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LOWER MOORE RIVER WORKING GROUP
REPORT ON ACTIVITIES FOR YEAR ENDING 19 MARCH 2005

The following report on initiatives and activities of the LMRWG reflects the commitment and dedication by the current committee and volunteers over the preceding 12 months. It has been a most challenging year with determination and perseverence mostly winning through and continued perseverence coupled with endless patience adopted to educate and encourage ownership of and respect for our natural heritage.

Projects:

River Walk Trail
Steps, handrails, safety rails and a seat were installed along the walk trail by Limestone Innovations assisted by Coastal Dingo. Moore River Tours were contracted to deliver materials and labour. This project was completed within three weeks. Some revegetating may be required at site and will be assessed in July. The project was largely funded by Lower Moore River Working Group with support from the Gingin Shire, Gingin Land Conservation District Committee and Envirofund 2.

As Envirofund 2 regarded the project as an 'amenity' their funding was less than anticipated. The LMRWG would like to acknowledge the support and generosity of Limestone Innovations and funding assistance from the Gingin Land Conservation District Committee in enabling the project to continue.

Silver Creek Rehabilitation
We are pleased to report the success of our application for a $5,000 grant from the 2004 Community Conservation Grant scheme. This project involves removal of Buffalo grass and Lovegrass. The target area is opposite the golf course on Guilderton Road. To be followed up by planting. Propagation/retention rates of Banksias, not impacted by the previous fire, indicate good outcomes.

Removal of bulbs (unofficially Wavy Gladiolus) along the walk trail is an in-kind contribution in support of this Grant and 'weeding days' will commence as soon as weather permits. Dates and time will be displayed on the Mortimer Road chalk board.

Moore River Reserves Rehabilitation at the Perth-Lancelin Road Bridge Site
An application for $15,265 has been lodged with Envirofund Round 6 for weed control and revegetation with a walk track and interpretative signage. Some fencing is required. See site plan. Result of our application will be known by end of June.

Gingin Shire Environmental Grant:
Funding was again received from the Shire for herbicide and administration for this financial year.

Silver Creek Management Plan
This Plan is being presented today by Consultant, Richard Hammond.

Other than initiating new projects, the LMRWG continued resolving issues.

Lancelin Road Bridge Site:
Bollards have been replaced by large rocks, having the desired affect of protecting plants from vehicles. Main Roads are maintaining the toilet and have made modifications improving its function.

Signs (Education):

- A 'fire' sign to place just outside townsite along the walk trail is progressing.
- A number of 'please do not disturb' signs have been installed in specific locations along the walk trail.
- A number of 'biological control area' signs have been installed.
- Gingin Shire have been requested to supply 'no dumping' signs.

Tree Planting:

- Reeds, rushes and sedges (riverside)
- Eucalyptus rudis (downstream of five groynes)
- Tuarts (downstream of five groynes)
- Acacia saligna
- Coastal Hop Bush.
- Melaleuca hueglii (No. 1 area)
- Spyridium globulosum (No. 1 area)

were all planted out this year. Not as many as previous years due to financing the steps.

Students from Helena College assisted in pulling Lupins again this year as well as planting reeds/rushes along with Central Midland Senior High School, Moora and Christian Brothers Agricultural School, Tardun.

LMRWG has received a letter of consent from The Water Corporation to use the stand pipe in Gordon Street for watering as requested.

Weed control:
Biological controls of Bridal Creeper are having an impact on this weed.
Brazilian/Japanese Peppers were treated in Gabbadah Park with assistance from Gingin Shire, along the river walk trail and along Stevens Crescent.
Lovegrass was treated at the entrance to town, at the Fish Flats, and along the riverbank in Stevens Crescent.
Geraldton Carnation weed was treated throughout townsite with assistance from Gingin Shire.
Veldt grass is being removed from Silver Creek to prepare for planting.
A contractor has been engaged to treat Buffalo grass in Silver Creek.

Fire Management:
Progress of 'fire sign' along walk trail.
Weed management.
Initiation of and attendance at a 'Fire Forum' chaired by FESA. Resulting from the Forum was the Guilderton Fire Management Plan although the Group expressed their disappointment at not being invited to participate in development of the plan inevitably meaning that many recommendations were not adopted.

Fauna Studies
Brendan and Chris from UWA undertook fauna studies again this summer.

LOWER MOORE RIVER



RIVER ACTION PLAN





A Rivercare funded project supported by the Guilderton Community Association

Nicole Siemon

Ecosystem Management Services

August 2000

Acknowledgments

Many people were involved in the development of this report. The author wishes to thank all of the members of the Lower Moore River Rehabilitation Working Group and private landholders for their information, support and advice throughout the development of the action plan and status report.

Special thanks go to, Chris and Bill Ros for their ongoing support and inventory of birds of the region, John Forehan for his generosity, the Murray family for spending so much time discussing the river, its processes and management and Jonelle Black from the Water and Rivers Commission for information relating to catchment issues.

Special recognition also needs to go the Caraban Landholders for their time and willingness to meet with the author at different stages of the development of the documents. Phil Smeeton, Elaine and Vic McCartin, Peter Robertson and the Grant family who made themselves available to discuss issues, current actions and listings of available information.

Thank you to the Shire office staff who provided me with access to reserve and contact information.

Thank you to all landholders for allowing me to access and assess the foreshores within their properties.

Many thanks go to Peter May from Ecosystem Management Services for the development of the maps included in both documents.

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Introduction

Background

The riparian environment of the Lower Moore River has been changing significantly as the result of human activities since settlement. Recognition of the continuing degradation of the natural environment resulted in the Guilderton Community Association seeking an integrated approach to management focused on achievable actions. The Guilderton Community Association successfully applied for funding through the Natural Heritage Trust in conjunction with the Water and Rivers Commission. This money is funding on-ground works, a series of scientific studies and development of this action plan.

This River Action Plan aims to provide a framework and details to enable effective management of the natural areas persisting on the Lower Moore River. It should be read in conjunction with the Lower Moore River Status report.

Rehabilitation plans, with detailed actions and costings, enable all levels of the community, both townsfolk and the agricultural community to contribute to the effective management of the river resource. Such frameworks can be used in conjunction with strategic and local planning mechanisms available, to achieve a range of objectives including the ability to:

- manage and improve the natural environment,
- create ambience and enhance natural features within new housing and development areas, and
- Provide the community with a resource to influence environmental planning in a regional context.

River Action Plans are on-ground documents that enable the community and state and local government to work together in implementation of river restoration actions. Further these documents assist planners, engineers and other key staff within local and state government to assess future development applications against the management framework provided in the River Action Plan to ensure that the environmental goals along with commercial, agricultural, tourism and recreational use are considered.

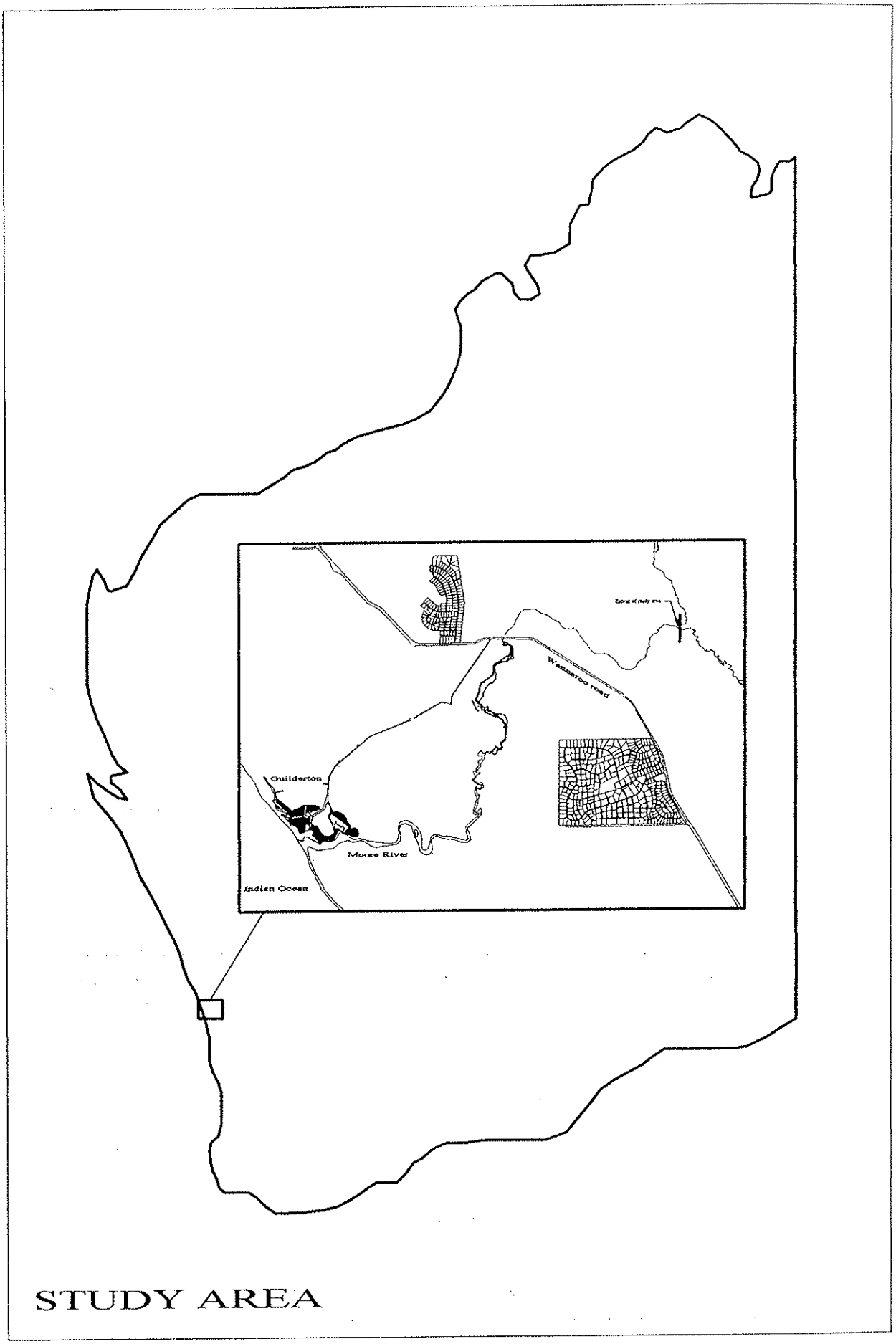
These plans can focus effort to appropriate nodes, and with consideration and provide guidance to community and landcare groups for their rehabilitation and revegetation works.

