola	Desert copperburr
	Sclerolaena diacantha	grey bindyi
	Sclerolaena divaricata	poverty-bush
	Sclerolaena eriacantha	silky copperburr
	Sclerolaena fontinalis	
	Sclerolaena glabra	
	Sclerolaena holtiana	
	Sclerolaena intricata	tangled poverty-bush
	Sclerolaena johnsonii	Johnsons copperburr
	Sclerolaena lanicuspis	woolly bindyi
	Sclerolaena limbata	pearl copperburr

Family	Scientific Name	Common Name
	Sclerolaena longicuspis	long-spine poverty-bush
	Sclerolaena muricata var. *muricata*	Five-spined bassia
	Sclerolaena muricata var. *semiglabra*	Five-spined bassia
	Sclerolaena obliquicuspis	limestone copperburr
	Sclerolaena parallelicuspis	Western copperburr
	Sclerolaena parviflora	small-flower bindyi
	Sclerolaena patenticuspis	spear-fruit bindyi
	Sclerolaena tatei	Tate's bindyi
	Sclerolaena tricuspis	Glant redburr
	Sclerolaena uniflora	small-spine bindyi
	Sclerolaena ventricosa	salt bindyi
	Sclerostegia disarticulata	samphire
	Sclerostegia medullosa	glasswort
	Sclerostegia tenuis	slender glasswort
	Tecticornia verrucosa	Fat samphire
	Threlkeldia inchoata	Tall bonefruit
AMARANTHACEAE		
	* *Aerva javanica*	Kapok bush
	Alternanthera angustifolia	Narrow-leaved joyweed
	Alternanthera denticulata	lesser joyweed
	Alternanthera nana	joyweed
	Alternanthera nodiflora	common joyweed
	Amaranthus grandiflorus	large-flower amaranth
	Amaranthus interruptus	Native amaranth
	Amaranthus macrocarpus var. *macrocarpus*	Dwarf amaranth
	Amaranthus mitchellii	Boggabri weed
	* *Amaranthus viridis*	Green amaranth
	Gomphrena lanata	
	Hemichroa diandra	Mallee hemichroa
	Hemichroa mesembryanthema	
	Ptilotus aristatus var. *aristatus*	Crimson fox tail
	Ptilotus aristatus var. *eichlerianus*	
	Ptilotus barkeri	
	Ptilotus blackii	
	Ptilotus “Cordillo Downs”	
	Ptilotus decipiens	
	Ptilotus exaltatus var. *exaltatus*	tall mulla mulla
	Ptilotus gaudichaudii var. *gaudichaudii*	paper fox tail
	Ptilotus helipteroides	hairy mulla mulla
	Ptilotus helipteroides var. *helipteroides*	hairy mulla mulla
	Ptilotus helipteroides var. *minor*	hairy mulla mulla
	Ptilotus incanus var. *incanus*	
	Ptilotus latifolius var. *latifolius*	Tangled mulla mulla
	Ptilotus macrocephalus	Green pussy tail
	Ptilotus murrayi var. *major*	
	Ptilotus murrayi var. *murrayi*	
	Ptilotus nobilis var. *nobilis*	regal fox-tail
	Ptilotus obovatus var. *griseus*	Silver mulla mulla
	Ptilotus obovatus var. *obovatus*	mulla mulla
	Ptilotus parvifolius var. *parvifolius*	Shrubby fox tail
	Ptilotus polystachyus var. *polystachyus*	long-tails
	Ptilotus sessilifolius	Silver tails
RANUNCULACEAE		
	* *Myosurus minimus* var. *australis*	mousetail
	Ranunculus pentandrus var. *pentandrus*	
	Ranunculus pentandrus var. *platycarpus*	inland buttercup
	Ranunculus pumilio var. *pumilio*	ferny buttercup
	Ranunculus sessiliflorus var. *sessiliflorus*	Small-flowered buttercup
GUTTIFERAE		
	Hypericum gramineum	small St John's wort
DROSERACEAE		
	Drosera indica	flycatcher
PAPAVERACEAE		
	* *Glaucium corniculatum* var. *corniculatum*	bristly horned-
	* *Papaver hybridum*	rough poppy
CAPPARACEAE		
	Capparis mitchellii	native orange
	Cleome viscosa	Tick weed
CRUCIFERAE		
	* *Alyssum linifolium*	flax-leaf alyssum

Family	**Scientific Name**	**Common Name**
	Arabidella eremigena	priddiwalkatji
	Arabidella filifolia	thread-leaf cress
	Arabidella glaucescens	
	Arabidella nasturtium	yellow cress
	Arabidella procumbens	creeping cress
	Arabidella trisecta	shrubby cress
	Blennodia canescens	native stock
	Blennodia pterosperma	wild stock
	* *Brassica tournefortii*	long-fruit wild turnip
	* *Capsella bursapastoris*	shepherd's purse
	Carinavalva glauca	
	* *Carrichtera annua*	Ward's weed
	Cuphonotus andraeanus	Downy mother of misery
	Cuphonotus humistratus	mother of misery
	Harmsiodoxa blennodioides	hairypod cress
	Harmsiodoxa brevipes var. *brevipes*	short cress
	Harmsiodoxa brevipes var. *major*	short cress
	Harmsiodoxa puberula	
	Lepidium fasciculatum	bundled peppercress
	Lepidium muelleri-ferdinandi	Mueller's peppercress
	Lepidium oxytrichum	green peppercress
CRUCIFERAE	*Lepidium papillosum*	warty peppercress
	Lepidium phlebopetalum	veined peppercress
	Lepidium rotundum	veined peppercress
	Lepidium sagittulatum	fine-leaf peppercress
	Lepidium strongylophyllum	
	* *Matthiola incana*	Common stock
	Menkea australis	fairy spectacles
	Menkea crassa	fat spectacles
	Menkea sphaerocarpa	
	Menkea villosula	
	Phlegmatospermum cochlearinum	downy cress
	Phlegmatospermum eremaeum	Spreading cress
	* *Raphanus raphanistrum*	Wild radish
	* *Rapistrum rugosum*	Turnip weed
	* *Sisymbrium erysimoides*	smooth mustard
	* *Sisymbrium irio*	London rocket
	* *Sisymbrium orientale*	wild mustard
	Stenopetalum anfractum	
	Stenopetalum lineare	narrow thread-petal
	Stenopetalum nutans	Stinking thread-petal
	Stenopetalum velutinum	Downy thread-petal
CRASSULACEAE		
	Crassula colorata var. *acuminata*	dense stonecrop
	Crassula colorata var. *colorata*	dense stonecrop
	Crassula sieberana	crassula
PITTOSPORACEAE		
	Pittosporum phylliraeoides var. *microcarpa*	native apricot
LEGUMINOSAE		
	Acacia aneura var. *aneura*	mulga
	Acacia aneura var. *conifera*	mulga
	Acacia ayersiana Maconochie var. *ayersiana*	broad-leaf mulga
	Acacia ayersiana var. *latifolia*	broad-leaf mulga
	Acacia calcicola	Northern myall
	Acacia cambagei	gidgea
	Acacia cibaria	umbrella mulga
	Acacia confluens	wyrilda
	Acacia coriacea	Wire wood
	Acacia cowleana	
	Acacia cyperophylla	mineritchie
	Acacia dictyophleba	Waxy wattle
	Acacia estrophiolata	ironwood
	Acacia farnesiana	sweet acacia
	Acacia georginae	Georgina gidgea
	Acacia jennerae	Coonavittra wattle
	Acacia kempeana	Witchetty bush
	Acacia ligulata	umbrella bush
	Acacia minyura	Desert mulga
	Acacia murrayana	sandplain wattle
	* *Acacia nilotica*	
	Acacia nyssophylla	spine bush

Family	Scientific Name	Common Name
	Acacia oswaldii	umbrella wattle
	Acacia papyrocarpa	Western myall
	Acacia paraneura	
	Acacia pickardii	
	Acacia ramulosa	Horse mulga
	Acacia rigens	Nealie
	Acacia rivalis	Silver wattle
	Acacia salicina	Broughton willow
	Acacia stenophylla	River coobah
	Acacia stowardii	Bastard mulga
	Acacia tenuissima	
	Acacia tetragonophylla	dead finish
	Acacia victoriae ssp. *arida*	elegant wattle
	Acacia victoriae ssp. *victoriae*	elegant wattle
	Aeschynomene indica	Budda pea
	Crotalaria cunninghamii	Birdflower
	Crotalaria eremaea ssp. *eremaea*	bluebush pea
	Crotalaria eremaea ssp. *strehlowii*	Bluebush pea
	Crotalaria medicaginea	Trefoil rattlepod
	Crotalaria novae-hollandiae ssp*. lasiophylla*	
	Crotalaria smithiana	Yellow rattlepod
	Erythrina vespertilio	Bats wing coral tree
	Galactia tenuiflora	
	Glycine canescens	silky glycine
	Glycine clandestina var. *sericea*	Twining glycine
LEGUMINOSAE	*Indigofera australis* var. *australis*	austral indigo
	Indigofera colutea	Sticky indigo
	Indigofera georgei	Georges indigo
	Indigofera leucotricha	Silver indigo
	Indigofera linifolia	Native indigo
	Indigofera linnaei	Birdsville indigo
	Indigofera longibractea	Showy indigo
	Indigofera psammophila	Desert indigo
	Isotropis wheeleri	Wheelers lamb-poison
	Lotus cruentus	red-flower lotus
	Lysiphyllum gilvum	Bauhinia
	** Medicago orbicularis*	Button medic
	** Medicago polymorpha* var. *polymorpha*	burr-medic
	Neptunia dimorphantha	Sensitive plant
	Petalostylis labicheoides	
	** Prosopis juliflora*	Mesquite
	Psoralea australasica	tall scurf-pea
	Psoralea cinerea	hoary scurf-pea
	Psoralea graveolens	Native lucerne
	Psoralea pallida	Bullamon lucerne
	Psoralea patens	Native verbine
	Ptsychosema anomalum	
	Rhynchosia minima	rhynchosia
	Senna artemisioides nothossp. *artemisioides*	Silver senna
	Senna artemisioides nothossp. *coriacea*	broad-leaf desert senna
	Senna artemisioides nothossp. *sturtii*	grey senna
	Senna artemisioides ssp. *alicia*	desert senna
	Senna artemisioides ssp. *filifolia*	fine-leaf desert senna
	Senna artemisioides ssp. *helmsii*	blunt-leaf senna
	Senna artemisioides ssp. *oligophylla*	limestone senna
	Senna artemisioides ssp. *petiolaris*	flat-stalk senna
	Senna artemisioides ssp. *quadrifolia*	four-leaf desert senna
	Senna artemisioides ssp. *zygophylla*	twin-leaf desert senna
	Senna cardiosperma ssp. *gawlerensis*	Gawler Ranges senna
	Senna cardiosperma ssp. *microphylla*	Cassia
	Senna glutinosa ssp. *pruinosa*	
	Senna occidentalis	
	Senna planitiicola	
	Senna pleurocarpa var*. pleurocarpa*	Firebush
	Sesbania cannabina var. *cannabina*	Yellow pea-bush
	Swainsona adenophylla	
	Swainsona affinis	Small-leaved swainsona pea
	Swainsona burkei	Burke swainsona
	Swainsona campylantha	Pea flower
	Swainsona canescens var. *canescens*	Grey canescens
	Swainsona flavicarinata	yellow-keel swainson-pea