There is a strong need to ensure effective use of financial and in-kind resources of any implementation strategy to ensure realistic strategies are developed. Grand schemes which have high labour requirements, and substantial dollar costs or other resources required need to be integrated into a framework which also offers achievable outcomes in the short to medium term, but also sustains the greater vision of the entire Lower Moore River and its catchments. This enables river assessment and development of an action plan to be the result of balanced negotiations across all disciplines to develop the best outcome.

The study area

The area covered by this study is the section of river and its foreshore between the confluence of Gingin Brook and the mouth of the Moore River at Guilderton.

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STUDY AREA

Aims

The Lower Moore River Rehabilitation Action Plan will aim to:

- Identify priority 'on-ground' and 'in-river' actions and relate these to natural physical and biological processes;
- Restore and rehabilitation vegetation communities and ensure the long term viability of existing flora;
- Provide a tool for the community to contribute to environmental planning and management by taking into account potential future uses; and
- Increase awareness and knowledge within the community in vegetation and river management, foster involvement in maintaining remnant bushland and encourage local residents to participate in the regeneration or enhancement of public and/or private land.

Funding for this study

The Rivercare component of the Federal Natural Heritage Trust has provided matching funds to enable the Guilderton Community Association to develop this river action plan. The community and local government will be providing money and in-kind works to achieve the objectives of this plan. This plan has been developed to assist with prioritising expenditure of the Natural Heritage Trust funds and provide a framework and avenues for further funding.

The National Goal of the Natural Heritage Trust is:

To develop and implement resource management practices which enhance our soil, water and biological resources and which are efficient, sustainable, equitable and consistent with the principles of ecologically sustainable development.

The management and administration of the funds gained rests with a combined management committee comprising representatives from all key stakeholders within the Lower Moore River study area. This group is known as the Lower Moore River Rehabilitation Working Group.

The structure of the report

This report has been developed to provide an overview of the issues affecting the Lower Moore River. A series of recommended general actions with accompanying technical information has been provided to enable project development. The general actions are provided on coloured paper. The format for the issue section of the plan includes:

- a strategic objective for each issue;
- principles for management related to each issue;
- specific actions to be taken for each issue; and
- information brochure style technical information to enable an understanding of the recommended actions.

The next section of the report provides detailed site maps and descriptions for works on individual properties.

This is accompanied by a section providing detailed implementation plans, and is supported with specific information in the Appendices.

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Detailed Appendices collating as much information from the literature, anecdotal evidence and during the surveys of October/November 1999 complete the document.

This report needs to be read in conjunction with a report providing an overview of the status of the Lower Moore River. It includes information relating to the physical, biological and social features of the area.

Approach

Stakeholders

There are a large number of stakeholders that are critical to the success of overall management of the Moore River (Table 1). The existing management structure for the river itself, in terms of Council land, private land in both small and large land holdings and Crown Land will impact on management approaches for similar conditions for the entire length of the waterway. Groups with a role in management of the river are outlined below.

Table 1: List of stakeholders

♦ Guilderton Community Association ♦ Woodridge Community Association ♦ Neergabby Community Association ♦ Friends of the Moore River Estuary and Remnant Bushland ♦ Individual landholders ♦ Shire of Gingin — FIRE BRIGADE ? ♦ Water and Rivers Commission ♦ Department of Conservation and Land Management ♦ Natural Heritage Trust	♦ Caraban Landowners Action Group ♦ Gingin Land Conservation District Committee ♦ Other interest groups (e.g. recreational groups such as the 4WD Association) ♦ Ministry for Planning ♦ Wildflower Society ♦ Agriculture WA ♦ Wider community ♦ Fisheries WA ♦ Department of Transport

This report has been developed using information gathered at previous workshops and meetings, a meeting of the Lower Moore River Rehabilitation Working Group in December 1999, and numerous one to one interactions with many of the landholders of the Lower Moore River.

This report was released for public comment for a period of two months, subsequent to which the suggestions were assessed and included in the final report where appropriate. An additional document, a summary of submissions, was developed and released in August 2000.

Achieving implementation

There is a need for all stakeholders to work together to achieve implementation of this action plan. Many of the actions also require the approval of a range of statutory bodies including the Department of Transport (e.g. Navigable Waters Regulations), Water and Rivers Commission (e.g. Rights of Irrigation and Water Act) and Shire of Gingin (e.g. delegated powers under the State Planning Act). Further private landholders and members of the community groups have rights, needs and expectations from this process.

All stakeholders working together, compromising and negotiating to the best possible outcome will achieve most for the physical, biological, economic and social environment of the Lower Moore River.

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RIVER STABILISATION

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Examples of foreshore erosion in the Lower Moore River

Plate 1: Loss of vegetation behind the trees has resulted in loss of sediment during a high water event, and will ultimately result in all of the trees seen falling into the river.



Plate 2: A preferred stock watering hole has lost vegetation cover and eroded back.



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Issue 1: Sediment management

Strategic objective

To work to reduce sediment loads, manage existing instream areas of built up sediment and to encourage scouring and re-creation of the riverbed and banks.

There are three main sources of sediment - the catchment and stream flow, sand dunes (including 'The Desert') and long shore drift of sand on the beach being pushed into the estuary as river flow is reduced. Indications are that the quantity and mobility of sediment is greater than the river's natural load. This is evidenced by the observation that most of the large river pools are full of sediment, and are unable to self-clean. It is likely that the bulk of the mobile sand originates from the catchment, river banks and floodplain following clearing of vegetation, flood events (such as one experienced in March 1999) and modifications to the river channel in upstream areas. Water runoff and sediment loss from rural lands within the entire catchment, well beyond the study area, and channel erosion, both contribute significant amounts of sand.

The overall impact on the estuary and river environment is that it is becoming increasingly shallow, increasing water temperatures and increasing the potential for algal blooms. This is also impacting on recreation, visual amenity, loss of fish stocks and a decline in biodiversity.

The Water and Rivers Commission and the Department of Transport have recently undertaken a bathymetry survey to determine the current status of the lower reaches of the River and estuary. The results of this work are due to be published in late 2000. This provides a snapshot of the sediment levels, and will allow comparisons in future years.

As the estuary and lower river reaches fill up with sediment there is also an increased risk of localised flooding, changes to the bar dynamics and possible impacts on groundwater dynamics. Personal communications with officers of the Water and Rivers Commission and a report by Grimes and Eliot (1998) support this view.

Another significant problem is artificial management of the sand bar that closes the Moore River Estuary mouth for much of the year. Opening of the bar manually impacts significantly on the ability of the river to scour out the sediment that is accumulating.

Sediment management is a catchment-wide issue, however, it can be addressed at a local scale through riffles, baffles and selective removal and re-alignment of large and small woody debris. This is discussed in general management principles in the following section.

There is a risk that any works undertaken may significantly impact on the riverbed and banks in an unintentional way, if the works are not implemented carefully and in accordance with the management principles supplied. Obtaining advice, support and ultimately an approval from the Water and Rivers Commission will help to manage this risk.

Actions

1. Provide a training program for all middle of the river land title landowners outlining the principles and practices required to help restore river function through removal of small woody debris and re-alignment of large woody debris.

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2. Investigate the feasibility of implementing localised physical removal of sediment to reduce issues associated with managing the excessive sediment load.
3. Work to rehabilitate the exposed and eroding sandbanks, focussing on the verge and upper sections of the bank that are less mobile.
4. Provide information in the form of signage and brochures outlining the importance of allowing the river to function naturally, and the benefit of natural processes in maximising scouring and removal of sediment from the river system.
5. Continue research programs into the impacts, sources, and particle size distributions and in-river storage capacity of sediment.
6. Continually evaluate impacts of sediment load, current status, how is it changing, and how it compares with historical/anecdotal information.
7. Publicise the findings of the bathymetry study, sediment survey and core sampling through signage at key locations.