Family	Scientific Name	Common Name
	Swainsona formosa	Sturt's desert-pea
	Swainsona microphylla ssp. *pallescens*	Yellow poison-pea
	Swainsona microphylla ssp. *tomentosa*	Downy poison-pea
	Swainsona oligophylla	
	Swainsona oliveri	
	Swainsona oroboides	Variable swainsona
	Swainsona phacoides ssp. *phacoides*	dwarf swainsona
	Swainsona procumbens	Broughton pea
	Swainsona purpurea	
	Swainsona pyrophila	yellow Darling pea
	Swainsona stipularis	orange Darling pea
	Swainsona swainsonioides	downy Darling pea
	Swainsona tephrotricha	ashy-haired swainsona
	Swainsona villosa	
	Templetonia egena	desert broombush
	Tephrosia rosea	
	Tephrosia sphaerospora	mulga trefoil
	Trifolium glomeratum	Cluster clover
	Trigonella suavissima	channel clover
	* *Vicia monantha*	spurred vetch
	Vigna lanceolata var. *latifolia*	Yam
OXALIDACEAE		
	Oxalis perennans	native sorrel
GERANIACEAE		
	Erodium angustilobum	Crowfoot
	* *Erodium aureum*	
	* *Erodium cicutarium*	common stork's-bill
	Erodium crinitum	blue stork's-bill
	Erodium cygnorum ssp. *cygnorum*	blue heron's-bill
GERANIACEAE	*Erodium cygnorum* ssp. *glandulosum*	clammy heron's-bill
ZYGOPHYLLACEAE		
	Nitraria billardierei	nitrebush
	Tribulus astrocarpus	Caltrop
	Tribulus hystrix	Caltrop
	Tribulus macrocarpus	
	Tribulus occidentalis	Bull-head
	* *Tribulus terrestris*	caltrop
	Zygophyllum ammophilum	sand twinleaf
	Zygophyllum apiculatum	pointed twinleaf
	Zygophyllum aurantiacum	shrubby twinleaf
	Zygophyllum billardierei	scrambling twinleaf
	Zygophyllum compressum	rabbit-ears twinleaf
	Zygophyllum confluens	forked twinleaf
	Zygophyllum crassissimum	
	Zygophyllum crenatum	notched twinleaf
	Zygophyllum emarginatum	
	Zygophyllum eremaeum	climbing twinleaf
	Zygophyllum howittii	clasping twinleaf
	Zygophyllum humillimum	small-fruit twinleaf
	Zygophyllum hybridum	
	Zygophyllum iodocarpum	violet twinleaf
	Zygophyllum kochii	
	Zygophyllum prismatothecum	square-fruit twinleaf
	Zygophyllum simile	
	Zygophyllum "Terete leaves"	
	Zygophyllum tesquorum	
LINACEAE		
	* *Linum trigynum*	French flax
EUPHORBIACEAE		
	Adriana hookeri	Mallee bitterbush
	Beyeria opaca	Dark turpentine bush
	Calycopeplus paucifolius	
	Euphorbia australis	caustic weed
	Euphorbia coghlanii	
	Euphorbia drummondii	caustic weed
	Euphorbia inappendiculata	
	Euphorbia "Marree"	
	Euphorbia mitchelliana var. *mitchelliana*	
	Euphorbia parvicaruncula	rough-seeded spurge
	Euphorbia planiticola	Plains spurge
	Euphorbia stevenii	bottletree caustic

Family	Scientific Name	Common Name
	Euphorbia tannensis ssp. *eremophila*	bottle tree caustic
	Euphorbia wheeleri	Wheeler's spurge
	Phyllanthus fuernrohrii	Sand spurge
	Phyllanthus lacunarius	lagoon spurge
	Phyllanthus maderaspatensis var. *angustifolius*	
	* *Ricinus communis*	castor oil plant
	Sauropus ramosissimus	
	Sauropus rigens	stiff spurge
	Sauropus trachyspermus	slender spurge
MELIACEAE		
	Owenia acidula	Emu apple
POLYGALACEAE		
	Polygala isingii	Milkwort
SAPINDACEAE		
	Alectryon oleifolius ssp. *canescens*	bullock bush
	Atalaya hemiglauca	whitewood
	Dodonaea microzyga var. *microzyga*	brilliant hop-bush
	Dodonaea viscosa ssp. *angustissima*	narrow-leaf hop-bush
	Dodonaea viscosa ssp. *mucronata*	sticky hop-bush
	Dodonaea viscosa ssp. *spatulata*	sticky hop-bush
STACKHOUSIACEAE		
	Macgregoria racemigera	Carpet-of-snow
	Stackhousia clementii	
MALVACEAE		
	Abutilon macrum	Slender lantern-bush
	Abutilon malvaefolium	scrambling lantern-bush
	Abutilon otocarpum	desert Chinese-lantern
	Abutilon oxycarpum var. *oxycarpum*	Flannel weed
	* *Abutilon theophrasti*	Swamp Chinese- lantern
	Althaea australis	
	Gossypium sturtianum var. *sturtianum*	Sturt's desert rose
	Hibiscus brachysiphonius	Low hibiscus
MALVACEAE	*Hibiscus krichauffianus*	velvet-leaf hibiscus
	Hibiscus sturtii var. *grandiflorus*	hill hibiscus
	Hibiscus trionum var. *trionum*	Bladder ketmia
	Hibiscus trionum var. *vesicarius*	Bladder ketmia
	Lavatera plebeia	native hollyhock
	Lawrencia glomerata	clustered lawrencia
	Lawrencia squamata	thorny lawrencia
	* *Malva parviflora*	marshmallow
	Malvastrum americanum	malvastrum
	Sida ammophila	sand sida
	Sida argillacea	
	Sida calyxhymenia	Tall sida
	Sida corrugata var.	corrugated sida
	Sida cunninghamii	Ridge sida
	Sida everistiana	
	Sida fibulifera	silver sida
	Sida goniocarpa	
	Sida intricata	twiggy sida
	Sida petrophila	rock sida
	Sida rohlenae	Shrub sida
	Sida trichopoda	narrow-leaf sida
STERCULIACEAE		
	Gilesia biniflora	western tar-vine
	Keraudrenia nephrosperma	Common firebush
	Melhania oblongifolia	velvet hibiscus
	Rulingia loxophylla	
THYMELAEACEAE		
	Pimelea elongata	
	Pimelea microcephala ssp. *microcephala*	mallee riceflower
	Pimelea penicillaris	Sandhill riceflower
	Pimelea simplex ssp. *continua*	desert riceflower
	Pimelea trichostachya	spiked riceflower
VIOLACEAE		
	Hybanthus aurantiacus	
TAMARICACEAE		
	* *Tamarix aphylla*	Athel pine
FRANKENIACEAE		
	Frankenia cupularis	

Family	Scientific Name	Common Name
	Frankenia foliosa	Leafy sea-heath
	Frankenia pauciflora	Common sea-heath
	Frankenia pauciflora var. *fruticulosa*	Common sea-heath
	Frankenia pauciflora var. *gunnii*	Common sea-heath
	Frankenia plicata	
	Frankenia serpyllifolia	bristly sea-heath
	Frankenia subteres	
ELATINACEAE		
	Bergia ammannioides	Water-fire
	Bergia diacheiron	
	Bergia occultipetala	
	Bergia perennis ssp. obtusifolia	
	Bergia trimera	three-part water-fire
	Elatine gratioloides	Waterwort
CUCURBITACEAE		
	* *Citrullus colocynthis*	Paddy melon
	* *Citrullus lanatus* var. *lanatus*	bitter melon
	Cucumis melo	Ulcardo melon
	* *Cucumis myriocarpus*	paddy melon
	* *Cucurbita pepo*	
	Momordica balsamina	Balsam apple
	Mukia maderaspatana	Snake vine
	Mukia micrantha	Desert cucumber
LYTHRACEAE		
	Ammannia multiflora	Jerry-jerry
	Lythrum hyssopifolia	Lesser loosestrife
	Lythrum salicaria	Purple loosestrife
	Lythrum wilsonii	Wilson's loosestrife
MYRTACEAE		
	Eucalyptus camaldulensis var. *obtusa*	northern river red gum
	Eucalyptus centralis	Bloodwood
	Eucalyptus coolabah ssp. *arida*	coolibah
	Eucalyptus gillii	curly mallee
	Eucalyptus intertexta	gum-barked coolibah
	Eucalyptus oleosa	red mallee
	Eucalyptus oxymitra	Sharp-capped mallee
	Eucalyptus socialis	red mallee
MYRTACEAE	*Melaleuca dissitiflora*	
	Melaleuca glomerata	desert paper-bark
	Melaleuca pauperiflora	Boree
	Melaleuca uncinata	Broombush
	Thryptomene maisonneuvei	Desert heath myrtle
ONAGRACEAE		
	* *Ludwigia peploides* ssp. *montevidensis*	Water primrose
HALORAGACEAE		
	Haloragis aspera	rough raspwort
	Haloragis glauca forma *sclopetifera*	Grey raspwort
	Haloragis gossei	
	Haloragis odontocarpa	Mulga spinach
	Myriophyllum verrucosum	red water-milfoil
UMBELLIFERAE		
	Daucus glochidiatus	native carrot
	Eryngium plantagineum	Long eryngium
	Eryngium supinum	Little devil
	Hydrocotyle trachycarpa	wild parsley
	Hydrocotyle verticillata	Shield pennywort
	Trachymene glaucifolia	wild parsnip
PRIMULACEAE		
	* *Anagallis arvensis*	Blue / scarlet pimpernel
	* *Samolus repens*	creeping brookweed
OLEACEAE		
	Jasminum didymum ssp. *lineare*	native jasmine
GENTIANACEAE		
	* *Centaurium spicatum*	spike centaury
	Centaurium tenuiflorum	Branched centaury
MENYANTHACEAE		
	Nymphoides crenata	Wavy marshwort
ASCLEPIADACEAE		
	* *Calotropis procera*	
	Cynanchum floribundum	Desert cynanchum
	Marsdenia australis	native pear

Family	Scientific Name	Common Name
	Rhyncharrhena linearis	Climbing purple-star
	Sarcostemma viminale ssp. *australe*	caustic bush
RUBIACEAE		
	Asperula gemella	Twin-leaved bedstraw
	Canthium latifolium	Native currant
	Dentella pulvinata	
	Pomax umbellata	pomax
	Synaptantha tillaeacea	
CONVOLVULACEAE		
	Convolvulus erubescens	Australian bindweed
	Convolvulus microsepalus	small-flower bindweed
	Convolvulus remotus	grassy bindweed
	Cressa cretica	rosinweed
	Cuscuta australis	
	Cuscuta victoriana	Dodder
	Evolvulus alsinoides var. *decumbens*	tropical speedwell
	Evolvulus alsinoides var. *villosicalyx*	
	Ipomoea diamantinensis	Desert cow-vine
	Ipomoea lonchophylla	Cow-vine
	Ipomoea muelleri	Poison morning glory
	Ipomoea polymorpha	Silky cow-vine
	Ipomoea racemigera	Inland bell-vine
BORAGINACEAE		
	* *Buglossoides arvensis*	sheepweed
	Cynoglossum australe	Australian hound's tongue
	* *Echium plantagineum*	Salvation Jane
	Embadium johnstonii	
	Halgania cyanea	rough halgania
	Heliotropium asperrimum	Rough heliotrope
	* *Heliotropium curassavicum*	smooth heliotrope
	* *Heliotropium europaeum*	potato weed
	Heliotropium filaginoides	
	Heliotropium gossei	
	Heliotropium ovalifolium	
	* *Heliotropium supinum*	prostrate heliotrope
	Heliotropium tenuifolium	Heliotrope
	Heliotropium undulatum	Burr stickseed
	Omphalolappula concava	burr stickseed
	Plagiobothrys plurisepaleus	white forget-me-not
	Trichodesma zeylanicum	camel bush
VERBENACEAE		
	* *Verbena officinalis*	common verbena
	* *Verbena supina*	trailing verbena
CHOLANTHACEAE		
	Dicrastylis costelloi var. *costelloi*	
	Dicrastylis costelloi var. *eriantha*	
	Dicrastylis costelloi var. *globulifera*	
	Dicrastylis costelloi var. *violacea*	
	Dicrastylis lewellinii	Purple sand sage
	Newcastelia cephalantha var. *cephalantha*	
	Newcastelia spodiotricha	
	Spartothamnella teucriiflora	Bead bush
CALLITRICHACEAE		
	Callitriche sonderi	Matted water starwort
LABIATAE		
	* *Lamium amplexicaule*	Deadnettle
	Mentha australis	River mint
	Plectranthus intraterraneus	purple mintbush
	Prostanthera althoferi ssp. *longifolia*	
	Prostanthera striatiflora	striated mintbush
	Teucrium albicaule	scurfy germander
	Teucrium corymbosum	Forest germander
	Teucrium racemosum	grey germander
SOLANACEAE		
	* *Datura leichhardtii*	native thorn-apple
	Duboisia hopwoodii	pituri
	Lycium australe	Australian boxthorn
	* *Lycium ferocissimum*	African boxthorn
	* *Lycopersicon esculentum*	Tomato
	Nicotiana burbidgeae	

Family	Scientific Name	Common Name
	Nicotiana excelsior	
	* *Nicotiana glauca*	tobacco bush
	Nicotiana occidentalis ssp. *obliqua*	
	Nicotiana rosulata ssp. *rosulata*	native tobacco
	Nicotiana simulans	Wild tobacco
	Nicotiana velutina	velvet tobacco
	Solanum centrale	Desert raisin
	Solanum chenopodinum	goosefoot potato-bush
	Solanum cleistogamum	Shy nightshade
	Solanum coactiliferum	tomato-bush
	Solanum ellipticum	potato-bush
	Solanum esuriale	quena
	Solanum lacunarium	Lagoon nightshade
	Solanum lasiophyllum	Flannel bush
	* *Solanum nigrum*	black nightshade
	Solanum oligacanthum	Desert nightshade
	Solanum petrophilum	rock nightshade
	Solanum quadriloculatum	tomato bush
	Solanum sturtianum	Sturt's nightshade
SCROPHULARIACEAE		
	Elacholoma hornii	
	Glossostigma cleistanthum	spoon mud-mat
	Glossostigma diandrum	two-anther mud-mat
	Glossostigma drummondii	Desert mud-mat
	* *Kickxia elatine* ssp. *crinita*	Twining toadflax
	Limosella australis	Australian mudwort
	Limosella curdieana	large mudwort
	Limosella curdieana var. *"curdieana"*	large mudwort
	Limosella curdieana var. *"Long-pedicelled"(W.R.Barker 10)*	large mudwort
	Mimulus gracilis	Slender monkey-flower
	Mimulus repens	Creeping monkey-flower
	Peplidium aithocheilum	
	Peplidium foecundum	dwarf peplidium
	Peplidium sp. **B**	
	Peplidium sp. "Marla"	
	Stemodia florulenta	bluerod
	Stemodia glabella	Smooth blue rod
	Stemodia "Haegii"	
	* *Veronica peregrina* ssp. *xalapensis*	Wandering speedwell
ACANTHACEAE		
	Dipteracanthus australasicus ssp. *australasicus*	Pink tongues
	Dipteracanthus australasicus ssp. *glabratus*	pink tongues
	Rostellularia adscendens ssp. *adscendens*	pink tongues
ACANTHACEAE	*Rostellularia adscendens* ssp. *adscendens* var. *pogonanthera*	pink tongues
	Rostellularia adscendens ssp. *clementii* var. *clementii*	pink tongues
PEDALIACEAE		
	Josephinia eugeniae	Josephinia burr
OROBANCHACEAE		
	Orobanche cernua var. *australiana*	Australian broomrape
MYOPORACEAE		
	Eremophila alternifolia	narrow-leaf fuchsia-bush
	Eremophila battii	Short-leaved emubush
	Eremophila bignoniiflora	Bignonia emubush
	Eremophila bowmanii ssp. *latifolia*	Silver turkey-bush
	Eremophila dalyana	
	Eremophila deserti	turkey-bush
	Eremophila duttonii	harlequin fuchsia-bush
	Eremophila freelingii	rock fuchsia-bush
	Eremophila gilesii	Green turkey-bush
	Eremophila glabra	Tar bush
	Eremophila latrobei ssp. *glabra*	Crimson turkey-bush
	Eremophila longifolia	weeping emubush
	Eremophila macdonnellii	Macdonnells desert fuschia
	Eremophila macgillivrayi	Dog-bush
	Eremophila maculata var. *maculata*	spotted emubush
	Eremophila neglecta	Tar bush
	Eremophila obovata var. *obovata*	
	Eremophila oppositifolia var. *oppositifolia*	twin-leaf emubush

Family	Scientific Name	Common Name
	Eremophila paisleyi	
	Eremophila pentaptera	
	Eremophila polyclada	Flowering lignum
	Eremophila rotundifolia	Round-leaf emubush
	Eremophila scoparia	broom emubush
	Eremophila serrulata	green fuchsia-bush
	Eremophila sturtii	turpentine bush
	Eremophila verrucosa ssp. *verrucosa*	
	Eremophila willsii	Sandhill native fuchsia
	Myoporum brevipes	
	Myoporum montanum	native myrtle
	Myoporum platycarpum ssp. *platycarpum*	false sandalwood
PLANTAGINACEAE		
	* *Plantago coronopus* ssp. *commutata*	bucks-horn plantain
	Plantago cunninghamii	Sago weed
	Plantago drummondii	sago weed
	Plantago hispida	
	Plantago multiscapa	
	Plantago sp. B	plantain
	Plantago turrifera	Small sago weed
CAMPANULACEAE		
	Isotoma petraea	rock isotome
	Wahlenbergia communis	tufted bluebell
	Wahlenbergia gracilenta	annual bluebell
	Wahlenbergia queenslandica	Native bluebell
	Wahlenbergia tumidifructa	swollen-fruit bluebell
GOODENIACEAE		
	Brunonia australis	Blue pin-cushion
	Goodenia anfracta	
	Goodenia berardiana	twin-head goodenia
	Goodenia calcarata	streaked goodenia
	Goodenia chambersii	
	Goodenia cycloptera	serrated goodenia
	Goodenia fascicularis	silky goodenia
	Goodenia gibbosa	
	Goodenia glabra	Shining pansy
	Goodenia glauca	Pale goodenia
	Goodenia havilandii	hill goodenia
	Goodenia heterochila	Serrated goodenia
	Goodenia lobata	
	Goodenia modesta	
	Goodenia occidentalis	
	Goodenia pinnatifida	cut-leaf goodenia
	Goodenia pusilliflora	small-flower goodenia
	Goodenia saccata	
	Lechenaultia divaricata	Tangled leschenaultia
	Scaevola amblyanthera var. *centralis*	
	Scaevola collaris	
	Scaevola collina	
GOODENIACEAE	*Scaevola depauperata*	Skeleton fanflower
	Scaevola humilis	inland fanflower
	Scaevola parvibarbata	small-beard fanflower
	Scaevola spinescens	spiny fanflower
	Velleia arguta	spur velleia
	Velleia glabrata	Smooth velleia
STYLIDIACEAE		
	Stylidium desertorum	Trigger plant
COMPOSITAE		
	Actinobole uliginosum	flannel cudweed
	Anemocarpa podolepidium	rock everlasting
	Anemocarpa saxatilis	Hill sunray
	Angianthus brachypappus	spreading cup-flower
	Angianthus tomentosus	hairy cup-flower
	* *Arctotheca calendula*	Capeweed
	* *Aster subulatus*	wild aster
	Brachycome basaltica var. *gracilis*	Swamp daisy
	Brachycome campylocarpa	large white daisy
	Brachycome ciliaris var. *ciliaris*	variable daisy
	Brachycome ciliaris var. *lanuginosa*	woolly variable daisy
	Brachycome ciliaris var. *lyrifolia*	Variable daisy
	Brachycome dichromosomatica var. *dichromosomatica*	