Plate 3: In some river sections, woody debris is deflecting the water into the river banks causing washout.



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Technical notes

The Moore River is declared under the Rights of Irrigation and Water Act (1914). This means that it is illegal to disturb the bed or the banks of the river, affect river flow dynamics or impede water movement without gaining approval from the Water and Rivers Commission. During the survey of the study area, a number of characteristics such as significant quantities of large woody debris and suspended woody debris were identified as impacting on the flow characteristics of the river. While this is a normal feature of river systems, the volume of material appears to be greater than in similar river sections throughout Western Australia.

These technical notes are intended to provide information about river process and function. Suggestions relating to minimising floodplain damage are made, however, as outlined above, any works must gain the support and approval of the Water and Rivers Commission.

Engineering in the floodplain

Most rivers – especially in their middle and lower reaches – show a clear distinction between the sediment transporting low-water bed and the floodplain. The floodplain includes the areas inundated when the so-called bank-full stage is exceeded. Many sections of the Lower Moore River retain healthy paperbark woodlands and well-vegetated islands in the low-water bed. The floodplain contributes to the conveyance and storage capacity of the river when the river floods.

The transition between the two parts of the riverbed is normally quite clearly defined.

The floodplain may have two main functions:
1) contribution to the discharge, and
2) temporary storage of the flood wave and the corresponding top water levels in downstream river reaches (damping of flood waves).

Modification to the floodplain can have a definite influence upon the conditions in the low-water bed. It should be considered that works that locally reduce the water level would cause the upstream slope to increase, which may then cause erosion endangering the stability of upstream river engineering works such as embankments and bridge piers. This has been experienced in some of the upper parts of the Moore River catchment.

There are two bridges and one dam within the study area that might have affected the width and also the level of the floodplain. The filling-up of relatively low-lying parts of the floodplain and the construction of earthen approaches to bridges tends to result in localised areas of the floodplain being raised, as floodwaters carrying sediment are slowed and the sediment drops out. The outcome of such activities will produce a local decrease in the discharge capacity of the floodplain.

In the past, hard engineering works in the floodplain were carried out for various reasons, such as the following:

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(a) Erection of levees or the closure of spillways often necessitates river restoration works to prevent the higher flood levels, which might result from the narrowing of the floodplain and the loss of damping capacity.
(b) Remedial works in the floodplain in the area concerned can locally lower water levels. As such these works can be an alternative to strengthening of levees.
(c) Local increase of the sediment transport capacity, as a consequence of the presence of a constriction in the floodplain, can cause erosion in that particular river stretch and sedimentation further downstream.
(d) Restricting the conveying width of the floodplain, e.g. by the construction of a bridge and its approaches, might induce a local rise in the water level and may require counterbalancing.

River restoration techniques in the floodplain will have different effects on river reaches upstream and downstream that are quite different from the local effects. When discussing engineering works in the floodplain and their effects, a distinction is therefore made between the local conditions and the conditions downstream and upstream.

As mentioned above, this sort of work has been occurring in some of the middle reaches of the Moore River and is likely to be the cause of, or exacerbating, some of the problems arising downstream. The difficulty in this situation, is that the downstream landholders may not be in a position to manage these changes.

Again, the problems arising from modifying the bed and banks of rivers means that undertaking localised management of flow impediments such as large woody debris, baffles to slow water or other such management techniques needs to be used carefully and planned completely. Erring on the side of caution is critical.

Channel modifications

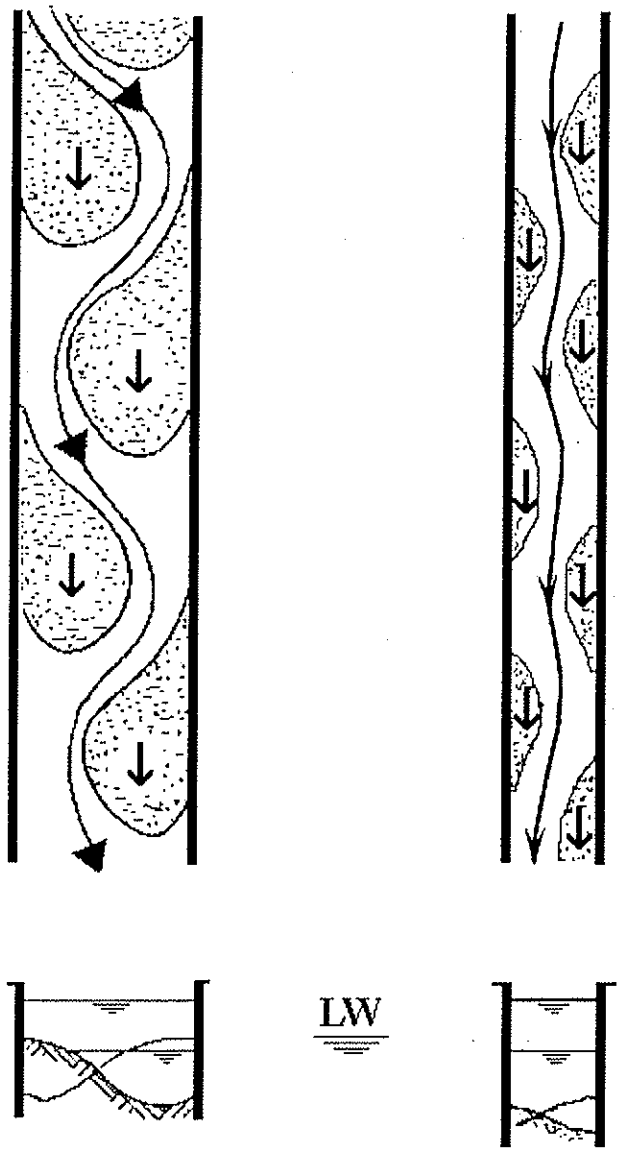
The sediment load is a significant issue facing the Moore River.

There is considerable interest amongst landholders along the river to modify the river's flow to protect power bends from further erosion, reduce the sedimentation rate and clear the channels to improve flow. The concept of influencing the channel position is to stabilise the low-water bed in an alignment that improves the river's ability to cope with the greater sediment and vegetation debris loads.

There is no easy way to describe the most effective way of improving the flow characteristics in the river, which would enable all landholders to work to manage the river processes. This work needs to occur with an engineer and an ecologist present. The Water and Rivers Commission has considerable expertise when it comes to this field of work, and are the approving body for any works undertaken within the river or its floodplain.

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Fig :1 Sandbank formation in straight channels (adapted from Chorley *et al*



1986).

There are a number of simplified concepts that can be kept in mind when considering modifying river flow, and it is important to remember that river restoration works not only impact on the immediate area but also on river characteristics upstream and downstream.

Single channel

It should be kept in mind that a straight channel with uniform cross-section is not stable. This has been effectively demonstrated by the training of the Avon River in the 1960s which is now being restored at great cost. If a disturbance of any kind occurs, by chance, at some place in the straight reach, the river will start meandering in its low water bed and alternating sandbanks will appear (Fig 1). For example, where trees have fallen into the river, the flow can be diverted into the opposite bank. The way in which the water flows will causes erosion at the upstream end of the sandbanks and sedimentation at their downstream ends. During low-water periods such sandbanks will partly

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emerge. This has become particularly evident following the Moore River floods during 1999.

In general, any works should aim at stabilising the sandbanks and shallows in the inner bends. This can be obtained by giving the low-water bed an S-shaped alignment. The shape and radius of the resulting curve needs to be such that the flow will be able to stabilise the location of sand and shallows.

These processes have been occurring in the Moore River system for tens of thousands of years. There are some variations to the causes of sedimentation, in that large stands of *Melaleuca rhaphiophylla* act as riffle zones, aerating the water, slowing the water flow and forcing considerable volumes of sand to drop out of the water column. The volume of sand that is mobilised during the peak flow events is significant as many of the deep river pools have been filled with sediment, and are no longer self-cleaning. Anecdotal evidence supports this theory – there are fewer deep pools than were present in the past.

There are significant levels of mobile sediment. This may be the result of sand and other particulate matter entering the river following clearing, loss of native vegetation and high surface runoff resulting from loss of trees in the wider catchment. It is likely that some sediment is contributed locally following large flow and flood events. The study currently being undertaken by the Water and Rivers Commission is aiming to identify the origins of different sediment particles, which may shed light on this feature of the lower Moore River.

In some locations, the sand has built up more than 2.5 m above last year's level. This is evidenced by living plant material being found at a depth of 2.5 m below the surface of drift sand in November 1999. Woody debris has been trapped in the dense paperbark thickets, further slowing the water and resulting in more accretion. In some places, this debris is trapped near the top of the trees. This is impacting on plant health, as the impact of debris hitting the tree can result in the death of many branches and branchlets in the upper parts of the canopy. This material will then be dislodged in future years. The rate of water movement during the 1999 flood event was also sufficient to embed sand particles between the layers of bark. This increases the trees' susceptibility to insect and fungal attack. This is a natural event.