Family	Scientific Name	Common Name
	Brachycome eriogona	woolly-seed daisy
	Brachycome exilis	Slender daisy
	Brachycome iberidifolia	Swan River daisy
	Brachycome leptocarpa	Small hairy daisy
	Brachycome lineariloba	hard-head daisy
	Brachycome melanocarpa	Black-seed daisy
	Brachycome rara	
	Brachycome tesquorum	
	Bracteantha bracteata	golden everlasting
	* *Calendula arvensis*	field marigold
	Calocephalus knappii	Billybuttons
	Calocephalus platycephalus	billybuttons
	Calocephalus sp. aff. *Platycephalus*	billybuttons
	Calocephalus sonderi	Pale beauty heads
	Calotis ancyrocarpa	anchor burr-daisy
	Calotis cymbacantha	showy burr-daisy
	Calotis erinacea	tangled burr-daisy
	Calotis hispidula	bogan flea
	Calotis kempei	
	Calotis lappulacea	yellow burr-daisy
	Calotis latiuscula	leafy burr-daisy
	Calotis multicaulis	woolly-headed burr-daisy
	Calotis plumulifera	woolly-headed burr-daisy
	Calotis porphyroglossa	channel burr-daisy
	Calotis scabiosifolia	Rough burr-daisy
	* *Carthamus lanatus*	saffron thistle
	* *Centaurea melitensis*	Maltese cockspur
	Centipeda cunninghamii	common sneezeweed
	Centipeda minima	sneezeweed
	Centipeda thespidioides	desert sneezeweed
	Chrysocephalum apiculatum	common everlasting
	Chrysocephalum eremaeum	
	Chrysocephalum pterochaetum	shrub everlasting
	Chrysocephalum semicalvum ssp. *semicalvum*	hill everlasting
	Chrysocoryne pusilla	
	Chthonocephalus pseudovax	Ground heads
	* *Cotula coronopifolia*	Water buttons
	Craspedia chrysantha	golden billy-buttons
	Craspedia glauca	billy-buttons
	Craspedia globosa	Drumsticks
	Craspedia pleiocephala	soft billy-buttons
	Dichromochlamys dentatifolius	
	Dimorphocoma minutula	
	Elachanthus pusillus	Elachanth
	Epaltes australis	spreading nut-heads
	Epaltes cunninghamii	Tall nut-heads
	Erigeron sessilifolius	Woolly mantle
	Eriochlamys behrii	woolly mantle
	Euchiton sphaericus	annual cudweed
	Flaveria australasica	yellow twin-stem
	Glossogyne tannensis	
	Gnaphalium diamantinense	
	Gnaphalium indutum	Tiny cudweed
COMPOSITAE	* *Gnaphalium polycaulon*	western cudweed
	Gnephosis arachnoidea	spidery button-flower
	Gnephosis eriocarpa	native camomile
	Gnephosis tenuissima	dwarf cup-flower
	Gratwickia monochaeta	
	* *Hedypnois rhagadioloides*	Cretan weed
	Hyalosperma semisterile	orange sunray
	* *Hypochaeris glabra*	smooth cat's ear
	Isoetopsis graminifolia	grass cushion
	Ixiochlamys cuneifolia	
	Ixiochlamys filicifolia	
	Ixiochlamys nana	small fuzzweed
	Ixiolaena brevicompta	Plains plover-daisy
	Ixiolaena chloroleuca	pale plover-daisy
	Ixiolaena leptolepis	stalked plover-daisy
	Ixiolaena tomentosa	woolly plover-daisy
	Kippistia suaedifolia	fleshy minuria
	* *Lactuca saligna*	Willow lettuce

Family	Scientific Name	Common Name
	Lawrencella davenportii	Sticky everlasting
	Lemooria burkittii	wires-and-wool
	Leptorhynchos baileyi	
	Leucochrysum fitzgibbonii	Glandular sunray
	Leucochrysum molle	hoary sunray
	Leucochrysum stipitatum	Woolly sunray
	* *Logfia gallica*	Narrow cudweed
	Millotia greevesii ssp. *greevesii* var. *greevesii*	Creeping millotia
	Millotia greevesii ssp. *kempei* var. *helmsii*	Creeping millotia
	Millotia greevesii ssp. *kempei* var. *kempei*	Creeping millotia
	Millotia myosotidifolia	broad-leaf millotia
	Millotia perpusilla	tiny bow-flower
	Minuria annua	annual minuria
	Minuria cunninghamii	bush minuria
	Minuria denticulata	woolly minuria
	Minuria integerrima	smooth minuria
	Minuria leptophylla	minnie daisy
	Minuria rigida	Daisy bush
	Myriocephalus pluriflorus	inland woolly-heads
	Myriocephalus rhizocephalus	woolly-heads
	Myriocephalus rudallii	
	Olearia arida	
	Olearia decurrens	clammy daisy-bush
	Olearia stuartii	Daisy-bush
	Olearia subspicata	shrubby daisy-bush
	* *Oncosiphon suffruticosum*	
	Othonna gregorii	fleshy groundsel
	Othonna gypsophila	
	* *Picris hieracioides* var. *hieracioides*	Hawkweed picris
	Pluchea dentex	bowl daisy
	Pluchea rubelliflora	Bowl daisy
	Pluchea tetranthera var. *tetranthera*	Pink plains-daisy
	Podolepis arachnoidea	clustered copper-wire daisy
	Podolepis canescens	large copper-wire daisy
	Podolepis capillaris	invisible plant
	Podolepis davisiana	
	Podolepis jaceoides	Showy copper-wire daisy
	Podolepis rugata var. *rugata*	Pleated podolepis
	Polycalymma stuartii	poached-egg daisy
	Pseudognaphalium luteoalbum	Jersey cudweed
	Pterocaulon sphacelatum	apple-bush
	Rhodanthe charsleyae	Charles daisy
	Rhodanthe citrina	Pale immortelle
	Rhodanthe corymbiflora	grey sunray
	Rhodanthe floribunda	white everlasting
	Rhodanthe gossypina	
	Rhodanthe microglossa	clustered everlasting
	Rhodanthe moschata	musk sunray
	Rhodanthe polygalifolia	brilliant sunray
	Rhodanthe pygmaea	pigmy sunray
	Rhodanthe stricta	slender sunray
	Rhodanthe stuartiana	clay sunray
	Rhodanthe tietkensii	Sand sunray
	Rhodanthe troedelii	small paper-everlasting
	Rhodanthe uniflora	woolly sunray
	Rutidosis helichrysoides	grey wrinklewort
	Schoenia ayersii	
COMPOSITAE	*Schoenia cassiniana*	Pink everlasting
	Schoenia ramosissima	dainty everlasting
	Senecio cunninghamii var. *serratus*	shrubby groudsel
	Senecio glossanthus	slender groundsel
	Senecio laceratus	
	Senecio lautus	variable groundsel
	Senecio magnificus	showy groundsel
	Senecio quadridentatus	cotton fireweed
	Senecio runcinifolius	tall groundsel
	Sigesbeckia australiensis	Australian sigesbeckia
	* *Sonchus asper* ssp. *asper*	rough sow-thistle
	* *Sonchus asper* ssp. *glaucescens*	rough sow-thistle
	Sonchus hydrophilus	Native sow-thistle
	* *Sonchus oleraceus*	common sow-thistle

Family	**Scientific Name**	**Common Name**
	* *Sonchus tenerrimus*	Clammy sow-thistle
	Sphaeranthus indicus	
	Streptoglossa adscendens	desert daisy
	Streptoglossa cylindriceps	
	Streptoglossa liatroides	Wertaloona daisy
	Stuartina hamata	prickly cudweed
	* *Taraxacum officinale*	
	Trichanthodium skirrophorum	woolly yellow-heads
	Vittadinia arida	
	Vittadinia blackii	narrow-leaf New Holland daisy
	Vittadinia cervicularis var. *cervicularis*	waisted New Holland daisy
	Vittadinia condyloides	
	Vittadinia dissecta var. *hirta*	dissected New Holland daisy
	Vittadinia eremaea	desert New Holland daisy
	Vittadinia pterochaeta	fuzzweed
	Vittadinia sulcata	furrowed New Holland daisy
	Waitzia acuminata var. *acuminata*	orange immortelle
	* *Xanthium occidentale*	Noogoora burr
	* *Xanthium spinosum*	Bathurst burr
JUNCAGINACEAE		
	Triglochin calcitrapum	spurred arrowgrass
	Triglochin centrocarpum	dwarf arrowgrass
	Triglochin hexagonum	Six-pointed arrowgrass
	Triglochin minutissumum	Tiny arrowgrass
	Triglochin multifructum	
	Triglochin procerum var. *procerum*	Water ribbons
	Triglochin striatum	Streaked arrowgrass
POTAMOGETONACEAE		
	* *Potamogeton crispus*	Curly pondweed
	Potamogeton pectinatus	Fennel pondweed
	Potamogeton tepperi	
	Ruppia maritima	Sea tassel
ZANNICHELLIACEAE		
	Lepilaena preissii	Slender water-mat
LILIACEAE		
	* *Asphodelus fistulosus*	onion weed
	Bulbine alata	winged leek-lily
	Bulbine semibarbata	annual leek-lily
	Corynotheca micrantha var. *divaricata*	
	Caesia lateriflora	Native leek
	Lomandra leucocephala ssp. *robusta*	woolly mat-rush
	Lomandra multiflora ssp. *dura*	iron-grass
	Thysanotus exiliflorus	Fringe-lily
	Wurmbea dioica ssp. *dioica*	early Nancy
	Xanthorrhoea quadrangulata	Mount Lofty grass-tree
AMARYLLIDACEAE		
	Calostemma luteum	Yellow garland lily
	Calostemma purpureum	purple bells
	Crinum flaccidum	Darling lily
HYPOXIDACEAE		
	Hypoxis glabella var. *glabella*	tiny star
JUNCACEAE		
	Juncus aridicola	tussock rush
	Juncus bufonius	toad rush
	* *Juncus capitatus*	Capitate rush
	Juncus kraussii	Sea rush
	Juncus subsecundus	finger rush
COMMELINACEAE		
	Commelina ensifolia	Scurvy grass
ERIOCAULACEAE		
	Eriocaulon carsonii	Salt pipewort
CENTROLEPIDACEAE		
	Centrolepis eremica	dryland centrolepis
	Centrolepis polygyna	Wiry centrolepis
GRAMINEAE		
	Agrostis avenacea var. *avenacea*	common blown-grass
	Agrostis avenacea var. *perennis*	perennial blown-grass
	* *Alopecurus geniculatus*	marsh fox-tail
	Amphipogon caricinus	Long greybeard grass
	Aristida anthoxanthoides	pale wire-grass
	Aristida biglandulosa var. *biglandulosa*	Two-gland threeawn

Family	Scientific Name	Common Name
	Aristida capillifolia	Needle leaved threeawn
	Aristida contorta	mulga grass
	Aristida holathera var. *holathera*	tall kerosene grass
	Aristida inaequiglumis	Unequal threeawn
	Aristida latifolia	feathertop wiregrass
	Aristida nitidula	brush threeawn
	Aristida obscura	Brush threeawn
	Aristida strigosa	rough wire-grass
	Astrebla lappacea	curly Mitchell-grass
	Astrebla pectinata	barley Mitchell-grass
	* *Avena barbata*	Bearded oat
	* *Avena fatua*	wild oat
	* *Avena sativa*	Cultivated oat
	* *Avena sterilis* ssp. *ludoviciana*	Wild oat
	Bothriochloa ewartiana	Desert blue-grass
	Brachyachne ciliaris	Hairy native couch
	Bromus arenarius	sand brome
	* *Bromus catharticus*	prairie grass
	* *Bromus diandrus*	Great brome
	* *Cenchrus ciliaris*	buffel grass
	* *Cenchrus longispinus*	Innocent weed
	* *Cenchrus pennisetiformis*	White buffel grass
	* *Cenchrus setigerus*	Birdwood grass
	* *Chloris gayana*	Rhodes grass
	Chloris pectinata	comb windmill grass
	Chloris truncata	windmill grass
	* *Chloris virgata*	Feathertop rhodes
	Chrysopogon fallax	Golden-bearded grass
	* *Critesion murinum* ssp. *glaucum*	northern barley-grass
	* *Critesion murinum* ssp. *leporinum*	barley-grass
	Cymbopogon ambiguus	lemon-grass
	Cymbopogon obtectus	silky-heads
	* *Cynodon dactylon*	couch-grass
	* *Cynosurus echinatus*	Rough dogs tail grass
	Dactyloctenium radulans	button-grass
	Danthonia caespitosa	common wallaby-grass
	Dichanthium sericeum ssp. *humilius*	dwarf blue-grass
	Dichanthium sericeum ssp. *sericeum*	silky blue-grass
	Digitaria ammophila	spider grass
	Digitaria brownii	cotton panic-grass
	Digitaria coenicola	spider grass
	Digitaria ctenantha	Comb finger-grass
	Diplachne fusca	brown beetle-grass
	Distichlis distichophylla	Emu grass
	* *Echinochloa crus-galli*	barnyard grass
	Echinochloa inundata	Channel millet
	Elytrophorus spicatus	Spike grass
	Enneapogon avenaceus	common bottle-washers
	Enneapogon caerulescens var. *caerulescens*	blue nineawn
	Enneapogon cylindricus	jointed bottle-washers
	Enneapogon intermedius	
	Enneapogon nigricans	black-heads
	Enneapogon polyphyllus	limestone bottle-washers
	Enteropogon acicularis	umbrella grass
	Enteropogon ramosus	umbrella grass
	Eragrostis australasica	cane-grass
	* *Eragrostis barrelieri*	pitted love-grass
	Eragrostis basedowii	Neat lovegrass
	* *Eragrostis cilianensis*	stink grass
	Eragrostis confertiflora	Spike lovegrass
	Eragrostis dielsii var. *dielsii*	mulka grass
	Eragrostis elongata	Clustered lovegrass
	Eragrostis eriopoda	woollybutt
	Eragrostis falcata	sickle love-grass
	Eragrostis kennedyae	Small-flowered lovegrass
GRAMINEAE	*Eragrostis lacunaria*	neverfail
	Eragrostis laniflora	hairy-flower woollybutt
	Eragrostis lanipes	
	Eragrostis leptocarpa	slender love-grass
	Eragrostis parviflora	weeping love-grass
	* *Eragrostis pergracilis*	small love-grass

Family	Scientific Name	Common Name
	Eragrostis setifolia	narrow-leaf neverfail
	Eragrostis speciosa	Handsome lovegrass
	* *Eragrostis tenellula*	delicate love-grass
	Eragrostis xerophila	knotty-butt neverfail
	Eriachne aristidea	three-awned wanderrie
	Eriachne helmsii	Woollybutt wanderrie
	Eriachne mucronata	mountain wanderrie grass
	Eriachne ovata	Swamp wanderrie
	Eriachne pulchella	pretty wanderrie grass
	Eriochloa australiensis	Australian cupgrass
	Eriochloa creba	Tall cupgrass
	Eriochloa procera	Slender cupgrass
	Eriochloa pseudoacrotricha	perennial cupgrass
	Eulalia aurea	silky browntop
	* *Hainardia cylindrica*	Common barb-grass
	* *Hordeum vulgare* ssp. *distichon*	Barley
	Imperata cylindrica	Kunai grass
	Iseilema eremaeum	Flinders grass
	Iseilema membranaceum	small Flinders-grass
	Iseilema vaginiflorum	Red flinders grass
	Leptochloa digitata	umbrella cane-grass
	* *Lolium rigidum*	Wimmera ryegrass
	Monachather paradoxa	bandicoot grass
	Neurachne munroi	Window mulga grass
	Oxychloris scariosa	Winged windmill grass
	Panicum decompositum var. *decompositum*	native millet
	Panicum effusum var. *effusum*	hairy panic
	Panicum laevinode	
	Paractaenum novae-hollandiae ssp. *reversum*	barbed-wire grass
	Paractaenum refractum	Bristle brush-grass
	Paraneurachne muelleri	Northern mulga-grass
	* *Parapholis incurva*	Coast barb-grass
	Paspalidium basicladum	Summer grass
	Paspalidium clementii	Clement's paspalidium
	Paspalidium constrictum	knotty-butt paspalidium
	Paspalidium jubiflorum	Warrego summer-grass
	* *Paspalum dilatatum*	Paspalum
	* *Pennisetum clandestinum*	Kikuyu grass
	* *Pennisetum villosum*	Long-style feather grass
	* *Perotis rara*	Comet grass
	* *Phalaris minor*	annual canary grass
	Phragmites australis	common reed
	Phragmites karka	Bamboo reed
	* *Poa annua*	Winter grass
	Poa fordeana	Forde's poa
	* *Polypogon monspeliensis*	annual beard-grass
	Pseudoraphis spinescens	Spiny mud-grass
	* *Rostraria pumila*	tiny bristle-grass
	* *Schismus arabicus*	
	* *Schismus barbatus*	mulga grass
	Setaria dielsii	Diel's pigeon-grass
	* *Setaria italica*	foxtail millet
	* *Setaria verticillata*	Whorled pigeon-grass
	* *Setaria viridis*	Green pigeon-grass
	* *Sorghum x almum*	
	* *Sorghum halepense*	Johnson grass
	Sporobolus actinocladus	ray grass
	Sporobolus blakei	
	Sporobolus caroli	yakka grass
	* *Sporobolus indicus* var. *capensis*	
	Sporobolus mitchellii	rats-tail couch
	Sporobolus virginicus	Salt couch
	Stipa nitida	Balcarra spear-grass
	Stipa nodosa	tall spear-grass
	Stipa pilata	
	Stipa platychaeta	flat-awn spear-grass
	Stipa scabra ssp. *falcata*	Rough spear-grass
	Stipa trichophylla	
	Themeda triandra	kangaroo grass
GRAMINEAE	*Thyridolepis mitchelliana*	window mulga-grass
	Thyridolepis multiculmis	

Family	Scientific Name	Common Name
	Tragus australianus	burr grass
	Triodia basedowii	Lobed spinifex
	Triodia irritans	porcupine grass
	Triodia pungens var. *pungens*	Gummy spinifex
	Tripogon loliiformis	five-minute grass
	Triraphis mollis	purple heads
	* *Triticum aestivum*	Wheat
	Uranthoecium truncatum	Flat-stem grass
	Urochloa gilesii ssp. *gilesii*	hairy-edged arm-grass
	Urochloa piligera	
	Urochloa praetervisa	large arm-grass
	Urochloa subquadripara	Armgrass millet
	* *Vulpia myuros* forma *myuros*	silver grass
	Yakirra australiensis	Bunch panic
	Zygochloa paradoxa	sandhill cane-grass
PALMAE		
	* *Phoenix dactylifera*	Date palm
LEMNACEAE		
	Lemna disperma	Common duckweed
TYPHACEAE		
	Typha domingensis	bullrush
	Typha orientalis	Cumbungi
CYPERACEAE		
	Baumea arthrophylla	
	Baumea juncea	Bare twig-rush
	Bolboschoenus caldwellii	sea club-rush
	Bolboschoenus medianus	
	Bulbostylis barbata	
	Bulbostylis turbinata	
	Cyperus alterniflorus	umbrella flat-sedge
	Cyperus bifax	Downs nut-grass
	Cyperus bulbosus	bulbous flat-sedge
	Cyperus centralis	
	Cyperus dactylotes	
	Cyperus difformis	rice sedge
	Cyperus exaltatus	Tall flat-sedge
	Cyperus gilesii	Gile's flat-sedge
	Cyperus gunnii	Flecked flat-sedge
	Cyperus gymnocaulos	spiny flat-sedge
	* *Cyperus hamulosus*	Club-rush
	Cyperus iria	Rice flat-sedge
	Cyperus laevigatus	bore-drain sedge
	* *Cyperus pygmaeus*	Dwarf sedge
	Cyperus rigidellus	dwarf flat-sedge
	Cyperus sp. aff. *Cunninghamii*	flat-sedge
	Cyperus squarrosus	bearded flat-sedge
	Cyperus vaginatus	Stiff-leaved sedge
	Cyperus victoriensis	Yelka
	Eleocharis acuta	Common spike-thrush
	Eleocharis geniculata	
	Eleocharis pallens	pale spike-rush
	Eleocharis papillosa	
	Eleocharis plana	Ribbed spike-thrush
	Eleocharis pusilla	Small spike-thrush
	Fimbristylis dichotoma	common fringe-rush
	Fimbristylis ferruginea	
	Fimbristylis sieberana	
	Fimbristylis velata	
	Gahnia trifida	Cutting grass
	Isolepis australiensis	southern club-rush
	Isolepis cernua	
	Isolepis hookeriana	Club-rush
	Lepidosperma laterale	Variable sword-hedge
	Lepidosperma viscidum	Sticky sword-hedge
	Lipocarpha microcephala	Button rush
	Schoenoplectus dissachanthus	inland club-rush
	Schoenoplectus litoralis	shore club-rush
	Schoenoplectus pungens	American club-rush
	Schoenoplectus validus	club-rush

APPENDIX C

BIRD SPECIES RECORDED FROM THE MARREE SOIL CONSERVATION DISTRICT

The columns indicate the source of bird species records as follows:

1 South Australian Environmental Database 1997.

2 Pedler, L.P. and Ragless, G.B. (1978) Birds Observed near Lakes Frome and Callabonna. *S.A.Orn.* **27:** 274 – 276.

3 McGilp, J.N. (1923) Birds of Lake Frome District, South Australia. *Emu.* **22:** 237 – 243, 274 – 287.

4 Badman, F.J. (1989) *The Birds of Middle and Lower Cooper Creek in South Australia*. Nature Conservation Society of South Australia.