Complex channels

Braided channels are one of many natural river forms. The following description is intended to provide an understanding of how these patterns occur, particularly as it relates to any projects that occur within these sections. In some instances, encouraging movement of some instream sediment can be beneficial to plant health. This is not intended to reflect a desire to prevent braided channels from remaining within the Lower Moore River. In the case of complex channel systems with islands, braided channels, moving sand banks, etc. requires great care. Gradual small changes which lead to the ultimate goal are preferred. The implementation of works may cover several years and requires good planning and flexibility so that the plans can be adapted to the developments and changing environmental conditions during those years.

An example of gradual works is shown in Figure 2.

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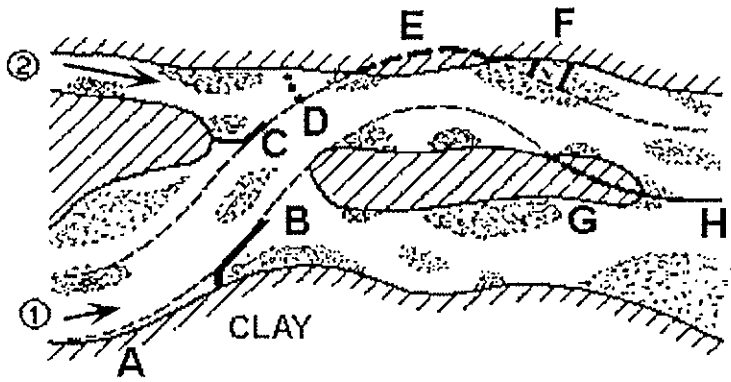


Figure 2. Possible approach to assist in stabilising a complex channel pattern.

The bank A, if not subject to erosion, it could be used to guide the formation of a new channel. Lengthening this bank with a spur B (possibly a fallen tree) will help to stabilise the curve. In the first phase the height of this spur must be kept low to prevent large extra resistance to flood flow. The flow is now directed to the left bank, but again instream debris needs to be used as a guiding structure. These should occur in accordance with the alignment of C and D and F and H. Working to stabilise the banks E and G needs to wait until the river has formed a stable pattern and moved to its designated alignment.

When working to manage a river section in this way it is always necessary to remain alert to the behaviour of the river upstream in order to avoid surprises such as channels shifting around a stabilised reach.

The difficulty in adequately describing such a process reinforces the need for technical advice from the relevant government authorities to ensure that further accidental damage is avoided in implementing any physical changes to the environment. Further, approvals from the Water and Rivers Commission are required before any such localised re-alignment of woody debris is undertaken.

Powerbends

It may be possible to protect eroding powerbends on the river. There are a number of private landholders with considerable infrastructure at risk from the river modifying its course. The complex nature of the river, with the confounding influencing factors such as the increased water, sediment and organic load from the catchment, may encourage some rearrangement of instream snags and large woody debris. There are a number of potential techniques to encourage sedimentation to occur in eroding areas, and deflecting the main flows back to the middle of the river through careful alignment of large woody debris.

Such techniques may have a number of benefits, including increasing the water speed through the middle of the channel, which may improve erosion of the river bed and continue to move the sand through to the river mouth.

Again, as outlined above, these techniques are risky and if implemented incorrectly may result in a greater problem than that currently experienced. Approval and advice from the Water and Rivers Commission are critical.

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Snags and Large Woody Debris

Large woody debris is a naturally occurring phenomenon and it is important in streams and rivers for number of reasons. In the Lower Moore River however changing water flows, increased death of instream vegetation due to floodwaters transporting heavy branches and sand and inflicting physical damage on plants, has increased the quantity of large, medium and small woody debris in the system.

Large woody debris is important for a number of reasons. Some of these (adapted from LWRRDC 1999) are:

- Large woody debris provides habitat for both aquatic and terrestrial animals including:
  - Fish
  - Invertebrates, microbes and algae which either feed on the wood or live/graze on the biofilm (combined algal and microbe community)
  - Birds, mammals and reptiles use woody debris for resting, lookout sites and crossing points and for nest construction.

  The habitat functions include providing shelter from high water velocities, shade, feeding sites, spawning and nursery areas for larvae and juvenile animals, territory markers and offering refuge from predators.

- Large woody debris is important in nutrient cycling processes as it provides sites for carbon and nutrients processing (photosynthetic process of algae) which is a major food source for many invertebrates and vertebrates.
- Water flow over snags helps to re-oxygenate the water thus preventing stagnation, odours and other water quality problems.
- Snags and their orientation in the stream contribute to the habitat formation and impact on channel structure. Depending on their position in the stream (parallel, angled or perpendicular to the water flow), they create different habitat types (scour pools, bars, islands, depositional zones).
- Snags are involved in the normal erosion and deposition processes that result in shaping the stream/channels. The force of these processes depends on the size of snags, their orientations and water velocities and levels.
- Snags help reduce boating access to the middle and upper reaches of the river and therefore help to minimise conflict between recreational users and private landholders with middle of the river titles.

MANAGING SNAGS

The critical factor associated with managing existing snags is assessing their actual contribution to flooding and erosion.

Before attempting any action, the following questions should be asked:

- Is the large woody debris the actual cause of observed problems?
- Is the bank erosion caused by other factors such as bank instability?
- Have the constructions/impoundment's impacted on the hydraulic characteristics or caused flooding elsewhere in the river?

It is important to remember that rivers are complex, interdependent systems that are sensitive to change. The removal of snags may trigger problems of channel instability and erosion, particularly downstream.

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In the Moore River, there are several areas that are choked with debris and others that retain limited instream large woody debris. This is turn increases sediment build up. In some sections, re-alignment of selected pieces of large woody debris may benefit channel stability however, every case needs to be discussed with, approved and managed by an ecologist and engineer from the Water and Rivers Commission. Any snags that are re-aligned may require anchoring in position.

Generally, all large woody debris should be retained instream, with re-alignment preferred to removal. The debris in the Moore River is likely to be having an impact on flood levels, bank erosion and channel widening. Again, it is important to stress that re-orientation or lopping is generally not recommended in other than exceptional circumstances, as it may trigger unwanted bank erosion. Lopping is discussed below.

The Capel River Action Plan (WRC 1999) provides a diagram of snag management.

Further information can be obtained from the Water and Rivers Commission and the River Landscapes Series prepared by LWRRDC.

Removal of
1. trees susceptible to erosion and
2. suspended debris

There is considerable discussion within the farming community about the benefits of de-snagging and removal of both live vegetation and dead plant material from within the main floodway. The dense paperbark thickets that characterise sections of the river, large Flooded Gums and Tuarts bounding the banks often coincide with areas where erosion has been exacerbated.

Many of these trees occur in areas where the extent of trees has been reduced to a single row of mature plants. These are inherently unstable, as the root structure from one plant is insufficient to provide sufficient in-ground strength. Single rows of trees do not trap as much woody debris as well-vegetated sections.

In other areas, loose coarse sand particles occur over fine compacted clay substrates. This duplex soil structure is unstable because the flow velocity and volume increase the sediment carrying capacity of the flow. The sediment-laden water also has considerably more abrasive force.

Removal of live and dead material from within river systems is an extremely complex management technique as discussed in other sections of this document.

Suspended debris and dense vegetation perform several functions during medium and peak flow conditions. These include:

- Trapping sediment,
- Slowing flow;
- Removing suspended debris; and
- Providing habitat for aquatic life.

Instream live and dead plant material performs a range of functions. By slowing the water and dropping sediment, the amount of scouring and erosion of the banks can be reduced downstream. However, in areas where sediment has accumulated, the

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river levels become higher and therefore erosion occurs higher on the banks than previously.

Removing instream debris will result in increased flow rates. As the water moves faster, it again has the capacity to collect more sand from the bed and increase erosion in other locations.

Undercutting and slumping of the banks occurs as a natural river process. The rate and locations of erosion reflect the amount of vegetation cover, speed of water movement, amount of large sediment being carried by the water and position on the river banks, where position relates to power bends, straight stretches or slow meanders. In undisturbed environments, there are localised areas where there is little vegetation and tracks made by native animals. Similarly, stock tracks and camps close to the river's edge can loosen or compact the ground depending on the soil type and prevent the growth of plants (particularly ground covers).

Over time, in a flood event, the water will preferentially flow in areas lacking vegetation. This often coincides with stock tracks. The water in these areas flows more quickly and can scour the sediment. In some areas, this exposes tree roots. Should the tree die, stock can knock small branches off the trees. The depression following erosion of soil from around the tree roots continues to become deeper and with future flow events, more soil is lost until the tree falls.

This process also occurs where woody material is trapped against the base of trees, causing scouring both around and under the original bank. Again, this influences river flow and can result in trees falling.

Once the tree falls, depending on the strength of the river waters, it will either stay in situ or will be washed downstream. This woody material builds up against live or other dead trees, forcing the water around the obstacle. This can further increase bank erosion and conversely encourages sediment build up. This process is occurring along the entire length of the Moore River, and the study area is collecting all of this material, as well as contributing its own.

The load of woody debris in the Moore River is greater than that expected in undisturbed environments.

While de-snagging of the river has been a common practice in the past (particularly with the use of fire), the current management practices emphasis is to leave as much large woody debris as possible. Rather than removing large woody debris, the offending objects should be re-positioned at an angle 20-40 degrees to the stream bank. This will minimise the effect the dead debris has in the flow levels and direction. Refer to the discussion on large woody debris. All landholders must negotiate with, and gain approval from, the Water and Rivers Commission prior to implementing such works.

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To lop or not to lop?

Living trees that are being undermined; as a result of changes to the river flow is another source of conflict among the local community with diverse opinions about effective management of such situations.

Changing river courses often result in trees roots becoming exposed, and eventually, with continuing loss of soil the trees fall in and the river tends to migrate between the land and the tree. Over time, the river course continues to migrate across the river valley until it finds a stable alignment. Any changes to the characteristics of the river, for example increased flow, can then stimulate yet another change to the river course.

In the Lower Moore River the load of water, suspended organic material and considerable sediment load are exacerbating erosion, and resulting in these processes working at a more rapid rate. This is impacting on the living trees and resulting in a greater number than anticipated being undermined. The woody debris that gets trapped at the base of existing trees also results in increased scouring. The debris forces the water around and under the trapped debris, resulting in erosion.

This is most common in areas where stock have continuous (all year round) access to the foreshore, and there is often no regeneration of trees, shrubs or groundcovers, so bank stability is significantly reduced. The root structure is not present to help protect the bank from erosive forces.

Generally, live trees are being undermined in river sections that have only a narrow strip of mature trees remaining.

In some situations, the trees are growing such that their weight/mass is not evenly distributed. Where a single substantial branch is leaning instream it may be possible to remove the branch to restore the weight balance upslope. There is no hard and fast rule that enables assessment over entire reaches. Again, each individual tree needs to be assessed with officers from the Water and Rivers Commission.

Some landholders recommend removal where trees are being undermined and likely to fall in during the next peak flow event. These occur where the riparian vegetation is limited to a narrow band of trees, with no shrubs or understorey to help stabilise the banks. One of the reasons that removal is preferred is that the landholders recognise that the tree (as large woody debris) will block flow and divert the river channel, either upslope or across the paddock, and a new channel will form.

Removal of mature trees to accelerate the process of their loss is not recommended due to the loss of habitat, potential to create worse issues, and the threat posed to bank stability. Selective removal of branches or trunks to encourage the tree to re-shoot can be useful in some situations. This technique is not suitable for paperbarks which tend to re-sprout from all over the plant following disturbance, but can be useful for Flooded Gums in some situations.

The preferred management approach is to fence off above the area lacking vegetation, install tubestock at a moderate to high density, and work to reinforce the neighbouring vegetation. This technique is only suitable in locations where fencing is achievable and will not impact on water flow dynamics.

An alternative technique is to encourage the creation of defined river paddocks where they do not currently exist. The aim of this management technique is to allow

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natural regeneration of the understorey and middlestorey before allowing stock to return to that section of the paddock. Again, this can not be achieved everywhere and it is important to ensure that stock has sufficient access to enable weed control during the regeneration process.

Generally re-establishing groundcovers and medium vegetation needs to be the focus, not trees. Along the length of the study area, there are very few areas lacking overstorey but many areas that lack middlestorey and understorey plants.

Works to reduce erosion

Small blowouts

Many of the small blowouts within the study area are where the shoreline is receding in half-moon shapes. The cause of the water deflection that is causing these new blowouts needs to be identified, assessed and treated with approval from the Water and Rivers Commission. Limestone spalls, baffles, erosion control matting and other structures can be installed to armour the newly eroding face and reduce water flow along the new alignment. Additional planting may be beneficial. The plants should also be protected with tree guards as recommended above. Note it is critical to remove the tree guards prior to the onset of winter or in the event of summer rains to ensure that they are not washed downstream by a large flow event.

Constructing swales/mini-interceptor banks

There is discussion in other parts of this series of reports recommending the construction of mini-interceptor banks. There are a number of zones within the study area where there is an opportunity to undertake earthworks to recreate small mounds and swales. These swales help to protect new plantings by providing shelter and directing stormwater runoff to the plants, control sheet runoff from paddocks and help to trap pasture, weed and native plant seed within the property.

There is a considerable risk of exacerbating erosion should large-scale works be undertaken by machinery. It is critical that these banks be installed well above the river verge and not on the floodplain or banks, as they will encourage the formation of preferential flow paths in such environments. Further, it is essential that they are constructed exactly parallel with the contours.

It is possible to construct mini-interceptor banks while hoeing firebreaks. This ensures that there are no additional costs in installing these features.

Hemp matting

In areas with severe erosion issues, it is useful to cover the bank with hemp matting or an equivalent biodegradable product, with the matting buried into the sand (at least 600 mm) on the upstream and downstream side of the erosion zone and pegged at all levels. Lying and pegging fence post parallel with the contours can assist with gaining access.

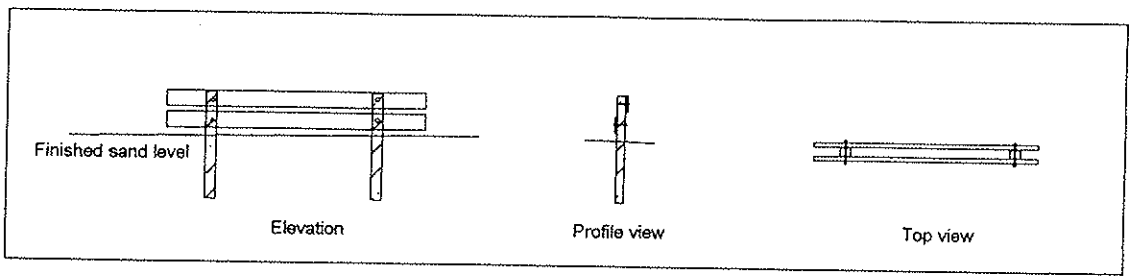
Small holes could be cut into the matting and replanting works undertaken using Shore Rush (*Juncus kraussii*) and Knotted Club Rush (*Isolepis nodosa*), close to the water's edge along with paperbarks and wattles. The planting should reflect the location of the zone in the landscape.

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Baffle boards

Baffle boards are instream structures designed to protect plantings from the force of peak flows as shown below. Large woody debris can also be used for this purpose.

Figure 3 : Suggested baffle design



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POLLUTION PREVENTION

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Plate 4: Suspended sediment is one of many issues facing the Lower Moore River.



Plate 5: The Water and Rivers Commission are studying the water quality of the Moore River.



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Issue 2: Water quality

Strategic objective
To minimise the loss of pollutants from agricultural land and townsites to the Moore River, considering both surface and ground water.

There are a number of sources of pollution of the Lower Moore River including diffuse and point sources. Water quality threats can be divided into three categories: eutrophication (nutrient enrichment), contamination and salinisation. The information is limited with consistent studies only being implemented in the last couple of years. There is a need to continue work to determine baseline water quality conditions, spatial and temporal variation, changes to water quality as a result of human activities and the impact of these changes. This work may assist in determining the relative contributions of different landuses.

The monitoring program currently includes surface water, however should be expanded to include groundwater studies. Determining the function and contribution of groundwater seeps would also assist in understanding the river processes. Linking the data with meteorological information would be beneficial.

Salinity, nutrient enrichment and sediment load are all factors being investigated by the Water and Rivers Commission. There is evidence of elevated nutrient levels from the sampling program and the presence of blooms of aquatic algae in the river pools. It is likely that the bulk of the input arises from the upper catchment beyond the study area, however, landuses adjoining the study area may contribute some pollutants in runoff. Examples of landuses that may contribute to the water quality problems in the area include:

- faecal material (nutrients and bacteria) from sheep, goats or cattle in broadacre farming,
- faecal material (nutrients and bacteria) from intensive landuses such as piggeries, poultry farms,
- nutrients from intensive horticulture such as market gardens, turf farms and similar operations
- pesticides and herbicides from broadacre agriculture and intensive horticulture (e.g. market gardens), and
- wastewater from residential areas and leachates from septic tanks.

There is a threat that as water quality declines, stock drinking from river pools in summer may consume toxic algae which proliferate in warm nutrient rich water.

The impacts of contamination of the waterways include creating an imbalance in the aquatic ecosystem, changes in species composition, fish kills and significant impacts on the recreation use of the river by decreasing fishing and swimming opportunities and an increasing threat to public health. Increasing salinity also reduces the ability of landholders to water stock from the river and can result in loss of extensive areas of vegetation that is dependent on freshwater. Powerboats may also impact on salinity levels in the river, by increasing the level of mixing of saline and fresh waters.

Dealing with the nutrient issues of the Lower Moore River is predominantly beyond the scope of this report, however, will be considered by the Moore Catchment Group. There are local treatments and activities that can be implemented to reduce nutrient and sediment input into the river and its tributaries.

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In addition, bacterial levels in the river have exceeded acceptable limits in the past according to a study undertaken in the late 1980s (Gingin 1988). This is an issue because some landholders still extract from the river for consumption. The Shire of Gingin is increasing the frequency and regularity of monitoring bacteria levels in the river.