5 Gillen, J.S. and Reid, J.R.W. (1990) *Progress Report. The Della and Marqualpie Land System's Faunal Monitoring Programme for Santos Ltd.*

6 Drewien, G. and Best, L. (1992) *A Survey of the Waterbirds in North-East South Australia.* DENR.

* Introduced species

Common Name	**Scientific Name**	**Source**					
CASUARIIDAE							
Emu	*Dromaius novaehollandiae*	1	2	3	4	5	6
PHASIANIDAE							
Stubble Quail	*Coturnix novaezelandiae*	1	2	3	4	5	6
Brown Quail	*Coturnix ypsilophorus*			3		5	
ANATIDAE							
Chestnut Teal	*Anas castanea*	1		3	4		
Northern Shoveler	*Anas clypeata*				4		
Australasian Grey Teal	*Anas gracilis*	1		3	4	5	6
* Mallard	*Anas platyrhynchos*			3			
Australasian Shoveler	*Anas rhynchotis*		2	3	4		
Pacific Black Duck	*Anas superciliosa*	1	2	3	4		6
Magpie Goose	*Anseranas semipalmata*			3	4		
Hardhead	*Aythya australis*		2	3	4		
Musk Duck	*Biziura lobata*	1		3	4		
Cape Barren Goose	*Cereopsis novaehollandiae*	1					
Wood Duck	*Chenonetta jubata*	1		3	4	5	6
Black Swan	*Cygnus atratus*	1	2	3	4	5	
Plumed Whistling-Duck	*Dendrocygna eytoni*	1		3	4	5	
Pink-eared Duck	*Malacorhynchus membranaceus*	1		3	4	5	
Blue-billed Duck	*Oxyura australis*			3	4		
Freckled Duck	*Stictonetta naevosa*	1		3	4		
Australian Shelduck	*Tadorna tadornoides*			3	4		
TURNICIDAE							
Little Button-quail	*Turnix velox*	1		3	4		
DACELONIDAE							
Red-backed Kingfisher	*Halcyon pyrrhopygia*		2	3		5	6
Sacred Kingfisher	*Halcyon sancta*	1		3	4		
MEROPIDAE							
Rainbow Bee-eater	*Merops ornatus*	1	2	3	4	5	6
CORACIIDAE							
Dollarbird	*Eurystomus orientalis*				4		
CUCULIDAE							
Horsfield's Bronze-cuckoo	*Chrysococcyx basalis*	1	2	3	4		6
Black-eared Cuckoo	*Chrysococcyx osculans*			3	4	5	
Pallid Cuckoo	*Cuculus pallidus*	1	2	3	4	5	
Channel-billed Cuckoo	*Scythrops novaehollandiae*				4		
PSITTACIDAE							
Red-winged Parrot	*Aprosmictus erythropterus*	1	2	3	4		
Ringneck Parrot	*Barnardius zonarius*	1	2	3	4		
Major Mitchell Cockatoo	*Cacatua leadbeateri*				4		
Common Name	**Scientific Name**	**Source**					
Little Corella	*Cacatua sanguinea*	1	2	3	4	5	6
Red-tailed Black Cockatoo	*Calyptorhynchus magnificus*				4		
Galah	*Eolophus roseicapilla*	1	2	3	4	5	6
Budgerigah	*Melopsittacus undulatus*	1	2	3	4	5	6
Bourke's Parrot	*Neophema bourkii*				4		
Blue-winged Parrot	*Neophema chrysostoma*	1	2		4	5	6
Elegant Parrot	*Neophema elegans*			3			
Scarlet-chested Parrot	*Neophema splendida*	1		3			
Blue Bonnet	*Northiella haematogaster*	1	2		4	5	6
Cockatiel	*Nymphicus hollandicus*	1		3	4	5	
Night Parrot	*Pezoporus occidentalis*				4		
Red-rumped Parrot	*Psephotus haematonotus*	1		3	4		6
Mulga Parrot	*Psephotus varius*	1		3			
APODIDAE							

Fork-tailed Swift	*Apus pacificus*			3	4		6
TYTONIDAE							
Barn Owl	*Tyto alba*	1	2	3	4		6
STRIGIDAE							
Barking Owl	*Ninox connivens*	1			4		
Boobook Owl	*Ninox novaeseelandiae*	1		3	4	5	6
EUROSTOPODIDAE							
Spotted Nightjar	*Eurostopodus argus*	1		3	4	5	
AEGOTHELIDAE							
Australian Owlet-nightjar	*Aegotheles cristatus*	1		3	4	5	6
PODARGIDAE							
Tawny Frogmouth	*Podargus strigoides*	1	2	3	4	5	
COLUMBIDAE							
* Feral Pigeon	*Columba livia*				4		
Diamond Dove	*Geopelia cuneata*	1		3	4	5	6
Peaceful Dove	*Geopelia placida*	1			4		6
Plumed Pigeon	*Geophaps plumifera*	1					
Crested Pigeon	*Ocyphaps lophotes*	1	2	3	4	5	6
Common Bronzewing	*Phaps chalcoptera*		2	3	4		6
Flock Pigeon	*Phaps histrionica*	1			4	5	
OTIDIDAE							
Australian Bustard	*Ardeotis australis*	1		3	4	5	6
RALLIDAE							
Eurasian Coot	*Fulica atra*	1	2	3	4		6
Dusky Moorhen	*Gallinula tenebrosa*				4		
Black-tailed Native-hen	*Gallinula ventralis*	1	2	3	4	5	6
Purple Swamphen	*Porphyrio porphyrio*		2	3	4		
Australian Crake	*Porzana fluminea*	1		3	4		
Baillon's Marsh Crake	*Porzana pusilla*				4		
Spotless Crake	*Porzana tabuensis*				4		
GRUIDAE							
Brolga	*Grus rubicundus*	1		3	4		
PEDIONOMIDAE							
Plains-wanderer	*Pedionomus torquatus*			3	4		
SCOLOPACIDAE							
Common Sandpiper	*Actitis hypoleucos*				4		
Sharp-tailed Sandpiper	*Calidris acuminata*	1	2	3	4	5	
Curlew Sandpiper	*Calidris ferruginea*				4		
Pectoral Sandpiper	*Calidris melanotos*				4		
Red-necked stint	*Calidris ruficollis*	1			4		
Long-toed Stint	*Calidris subminuta*	1			4		
Latham's Snipe	*Gallinago hardwickii*		2		4		
Whimbrel	*Numenius phaeopus*				4		
Black-tailed godwit	*Limosa limosa*				4		
Wood Sandpiper	*Tringa glareola*	1			4		
Greenshank	*Tringa nebularia*				4	5	
Marsh Sandpiper	*Tringa stagnatilis*				4	5	
BURHINIDAE							
Southern Stone Curlew (Bush Thick-knee)	*Burhinus grallarius (B. magnirostris)*			3	4		

Common Name	**Scientific Name**	**Source**					
RECURVIROSTRIDAE							
Banded Stilt	*Cladorhynchus leucocephalus*	1			4		
White-headed Stilt	*Himantopus leucocephalus*	1	2	3	4		
Black-winged Stilt	*Himantopus himantopus*					5	6
Red-necked Avocet	*Recurvirostra novaehollandiae*	1	2	3	4	5	6
CHARADRIIDAE							
Red-capped Dotterel	*Charadrius ruficapillus*		2	3	4		
Oriental Dotterel	*Charadrius veredus*				4		
Black-fronted Dotterel	*Elseyornis melanops*	1	2	3	4	5	6

Red-kneed Dotterel	*Erythrogenys cinctus*	1		3	4	5	
Masked Lapwing	*Hoplopterus miles*	1	2	3	4	5	6
Banded Lapwing	*Hoplopterus tricolor*			3	4	5	
Inland Dotterel	*Peltohyas austalis*	1		3	4		6
Lesser Golden Plover	*Pluvialis fulva / dominica*				4		
GLAREOLIDAE							
Oriental Pratincole	*Glareola maldivarum*	1					
Australian Pratincole	*Stiltia isabella*	1		3	4		
LARIDAE							
Whiskered Tern	*Chlidonias hybridus*	1	2	3	4		
White-winged Black Tern	*Childonias leucopterus*				4		
Gull-billed Tern	*Gelochelidon nilotica*	1	2	3	4	5	6
Caspian Tern	*Hydroprogne caspia*	1	2	3	4		
Silver Gull	*Larus novaehollandiae*	1	2	3	4	5	
ACCIPITRIDAE							
Collared Sparrowhawk	*Accipiter cirrhocephalus*			3	4		6
Brown Goshawk	*Accipiter fasciatus*		2	3	4	5	
Wedge-tailed Eagle	*Aquila audax*	1	2	3	4	5	6
Swamp Harrier	*Circus aeruginosus*	1		3	4		6
Spotted Harrier	*Circus assimilus*	1	2	3	4	5	6
Black-shouldered Kite	*Elanus caeruleus*		2		4		6
Letter-winged Kite	*Elanus scriptus*	1			4	5	
Little Eagle	*Hieraaetus morphnoides*	1	2	3	4		6
Whistling Kite	*Haliastur sphenurus*	1	2	3	4		6
Black-breasted Kite	*Hamirostra melanosternon*	1	2	3	4		6
Black Kite	*Milvus migrans*	1	2	3	4	5	6
FALCONIDAE							
Brown Falcon	*Falco berigora*	1	2	3	4	5	6
Australian Kestrel	*Falco cenchroides*	1	2	3	4	5	6
Grey Falcon	*Falco hypoleucos*	1		3	4		
Little Falcon	*Falco longipennis*	1	2	3	4		
Peregrine Falcon	*Falco peregrinus*			3	4		
Black Falcon	*Falco subniger*	1	2	3	4	5	6
PODICIPEDIDAE							
Great Crested Grebe	*Podiceps cristatus*				4		
Hoary-headed Grebe	*Poliocephalus poliocephalus*	1		3	4		6
Australasian Grebe	*Tachybaptus novaehollandiae*		2		4		6
ANHINGIDAE							
Darter	*Anhinga melanogaster*	1		3	4		6
PROCELLARIIDAE							
Fluttering Shearwater	*Puffinus gavia*	1					
PHALACROCORACIDAE							
Black Cormorant	*Phalacrocorax carbo*	1	2		4		6
Little Pied Cormorant	*Phalacrocorax melanoleucos*			3	4		6
Little Black Cormorant	*Phalacrocorax sulcirostris*			3	4		6
Pied Cormorant	*Phalacrocorax varius*	1	2		4		
ARDEIDAE							
Great Egret	*Ardea alba*				4		6
Little Egret	*Ardea garzetta*				4		
Intermediate Egret	*Ardea intermedia*				4		
White-faced Heron	*Ardea novaehollandiae*	1	2	3	4	5	6
Pacific Heron	*Ardea pacifica*	1		3	4	5	
Common Name	**Scientific Name**	**Source**					
Cattle Egret							
Bubulcus ibis				4	5		
Nankeen Night Heron	*Nycticorax caledonicus*	1	2	3	4		6
THRESKIORNITHIDAE (PLATALEIDAE)							
Yellow-billed Spoonbill	*Platalea flavipes*	1	2	3	4	5	6