Actions

8. Continue regular surface and ground water quality monitoring programs (Water and Rivers Commission and Shire of Gingin) and implement proposed research programs (Table 1).
9. Investigate the contributions of leachates from townships, diffuse and points sources to the river system throughout the catchment by mapping landuse and prioritising risks to water quality.
10. Encourage landholders to install mini-interceptor banks parallel to the river bank to trap manure, seed from pasture species and slow water runoff to help improve water quality.
11. Implement the proposed schedule of fencing and re-vegetation of the riparian zone to create buffers to filter out nutrients and other polluting material, where agreed with all stakeholders.
12. Work to develop the fencing, revegetation and stock management systems using techniques that aim to improve water quality.
13. Initiate additional local involvement in the Ribbons of Blue program to provide supplementary water quality monitoring data.
14. Encourage a University project to investigate wastewater disposal techniques for existing and new developments and undertake a literature review on the potential impacts of septic tanks.
15. Investigate differences between groundwater levels on the floodplain and wells upslope.
16. Determine whether there is sufficient evidence to support anecdotal evidence that the groundwater levels are changing.

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STREAM ECOSYSTEM PROTECTION

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Plate 6: Annual grasses are spreading through natural bushland areas, increasing the fire hazard in ungrazed areas.



Plate 7: Kikuyu and Buffalo grass are difficult to manage in revegetation areas but are useful perennial plants in agricultural situations.



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Issue 3: Weeds

Strategic objective
To eradicate weeds from the river sections and restore native vegetation.

Weeds are common features of the riparian zone throughout much of the study area. These species are an issue as some threaten stock health and are toxic, others are opportunistic and exclude native plants which impacts on the ecological health of the river and many have a significantly greater fire risk than the naturally occurring vegetation.

Weeds also reduce habitat available for native animals, have a limited ability to stabilise the riverbed and bank and reduce the aesthetic appeal of the river environment.

Because weeds often act as primary colonisers in areas that are disturbed they also stabilise sediment plumes, impacting on sediment movement within the river system.

It is difficult to remove weeds entirely from the river system, as there are many sources of weed seed to replace those plants removed. The distribution of weeds needs to be addressed at a catchment and wider scale, however, control coordinated locally can make a difference.

The impact of removal of weeds on bank stability and habitat also needs to be considered prior to implementing weed control works. Further, it is critical that revegetation activities occur in any areas where weeds have been removed to reduce their ability to reinvade the area.

Appendix 3 provides weed control information for the major weed species found in this section of the river.

Many weeds present in the Guilderton townsite and neighbouring reserves have spread as a result of dumping garden waste.

Actions

17. Prepare coordinated weed control schedules for the townsite and farming regions focussing on specific species and local areas.
18. Link revegetation works to areas where weed control activities have been successful and stock access can be controlled.
19. Focus control on highly invasive weeds as discussed in the following section and Appendix 3 of this document.
20. Prepare an information brochure to landholders advising them of the impacts of dumping garden waste in foreshore reserves, the impact of weeds on the health of their natural landscape and encouraging their involvement in weed control activities in the townsite.
21. Investigate the feasibility of providing a landcare trailer equipped with items for revegetation works and weed control.
22. Continue to encourage the Council's roadside weed committee to continue to take action against highly invasive weed species such as Paterson's Curse, African Lovegrass, False Wanderrie Grass, Geraldton Carnation Weed and others.

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23. Establish an agreed timeframe where local farmers and community members undertake intensive weed control focussing on specific species.
24. Investigate landcare traineeship opportunities through the Shire of Gingin or a community group.

Plate 8: Annual grasses occur in the floodplain and adjoining bushland, reducing the conservation values and increasing fire risk.



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Technical notes: Weed control and management

Weeds that require focus in the Lower Moore River in accordance with the Draft Environmental Weeds Strategy for WA (CALM) include a number of declared weed species.

Species	***Common Name***	***Comments***
Eragrostis curvula	African Love Grass	This species was introduced as a pasture grass, and is spreading rapidly into the District. The hot spots occur upstream of the Lancelin Road Bridge, however, isolated infestations need to be removed as rapidly as possible. Roadside populations should be a focus. This species is a significant fire hazard.
Schinus terebinthifolia	Japanese Pepper	This tree has spread from residential gardens in Guilderton and is becoming increasingly widespread around the Estuary. As birds spread the seed from this plant, it is important to control it as quickly as possible.
Euphorbia terracina	Geraldton Carnation Weed	This species is toxic to stock and reduces fodder availability. This plant is another significant threat.
Watsonia bulbillifera	Watsonia	A small patch of this occurs adjoining a residential garden. Removal of this plant would reduce the possibility of it spreading over time.
Arundo donax	Giant Reed	This plant is being used as a windbreak by some of the market gardening companies in the area. It is able to spread rapidly and is extremely labour intensive to control and eradicate. Dumped segments can re-shoot.
Cyathochaeta avenacea	False Wanderrie Grass	This species occurs along many of the main roads in the area, however, is starting to move along fire access tracks. This species significantly increases the fire hazard.
Carthamus lanatus	Saffron Thistle	Thistles in generally are toxic to stock and people if handled due to their milky sap.
Citrullus lanatus	Paddy Melon; Afghan Melon	These plants are highly invasive and can ultimately dominate the landscape.
Emex australis	Double Gees	These plants impact on wool quality and make life uncomfortable for stock and people.

Detailed control strategies for each major weed species is provided in Appendix 3 of this document.

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General approaches to weed management

General notes about weeding

Why weed?

One of the major restrictions to growth and regeneration of native plants is competition from weeds.

Weeds are plant species growing in the wrong place. In a conservation area, weeds include all the non-local species, whatever their source. Weeds outcompete the local species for two reasons:

1. they lack predators; and
2. they are opportunists.

Opportunists are characterised by:

- abundant seed that is easily spread (by birds, wind or water),
- rapid growth, or
- faster growth than the local species in the given conditions.

Generally these species also lack native predators, for example insects.

As this remnant of foreshore vegetation is extensive and supports a number of highly invasive weeds, weed control is urgently needed. Many of the weeds within the Lower Moore River are recognised as significant environmental weeds of WA; Giant Reed, African Lovegrass, Gladiolus, Geraldton Carnation Weed, Kikuyu, Buffalo grass, Introduced Bulrush and Watsonia (Dixon and Keighery 1995).

A list of weed species found in the Lower Moore River and specific control instructions are provided in Appendix 3. It is important to note that the foreshore was assessed in summer and so may not include all weed species present.

Weeding in this environment is a highly specialised task. Thus the following guidelines need to be applied.

- Start weeding in the areas with fewer weeds and in areas where planting is proposed. There is more hope of success where there are fewer weeds.
- Focus attention on uncommon weeds with only a few plants. For example, Watsonia occurs only in MAP 4. Removing those adult plants reduces the amount of weeding required in the future. Never forget the common saying "one year's seeding, seven years' weeding."
- The other important aspect for weeding is that total removal will occur only in the area to be planted that season. In the remaining area, weed seed-heads need to be removed annually and if possible pulled out.
- Minimising disturbance is essential to minimise the chance of more weeds coming up. This also means that any seed of local plants will also not come up. The nature of the site is such that new native plant growth results from 'blow in' seed or seeds or plant segments brought in with the tides. Minimum disturbance will not affect these processes and is therefore recommended.

What to weed

- Make herbariums of pressed weeds and local plants so everyone knows which is which and subsequently specific weed treatments can be applied.

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- Target lower frequency weed species for control - they are easier to eliminate and a change can be seen reasonably quickly. Follow up weed treatment is essential so the extent of works should be at a manageable section.

- Pull out clumps of annual grasses only where planting will be occurring. Otherwise removal may create an erosion risk. Collect their seed heads before they ripen and dispose of as described above.

Where to weed

- Qualified or highly experienced bush regenerators should be responsible for overseeing the majority of weed control any healthy areas of remnant vegetation. Entry to this area should be limited to professionals as it is in reasonably good condition. Reducing the number of people entering this area will reduce the creation of paths, which may affect drainage, introduce weeds or damage vegetation.

- Different sections of the Lower Moore River will be worked on at different times in the five-year program – however, some weeds need to be targeted along the entire length of the River to make a difference.

- Working from areas with local plants towards the areas heavily infested with weeds will encourage the local plants to replace the weeds that have been removed.

Controlling bulbous and cormous species

Species with these types of growth include Watsonia and Gladiolus. Bulbs and corms are underground structures that sustain the plant in periods of stress and often help the plant to spread. They are similar to an onion, however, instead of just having one central body, they can have large numbers of small "bulbs" attached to the main body. Each one of these can grow into a new plant.

When these plants are pulled up, it is likely that the smaller bulbs/corms will be knocked off. To prevent reinfestation by these smaller bulbs/corms you can use a 1 m square piece of flyscreen as a sieve. The steps are as follows:

1. Loosen a 20 cm square around the plant with a spade – being careful not to get close to the bottom of the plant.
2. Push the spade in at least 20 cm from one side of the plant.
3. Lever the plant out of the ground gently.
4. Lift the sand and plant onto the flyscreen.
5. Shake so that the sand returns to the hole you've dug.
6. Bag all the corms/bulbs into black plastic bags.
7. Remove from site.