Royal Spoonbill	*Platalea regia*			3	4		6
Glossy Ibis	*Plegadis falcinellus*	1		3	4		6
Sacred Ibis	*Threskiornis aethiopicus*			3	4		
Straw-necked Ibis	*Threskiornis spinicollis*		2	3	4	5	6
PELECANIDAE							
Australian Pelican	*Pelecanus conspicillatus*		2	3	4		6
CLIMACTERIDAE							
Brown Treecreeper	*Climacteris picumnus*	1		3	4		
MALURIDAE							
Variegated Wren	*Malurus lamberti*	1			4	5	6
Purple-backed Wren	*Malurus lamberti assimilis*		2	3			
White-winged Wren	*Malurus leucopterus*	1	2	3	4	5	6
Splendid Blue Wren	*Malurus splendens*	1					
AMYTORNITHIDAE							
Grey Grasswren	*Amytornis barbatus*	1			4		
Eyrean Grasswren	*Amytornis goyderi*	1			4	5	6
Striated Grasswren	*Amytornis striatus*		2				
Thick-billed Grasswren	*Amytornis textillis*	1					
MELIPHAGIDAE							
Spiny-cheeked Honeyeater	*Acanthogenys rufogularis*	1	2	3	4		6
Gibberbird	*Ashbyia lovensis*	1	2	3	4	5	
Pied Honeyeater	*Certhionyx variegatus*	1		3	4	5	
White-fronted Chat	*Ephthianura albifrons*			3			
Orange Chat	*Ephthianura aurifrons*	1	2	3	4	5	6
Crimson Chat	*Ephthianura tricolor*	1		3	4	5	6
Painted Honeyeater	*Grantiella picta*				4		
Yellow-throated Miner	*Manorina flavigula*	1	2	3	4	5	6
Yellow-plumed Honeyeater	*Meliphaga ornata*			3			
White-plumed Honeyeater	*Meliphaga penicillata*	1	2	3	4	5	6
Grey-fronted Honeyeater	*Meliphaga plumula*	1	2	3			
Singing Honeyeater	*Meliphaga virescens*	1	2	3	4	5	6
Golden-backed Honeyeater	*Melithreptus laetior*				4		
White-fronted Honeyeater	*Phylidonyris albifrons*	1	2	3		5	6
New Holland Honeyeater	*Phylidonyris novaehollandiae*			3	4		
Striped Honeyeater	*Plectorhyncha lanceolata*			3			
Black Honeyeater	*Sugomel niger*	1		3	4	5	6
PARDALOTIDAE							
Red-browed Pardalote	*Pardalotus rubricatus*	1	2	3	4	5	
Striated Pardalote	*Pardalotus striatus*	1	2	3	4		
ACANTHIZIDAE							
Inland Thornbill	*Acanthiza apicalis*		2				
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*			3	4		
Brown Thornbill	*Acanthiza pusilla*			3			
Chestnut-rumped Thornbill	*Acanthiza uropygialis*	1	2	3	4		
Southern Whiteface	*Aphelocephala leucopsis*	1	2	3	4	5	6
Banded Whiteface	*Aphelocephala nigricincta*	1		3	4	5	
Chestnut-breasted Whiteface	*Aphelocephala pectoralis*	1					
Western Fieldwren	*Calamanthus campestris*	1		3	4		6
Shy Hylacola	*Hylacola cauta*			3			
Redthroat	*Pyrrholaemus brunneus*	1		3	4		
Weebill	*Smicrornis brevirostris*		2	3	4		
EOPSALTRIIDAE							
Varied Sittella	*Daphoenositta chrysoptera*			3			
Hooded Robin	*Melanodryas cucullata*	1		3	4		6
Jacky Winter	*Microeca leucophaea*	1			4		
Common Name	**Scientific Name**	**Source**					
Red-capped Robin	*Petroica goodenovii*	1	2	3	4	5	6
POMATOSTOMIDAE							

Chestnut-crowned Babbler	*Pomatostomus ruficeps*	1	2	3	4	5	6
White-browed Babbler	*Pomatostomus superciliosa*		2	3			
CINCLOSOMATIDAE							
Chestnut Quail-thrush	*Cinclosoma castanotum*			3			
Cinnamon Quail-thrush	*Cinclosoma cinnamomeum*	1	2	3	4	5	6
Chirruping Wedgebill	*Psophodes cristatus*	1	2	3	4	5	
PACHYCEPHALIDAE							
Grey Shrike-thrush	*Colluricincla harmonica*	1	2	3	4		
Crested Bellbird	*Oreoica gutturalis*	1		3	4		
Rufous Whistler	*Pachycephala rufiventris*	1	2	3	4	5	
CORVIDAE							
Black-faced Woodswallow	*Artamus cinereus*	1	2	3	4	5	6
Dusky Woodswallow	*Artamus cyanopterus*			3			
White-breasted Woodswallow	*Artamus leucorhynchus*	1	2	3	4	5	6
Masked Woodswallow	*Artamus personatus*	1		3	4		
White-browed Woodswallow	*Artamus superciliosus*	1		3	4	5	
Ground Cuckoo-shrike	*Coracina maxima*		2		4	5	6
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	1	2	3	4	5	6
Little Crow	*Corvus bennetti*	1		3	4	5	6
Australian Raven	*Corvus coronoides*	1	2	3	4	5	6
Little Raven	*Corvus mellori*		2				
Pied Butcherbird	*Cracticus nigrogularis*			3			
Grey Butcherbird	*Cracticus torquatus*	1		3	4		
Australian Magpie	*Gymnorhina tibicen*	1	2	3	4	5	6
White-winged Triller	*Lalage sueurii*	1	2	3	4	5	
DICRURIDAE							
Magpie-lark	*Grallina cyanoleuca*	1	2	3	4	5	6
Satin Flycatcher	*Myiagra cyanloeuca*	1					
Restless Flycatcher	*Myiagra inquieta*	1		3	4		
Grey Fantail	*Rhipidura fuliginosa*	1	2	3	4		
Willie Wagtail	*Rhipidura leucophrys*	1	2	3	4	5	6
STURNIDAE							
* European Starling	*Sturnus vulgaris*			3	4		6
ORIOLIDAE							
Olive-backed Oriole	*Oriolus sagittatus*				4		
HIRUNDINIDAE							
White-backed Swallow	*Chermoeca leucosternum*	1	2	3	4	5	6
Fairy Martin	*Hirundo ariel*	1	2	3		5	6
Welcome Swallow	*Hirundo neoxena*		2	3	4	5	6
Tree Martin	*Hirundo nigricans*	1	2	3	4		6
ZOSTEROPIDAE							
Silvereye	*Zosterops lateralis*		2	3			
SYLVIDAE							
Clamorous Reed-warbler	*Acrocephalus stentoreus*	1		3	4		6
Brown Songlark	*Cinclorhamphus cruralis*	1	2	3	4	5	6
Rufous Songlark	*Cinclorhamphus mathewsi*	1			4	5	6
Little Grassbird	*Megalurus gramineus*	1			4		

ALAUDIDAE								
Singing Bushlark	*Mirafra javanica*	1			4	5	
NECTARINIIDAE								
Mistletoe Bird	*Dicaeum hirundinaceum*	1	2	3	4	5	
PASSERIDAE								
* House Sparrow	*Passer domesticus*			3	4	5	
MOTACILLIDAE								
Richard's Pipit	*Anthus novaeseelandiae*	1	2	3	4	5	6
ESTRILDIDAE								
Zebra Finch	*Poephila guttata*	1	2	3	4	5	6

APPENDIX D

MAMMAL SPECIES RECORDED FROM THE MARREE SOIL CONSERVATION DISTRICT

Species are listed by scientific name in taxonomic order of family using the nomenclature of; Kemper, C.M. and Queale, L. (1990) Mammals. **In**, Watts, C.H.S. (Ed.), *A List of the Vertebrate of South Australia.* Biological Survey Coordinating Committee and Department of Environment and Planning, South Australia.

The columns indicate the source of mammal species records as follows:

1 South Australian Environmental Database 1997.

2 Gillen, J.S. and Reid J.R.W. (1990) *Progress Report. The Della and Marqualpie Land System's Faunal Monitoring Programme for Santos Ltd.*

Scientific Name	Common Name	Source	
TACHYGLOSSIDAE			
Tachyglossus aculeatus	Short-beaked Echidna	1	
DASYURIDAE			
Antechinomys laniger	Kultarr	1	
Dasycercus byrnei	Kowari	1	
Dasycercus cristicauda	Mulgara	1	
Ningaui ridei	Wongai Ningaui	1	2
Planigale gilesi	Giles' Planigale	1	
Planigale tenuirostris	Narrow-nosed Planigale	1	2
Sminthopsis crassicaudata	Fat-tailed Dunnart	1	2
Sminthopsis macroura	Stripe-faced Dunnart	1	2
MACROPODIDAE			
Macropus robustus	Euro	1	
Macropus rufus	Red Kangaroo	1	2
Petrogale xanthopus	Yellow-footed Rock-wallaby	1	
PERAMELIDAE			
Macrotis lagotis	Greater Bilby	1	
MURIDAE			
Hydromys chrysogaster	Water Rat	1	
Leggadina forresti	Forrest's Mouse	1	2
Mus domesticus	House Mouse	1	2
Notomys alexis	Spinifex Hopping Mouse	1	
Notomys cervinus	Fawn Hopping Mouse	1	
Notomys cf. *fuscus*	Dusky-Hopping Mouse	1	
Pseudomys australis	Plains Rat	1	
Pseudomys bolami	Bolam's Mouse	1	
Pseudomys desertor	Desert Mouse	1	
Pseudomys hermannsburgensis	Sandy Inland Mouse	1	2
Rattus villosissimus	Long-haired (Plague) Rat	1	
EMBALLONURIDAE			
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	1	
MOLOSSIDAE			
Mormopterus planiceps	Little Mastiff-bat	1	
Nyctinomus australis	White-striped Mastiff-bat	1	
VESPERTILIONIDAE			
Chalinolobus gouldii	Gould's Wattled Bat	1	
Vespadelus baverstocki	Inland Eptesicus	1	
Vespadelus finlaysoni	Little Brown Bat	1	
Nyctophilus geoffroyi	Lesser Long-eared Bat	1	
Nyctophilus timoriensis	Greater Long-eared Bat	1	
Scotorepens balstoni	Western Broad-nosed Bat	1	
Scientific Name	**Common Name**	**Source**	
Scotorepens greyii	Little Broad-nosed Bat	1	

LEPORIDAE			
* *Oryctolagus cuniculus*	European Rabbit	1	2
CANIDAE			
* *Canis familiaris dingo*	Dingo	1	2
* *Vulpes vulpes*	Fox	1	2
FELIDAE			
* *Felis catus*	Cat	1	2
BOVIDAE			
* *Bos taurus*	Cattle	1	
* *Capra hircus*	Goat	1	
* *Ovis aries*	Sheep	1	
EQUIDAE			
* *Equus caballus*	Horse	1	
* *Equus asinus*	Donkey	1	2
SUIDAE			
* *Sus scrofa*	Pig	1	
CAMELIDAE			
* *Camelus dromedarius*	One-humped camel	1	2

APPENDIX E

REPTILE AND AMPHIBIAN SPECIES RECORDED FROM THE MARREE SOIL CONSERVATION DISTRICT

Species are listed by scientific name in taxonomic order of family using the nomenclature of Edwards, A. and Tyler, M.J. (1990) Reptiles and Amphibians. **In**, Watts, C.H.S. (Ed.), *A List of the Vertebrate of South Australia.* Biological Survey Coordinating Committee and Department of Environment and Planning, South Australia, which has been updated by the South Australian Museum (M. Hutchinson, pers. comm.).

The two columns indicate the source of reptile species records as follows:

1 South Australian Environmental Database 1997.

2 Gillen, J.S. and Reid, J.R.W. (1990) *Progress Report. The Della and Marqualpie Land System's Faunal Monitoring Programme for Santos Ltd.*

REPTILES

Scientific Name	Common Name	Source	
AGAMIDAE			
Amphibolurus gilberti	Gilbert's Lashtail	1	
Amphibolurus longirostris	Long-snouted Lashtail	1	
Ctenophorus fordi	Mallee Dragon	1	2
Ctenophorus gibba	Bull-dust Ground Dragon	1	
Ctenophorus isolepis	Military Sand Dragon	1	2
Ctenophorus maculosus	Salt-lake Ground Dragon	1	
Ctenophorus nuchalis	Central Netted Ground Dragon	1	2
Ctenophorus pictus	Painted Dragon	1	
Ctenophoru vadnappa	Red-barred Crevice Dragon	1	
Diporiphora winneckei	Canegrass Two-lined Dragon	1	2
Pogona vitticeps	Central Bearded Dragon	1	2
Tympanocryptis intima	Gibber Earless Dragon	1	
Tympanocryptis lineata	Five-lined Earless Dragon	1	
Tympanocryptis tetraporophora	Eyrean Earless Dragon	1	
GEKKONINAE			
Gehyra purpurascens	Purplish Dtella	1	
Gehyra variegata	Tree Dtella	1	2
Heteronotia binoei	Bynoe's Gecko	1	2
DIPLODACTYLINAE			
Diplodactylus byrnei	Pink-blotched Gecko	1	2
Diplodactylus conspicillatus	Burrow-plug Gecko	1	2
Diplodactylus damaeus	Beaded Gecko	1	2
Diplodactylus stenodactylus	Pale-snouted Ground Gecko	1	
Diplodactylus tessellatus	Tessellated Gecko	1	2
Nephurus levis	Smooth Knob-tailed Gecko	1	2
Nephurus milii	Barking (Thick-tailed) Gecko	1	
Rhynchoedura ornata	Beaked Gecko	1	2
Strophurus ciliaris	Northern Spiny-tailed Gecko	1	
Strophurus elderi	Jewelled Gecko	1	2
Strophurus intermedius	Southern Spiny-tailed Gecko	1	
PYGOPODINAE			
Delma australis	Barred Snake-lizard	1	
Delma butleri	Spinifex Snake-lizard	1	2
Delma tincta	Excitable Snake-lizard	1	
Lialis burtonis	Burton's Legless Lizard	1	2
Pygopus nigriceps	Black-headed Scaly-foot	1	2
SCINCIDAE			
SPHENOMORPHOUS GROUP			
Ctenotus ariadne	Skink	1	2

Scientific Name	Common Name	Source	
Ctenotus brachyonyx	Eastern Ctenotus	1	2
Ctenotus brooksi	Sandhill Ctenotus	1	2
Ctenotus helenae	Clay-soil Ctenotus	1	
Ctenotus joanae	Black-soil Ctenotus	1	
Ctenotus leae	Orange-tailed Fine-snout Ctenotus	1	2
Ctenotus leonhardii	Leonhardi's Ctenotus	1	2
Ctenotus olympicus	Spotted Ctenotus	1	
Ctenotus pantherinus	Leopard Skink	1	2
Ctenotus regius	Eastern Desert Ctenotus	1	2
Ctenotus robustus	Eastern Striped Skink	1	2
Ctenotus saxatilis	Stony-soil Ctenotus	1	
Ctenotus schomburgkii	Sandplain Ctenotus	1	2
Ctenotus strauchii	Short-legged Ctenotus	1	2
Ctenotus "red strauchii"	Red Short-legged Ctenotus		2
Eremiascincus fasciolatus	Narrow-banded Sand Swimmer	1	2
Eremiascincus richardsonii	Broad-banded Sand Swimmer	1	
Lerista dorsalis	Southern Slider	1	
Lerista labialis	Eastern Two-toed Slider	1	2
Lerista muelleri	Dwarf Three-toed Slider	1	
Lerista xanthura	Yellow-tailed Slider	1	2
EGERNIA GROUP			
Egernia inornata	Desert Skink	1	2
Egernia stokesii	Gidgee (Spiny-tailed) Skink	1	
Tiliqua multifasciata	Centralian Blue Tongue	1	2
Tiliqua occipitalis	Western Blue Tongue	1	
Tiliqua rugosa	Sleepy Lizard / Shingle Back	1	
EUGONGYLUS GROUP			
Cryptoblepharus carnabyi	Speckled Wall Skink	1	
Cryptoblepharus plagiocephalus	Desert Wall Skink	1	
Menetia greyii	Dwarf Skink	1	2
Morethia adelaidensis	Adelaide Snake-eye	1	
Morethia boulengeri	Common Snake-eye	1	
VARANIDAE			
Varanus eremius	Rusty Desert Monitor	1	2
Varanus gouldii	Sand (Gould's) Goanna	1	2
Varanus tristis	Black-tailed Monitor	1	
TYPHLOPIDAE			
Ramphotyphlops bituberculatus	Rough-nosed Blind Snake	1	
Ramphotyphlops endoterus	Interior Blind Snake	1	2
BOIDAE			
Antaresia stimsoni	Large-blotched Python	1	
Aspidites ramsayi	Woma Python	1	2
ELAPIDAE			
Pseudechis australis	Mulga (King Brown) Snake	1	2
Pseudonaja modesta	Five-ringed Snake		2
Pseudonaja nuchalis	Western Brown Snake (Gwardar)	1	2
Simoselaps australis	Coral Snake	1	
Simoselaps fasciolatus	Narrow-banded Shovel-nosed Snake		2
Suta suta	Curl Snake	1	2

AMPHIBIANS

Scientific Name	Common Name	Source	
HYLIDAE			
Litoria rubella	Red Tree Frog		2
LEPTODACTYLIDAE			
Neobatrachus centralis	Trilling Frog	1	2

APPENDIX F

Review of Marree 3 Year Plan (1997)

Review of Aims	**1. Did we achieve this? Yes or no?** **2. Still valid? Continue as is or suggested changes.**	**1. If not achieved - not, why not? valid reason?** **2. Any other issues associated with this aim?**
1. *To encourage and provide for communication within and between the local community, the wider community and agencies and organisations involved with land management.*	▪ Completion, production, promotion of the Marree Soil Conservation District Brochure, based on the information contained in the Information Bays. ▪ Posters ▪ Attended and presented to state and national Landcare Conferences, National and international rangeland conferences. ▪ Did media interviews ▪ Produced a video ▪ Produced a very successful booklet which was reviewed in the Australian Geographic, Australian farm Journal, Outback and the Stock Journal. ▪ Gave lots of formal addresses and talks.	▪ Speakers Kit has been started but not completed. ▪ Information bays have been completed but sometimes difficult to get groups to work together and get agreement. ▪ Projects can therefore take longer than first planned to achieve, groups have different timelines.

REVIEW OF MARREE 3 YEAR PLAN (1997)

Review of Aims	**1.Did we achieve this? Yes or no?** **2. Still valid? Continue as is or suggested changes.**	**1. If not achieved - not, why not? Valid reason?** **2. Any other issues associated with this aim?**
2. *To share and transfer land care skills and knowledge*	▪ Land holders participated in land system mapping together with a range of Board members ▪ Landholders in the district won a number of awards, including a state winner of a Land care Award. ▪ The district has received very positive media coverage, including recognition from Tim Flannery. ▪ Land holders have been involved in assisting with Biosurveys and a number of other projects including – floodplain grazing, Arid Flow (as part of scientific reference group), Kowari Project, Ute Guide to plants and Biograze. ▪ Landcare projects include - field days on rabbit control, rehabilitation, feral pig control, feral goat control.	

REVIEW OF MARREE 3 YEAR PLAN (1997)

Review of Aims	**1. Did we achieve this? Yes or no?** **2. Still valid? Continue as is or suggested changes.**	**1. If not achieved - not, why not? valid reason?** **2. Any other issues associated with this aim?**
3. *To promote the maintenance of viable industries through sustained health of the land and improved quality of production.*	▪ Promotion and involvement in PMP ▪ Flood plain grazing project and production of books ▪ Documentation of producers experience in workshop at Mungeranie ▪ Production and promotion of District Plan.	Need more partnership with agribusiness

REVIEW OF MARREE 3 YEAR PLAN (1997)

Review of Aims	**1.Did we achieve this? Yes or no?** **2. Still valid? Continue as is or suggested changes.**	**1. If not achieved - not, why not? valid reason?** **2. Any other issues associated with this aim?**
4. *To encourage and promote the effective control of pest plant and animal species*	▪ Board has become a prescribed body under the APC Act. ▪ Involved in a feral goat control program ▪ Produced a pest plant identification kit ▪ Encouraged APCC to look at hot spots – ie noogoora burr, sticky hopbush ▪ Board has provided assistance to land holders in control (shooting) of feral horses, donkeys and camels.	Note that Trevor Mitchell (former kangaroo Liaison Officer) is prepared to support new officer. It is necessary to have a board member in this position.

REVIEW OF MARREE 3 YEAR PLAN (1997)

Review of Aims	**1. Did we achieve this? Yes or no?** **2. Still valid? Continue as is or suggested changes.**	**1. If not achieved - not, why not? valid reason?** **2. Any other issues associated with this aim?**
5. *To encourage, promote and support ongoing inventory of the District's natural resources*	▪ Involvement in Biosurvey ▪ Developed a herbarium, a fantastic resource and achievement as every landholder has there own personal herbarium. ▪ Supported research into Mound Spring management ▪ LEB weeds initiative ▪ Mt Gason Exclosures ▪ Conducted a plant identification and a plant propagation course	

REVIEW OF MARREE 3 YEAR PLAN (1997)

Review of Aims	**1.Did we achieve this? Yes or no?** **2. Still valid? Continue as is or suggested changes.**	**1. If not achieved - not, why not? valid reason?** **2. Any other issues associated with this aim?**
6. *To encourage and promote improvement in land condition monitoring*	▪ Involved in the debate ▪ Represented the district on the Pastoral Board committee which looked into this issue ▪ Some landholders are doing it without the board assistance ▪ People are generally more aware and observant of land condition and are destocking much earlier ▪ Exclosures are being monitored ▪ Worked with the Assessment teams and supported the teams and landholders in this process	Did not take this up, not enough support from the land holders Recommend that the next Board re-visit this issue.

REVIEW OF MARREE 3 YEAR PLAN (1997)

Review of Aims	**1. Did we achieve this? Yes or no?** **2. Still valid? Continue as is or suggested changes.**	**1. If not achieved - not, why not? valid reason?** **2. Any other issues associated with this aim?**
7. *To encourage and support other research which focuses on land management within the District*	▪ Projects were supported ▪ Board supplied letters of support, reviewed conditions and criteria to ensure that outcomes were useful for landholders ▪ Involved in cross border initiatives, especially in pest animal and plant programs, ie NSW and Qld. ▪ Increased overall awareness – involved in education and discussion with land holders	Did not concentrate on Board directly achieving on ground changes.