It is important that if the plants are fruiting above the ground, that seed heads are removed prior to removing the plant. Otherwise seeds will be dropped and reinfest the site. This technique needs to be carried out as soon as any outbreaks or parent plants are noticed. This technique is not suitable for heavy clay soils or on steep sandy banks.

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Rhizomatous species

The predominant weeds of this type are the Buffalo (*Stenotaphrum secundatum*), Kikuyu *(Pennisetum clandestinum*) and Couch (*Cynodon dactylon*) grasses. These three species represent a significant threat to the integrity of the wetland and dryland vegetation. The intricate, dense nature of the roots of many weeds especially grasses, means they effectively outcompete juvenile trees and shrubs for nutrients and water. These characteristics conversely mean that where native understorey plants such as rushes and sedges are absent or patchy, the grasses perform a useful function in stabilising the riverbanks and providing stock feed. They are useful perennial pasture species provided they are managed and contained within the pasture situations. Control of these species may not be a priority in agricultural zones of the foreshore.

Rhizomatous grass control should be undertaken to assist the planting program. Licensed herbicide operators should be brought in where there is Buffalo, Kikuyu or Couch grass in areas where stock is no longer present and where these species are reducing the viability of native riparian vegetation.

In some areas it may be appropriate to cut back grasses with a brushcutter and then either cover with densely woven, weed suppression matting, or alternatively, employ a professional herbicide operator.

A minimum area of 1 to 2 m in diameter around each plant should be kept weed free. This will be clearly identifiable by the arrangement of the mulch in the planting zones.

Focus areas for this form of weed control should be negotiated with landholders.

Herbicides are to be used with extreme caution and while they are preferred as a localised follow up procedure, with application by hand wiping, stem injection or painting onto a cut stump, in this area blanket spraying is likely to be the most effective application. Any broadscale application needs to be undertaken on a fine, still day.

Systemic herbicides should be applied when the plants are growing vigorously. Plants will slow or shut down during stressful periods of extreme heat and cold, so it is not recommended to treat with herbicides under those conditions, as the amount of poison taken up by the plant will be minimal.

In summary:

- Herbicides are to be used with extreme caution.
- Extreme caution needs to be exercised in selection and application of any herbicides for weed control especially near surface waters.
- Physical removal of weeds is preferable. Minimal herbicide may be applied as a follow up procedure to control reinfestation, with application by wick, brush or injection but not spraying.
- Once the infestation has been controlled then planting and mulching, or direct seeding, of the area must be undertaken.
- Weed control should be continue to be carried out intensively for at least a year after planting, and then monitored closely forever.

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Species dispersed by wind

To reduce self-seeding of weeds, remove flowering heads before they go to seed across the entire reserve, in addition to the focused weeding efforts. Dispose of them by putting them in black plastic bags, tying the tops and leaving the bags in the sun for a week of hot weather before emptying the bags away from the river. Mulching or burning the flowering heads is an alternative. It is essential that the seeds be collected before they are ripe.

- Reduce self-seeding by collecting seed heads from weeds prior to them ripening. This is easily done for species such as giant reed (*Arundo donax**), fleabane (*Conyza** spp.), Watsonia (*Watsonia bulbillifera**) and bulrush (*Typha orientalis**).

Many of the newly germinated plants with this spreading mechanism are very easy to remove as juvenile plants. Monitoring drives or walks to monitor for any new infestations should be done once a month or more frequently if possible. Any new plants should be removed before they get too big. Always carry a plastic bag in which to put small plants while undertaking the monitoring trip, and remove from the site.

Summary of how to weed successfully

- Every year, the follow up program must be implemented and any weed seedlings removed immediately to prevent reinfestation. Maintain a weed free zone around each plant.

- Follow up plantings is an integral part of the rehabilitation program. Indigenous seedlings must be planted in weed cleared areas to prevent weed reinfestation.

- Some plants, such as Watsonia, have reproductive structures under the ground as well. For these it is important to dig around the clump for at least 20 cm then lift up all the sand around it. Place the spade full of sand onto some flyscreen and shake to find all the "corms". Put the corms in the bag and return the rest of the sand to the hole just dug. Do not use this technique on steep banks or in clay soils.

- Pull out small plants, which have germinated, from seed such as Fleabane and Dock. If they are already in flower, and seeds are developing, then cut the flowering head off the plant before pulling the plant out. Otherwise the seed will be released and require more effort. The seed heads that have been cut off should be put carefully into black garbage bags. Tie the top of the bags. If it is hot, leave the bags in the sun for a few days to kill the seeds before sending the rubbish bags to the tip, burning the seed or burying it at least 0.80 m below the ground.

- Where the plants are flowering, hand weed the plants or brushcut and dump material with roots suspended above the ground as the seeds have not yet developed and there is no risk of them invading new areas.

- Weeds with a rhizome or underground stem rooting system need to be cut and the regrowth poisoned to minimise ground disturbance.

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- Persistent brushcutting or whipper snippering has been found to be effective on small woody weeds. The continuous loss of leaf material will eventually starve the plant.

- Dead root systems are best left intact to prevent soil erosion from poisoned weeds.

- Mulching helps control soil water loss, soil temperature fluctuation and weed invasion. Mulches can be made cheaply - hay or straw mulch or mulch made from dead weeds. This mulch can be applied around any new plantings to minimise the need for re-weeding.

- It must be remembered to make minimal disturbance so the conditions do not favour weed regrowth. Any soil that has been disturbed should be replaced in its original layers ensuring that any native seed is on top.

- Native plant regeneration must dictate the rate of weed removal, as it is not possible to weed a site just once. Before moving onto new areas, the fact that native plants are re-establishing in the weeded areas must be confirmed.

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Issue 4: Wildlife

Strategic objective
To protect native animals and encourage natural vegetation to maximise habitat availability.

The fauna of the region can be divided into aquatic (freshwater and estuarine) and terrestrial.

The condition of the estuary, in particular the relationship between freshwater, marine and saltwater influxes from tributaries of the river, needs to be understood. For example, there is anecdotal evidence indicating that fish populations are in decline.

Some of the major fauna species that are likely to be found in the Lower Moore River area are listed in Appendices 4-7. Not all of these species have been positively sighted in the region, however, suitable habitat is present and it is considered likely that they occur in the area. A fauna survey has not yet been completed for the Lower Moore River. This information would be invaluable when decisions are being made about proposed fuel reduction and/or regenerative burning projects.

Areas cleared to parkland provide food and habitat for a range of native species such as kangaroos, members of the parrot and duck family and birds of prey (e.g. wedge tail eagles). These animals often preferentially feed in paddock situations. Similarly, introduced animals tend to focus their activities in farmed areas. Both stock and native animals co-exist well in these situations. Some landholders control the numbers of native animals grazing in their paddocks to reduce competition with stock.

Pest fauna is also a problem. The eradication of feral animals (especially rabbits, feral cats and foxes) is considered a priority with the local Land Conservation District Committee (LCDC) offering a baiting program when there is sufficient demand. These animals are present in the bushland along the river, and impact on native fauna, destroy native vegetation and reduce fodder available for stock.

Carp are present in the river, and their presence may in part account for reductions in native fish species.

Nuisance insects such as mosquitoes and stable flies also have the potential to impact on the enjoyment of recreational users, landholders and the Guilderton townsite. There is ongoing work to control the stable fly problem in the region, and the mosquito problems are generally effectively managed by good domestic practices.

Actions

25. Upgrade existing coordinated baiting program to increase use of this resource and investigate feasibility of expanding the program to include 1080 poisoned eggs to increase acceptance of this approach.
26. Investigate the potential for a fauna survey and annual monitoring program in conjunction with the WA Museum and a University.
27. Encourage more local residents to become involved in FrogWatch and other fauna programs such as the Bird Atlas.

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28. Encourage the Water and Rivers Commission to modify the gauging station on Gingin Brook to enable fish migration up and downstream.
29. Develop links between Birds Australia and the local community by holding bi-annual river cruises and bird watching tours.

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RIPARIAN ZONE MANAGEMENT

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Plate 9: Freshwater paperbark wetlands with an understorey dominated by Bare twig sedge characterise the floodplain vegetation.



Plate 10: There are several significant *Banksia* woodlands in the study area, but few with intact understoreys.



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Issue 5: Vegetation

Strategic objective
To protect significant remnant riparian vegetation, bushland and sand dune areas and work to enhance areas requiring revegetation.

The Lower Moore River Estuary foreshore and adjoining lands retain many significant areas of remnant vegetation. These range from Tuart and *Banksia* woodlands, wetlands and sand dune vegetation. The health and extent of riparian vegetation varies across the study area. Some of the healthy areas are protected in private property and reserves while others remain as an artefact of an inability to utilise the land for other purposes.

There is also a direct loss of foreshore vegetation in the overstorey, middlestorey and understorey with some areas completely denuded of vegetation. The degradation of native vegetation has been occurring for decades as a result of weed invasion, loss of species due to changing environmental conditions, fire and grazing. Large areas have been cleared to parkland to maximise the pasture area. The landuses are changing with some areas used for cropping and grazing, hobby farming and some rural residential lifestyles.

Most of the study area retains some vegetation, with the understorey predominantly comprising introduced annual grasses such as wild oats. Depending on the amount and type of vegetation persisting in the area, revegetation works will have different foci in different areas.

Protecting any revegetation works through in-stream stabilisation works, stock management practices and weed control works is essential. Further, site preparation needs to be a focus prior to any works being undertaken.

Actions

30. Implement proposed foreshore revegetation works recommended in the site specific projects in degraded areas using species information provided in Appendix 1.
31. Continue to protect healthy vegetation communities within the Lower Moore River region through stock exclusion, management of access and fire and implementing selective control of invasive weeds.
32. Implement a seed collecting and storage program.
33. Develop a regional herbarium.
34. Determine the feasibility of upgrading the existing nursery facilities to be able to provide all plants for local revegetation works.
35. Develop a vegetation restoration process for Silver Creek through weed control, revegetation and management of access. This site could be used as a demonstration site for areas with high recreational use.

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Technical notes

PROTECTING RIPARIAN VEGETATION

Riparian vegetation contributes to a number of river functions and is an important part of river systems. The advantages are:

- Acts to support the soil of the stream bank and helps to prevent erosion. Large roots of trees and shrubs anchor the river embankments in place with the finer roots of shrubs, sedges and rushes intertwined providing additional reinforcement. Hence, well vegetated riverbanks are less likely to suffer from undercutting and slumping, and prevent bank collapse.
- Dissipates the energy of running river flow, thus reducing the erosive capacity of the flow.
- Stabilises sediments (soil particles) and reduces nutrient runoff into the river system as the plants uptake the nutrients before they reach the water.
- Improves water quality not only by nutrient uptake but also by providing shade by overhanging tree and shrub branches. The shading assists in maintaining low temperatures and decreases the amount of light to prevent algae growth.
- Provides a range of habitats for many species of flora and fauna.

Well-vegetated riverbanks also provide considerable aesthetic appeal for landholders, are reputed to improve land values and improve overall amenity of the property. This is important when landuse changes are proposed in the long term.

Threats to Tuart and Flooded Gum

For the majority of the study area, there are remnant trees over pasture. Many of the trees, particularly Tuart (*Eucalyptus gomphocephala*) and Flooded Gum (*Eucalyptus rudis*) have been subject to insect attack. Insect attack becomes increasingly prevalent when trees become stressed due to changing environmental conditions. These changes can be the result of modifications to the groundwater level, disturbance to the roots through prolonged vehicle or livestock movement, increasing nutrient levels or broader environmental changes. The insect attack is also cyclic.

These types of changes can result in entire populations of trees being lost. While these trees have the ability to regenerate using a process of producing epicormic shoots, if the insect infestation is severe even these processes may not be sufficient to protect the entire tree.

Leaf lerp and a range of borer species are a significant threat to the long-term survival of these tree species in the Lower Moore River. Further south in areas around Lake Clifton, extending to Bunbury, the Tuart populations are dwindling, while in the corresponding region in the inland areas adjoining the Scarp, the Flooded Gum are also dying.

Many of the site specific recommendations relate to protecting the environment to minimise any potentially damaging changes to the environment and to minimise the Tuart and Flooded Gum's susceptibility to insect attack.

Significant remnants

There are a number of significant areas of remnant vegetation persisting along the Moore River, although these are generally beyond the study area. While all native vegetation is important, there are areas that have great significance because of their

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size, lack of weed invasion and disease and diversity of plant and animal communities.

Many of the large remnants have been protected by private landholders since the land was first released. Generally the protection has been an artefact of the presence of toxic plant species that can poison stock when present in a sufficiently high density.

These remnants can cause difficulty for farmers, as they are costly to manage. These costs are generally associated with fence maintenance due to kangaroo damage, loss of potentially productive land and other management costs.

There are a range of land management options that can be investigated to maintain this land in its current state. Such options aim to protect the values in the long term. Should new land managers enter the district there is a risk that the bushland, so valued by the current owners, may be cleared. These options are discussed in the Lower Moore River report on the current environment.

Alternative landuses that take advantage of the natural setting such as ecotourism, wildflower or honey production for example, may be appropriate.

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Seed collection, propagation and planting techniques

Sources of seed

Seed and cuttings from the local area should be used where possible. Some species may not currently be present due to disturbance factors, but may be suitable for re-introduction to the Lower Moore River. Seed can be collected from anywhere where the direction of the prevailing wind and water movement is likely to transport the seed.

The Guilderton Community association has members skilled in seed collection who will continue to coordinate and support the local seed collection and propagation program. There are opportunities for the GCA to provide seed to school groups, private landholders and other community groups for propagation. Involving and training others in seed collection could expand the seed collection ability. This program is very important to the success of the revegetation of lower Moore River and should be continued.

Should scheduling be difficult, to ensure seed collection occurs at the appropriate time, it may be necessary to employ professional seed collectors.

It is also important to note that it may be necessary to get a permit to collect seeds from within reserves managed by the Department of Conservation and Land Management, and permission from the landholders for private or public land managed by other authorities. It is possible to extend licences

Tips on seed collection and planting

Seed collection can occur at any time of year for some species, but is restricted to a very short period of time for others. The seed may take weeks to ripen and will vary depending on when the plants flowered. Flowering is dependent on the seasons and the amount of rain. A table is provided below to outline seed collection times and also provide information about planting densities.

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Collection times for native plant seed and planting notes. Note that common names are based on Bennett (1991) and Powell (1990).

Trees

Species	Common name	Seed collection time
Melaleuca cuticularis	Saltwater Paperbark	All year – capsules need to be woody and plump
Notes about planting: Plant in the middle of a group of either shore rush or knotted club rush – one tree per 15 rushes in May/June.		
Melaleuca rhaphiophylla	Freshwater Paperbark	All year
Notes for planting Plant in protected areas in swales surrounded by shore rush and other freshwater paperbarks in May/June.		
Casuarina obesa	Salt Sheoak	Mid to late summer but can be collected all year
Notes for planting Plant in amongst existing water sheoak stands; and recreate a grove in the southern end of the reserve in May/June.		
Melaleuca preissiana	Modong	Collect all year
Notes for planting: Plant sporadically landward of the freshwater paperbarks in the existing swales in May/June. They need shelter from the salty winds.		

Shrubs

Species	Common name	Seed collection time
Melaleuca viminea	Mohan	Dec – Jan but can be collected all year
Notes for planting: These occur in small groups above an understorey of shore rush. Plant landward of shore rush where weed control has been undertaken in May/June.		

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Jacksonia furcellata	Green Stinkwood	Dec to Feb
Notes for planting: Easily propagated from cuttings. Plant 1 m apart in groups of 10.		
Jacksonia sternbergiana	Grey Stinkwood	Dec to Feb
Notes for Planting: Easily propagated from cuttings. Plant 1 m apart in groups of 10 in May/June.		
Hakea varia	Variable-leaf Hakea	All year.
Notes for Planting: Plant in sheltered areas landward of wattles and close to the river verge in May/June.		
Hypocalymma angustifolium	White Myrtle	
Notes for Planting: Easily propagated from cuttings. Plant on the slopes of swales in protected areas in May/June close together.		
Viminaria juncea	Swishbush	Pick seed early to mid summer
Notes for Planting: Easily propagated from cuttings or seed. If taking cuttings, remove from as many plants as possible. Plant on the slopes of the swales in protected areas in May/June.		
Acacia saligna	Coojong	Nov - Dec
Notes for Planting: Future plantings will aim to reduce the frequency of this species and ultimately these protective shrubs will become less dominant. Plant only as protection from the wind if no success with other recommended species used with tree guards.		
Kennedia prostrata	Running Postman	Nov - Dec
Notes for Planting: Plant in protected areas on the top of the dune ridge leading back into the swale area in May/June.		
Acacia pulchella	Prickly Moses	Nov-Dec
Notes for Planting: Easy to seed direct and grow in a nursery environment. Seed needs to be placed in boiling water then soaked overnight, then sown immediately. Plant immediately landward of the Coojong in May/June.		
Conostylis candicans	Grey Cottonhead	Nov-Dec
Notes for Planting: Plant in close groups about 40 cm apart on top of sandy rise and swale banks. Again, protection from the wind helps so planting in association with the other recommended species is important.		
Acacia cyclops	Red-eyed Wattle	Summer
Notes for Planting: Future plantings will aim to increase the frequency of this species on the sandy rise/limestone between foredunes and swales. Plant in protected areas behind Coojong in May/June.		

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Rushes

Species	Common name	Seed collection time
Juncus kraussii	Shore Rush	Dec - March
Notes for Planting: Plant in close groups, 30 cm apart in groups of 15 in May/June in dry ground beyond high water mark. They are dormant over winter, however, it is possible to reduce the risk of loss. If planting between low and high-water mark, planting larger stock in August/September is recommended. If the water is moving then staking the pegs with U-shaped steel pegs will help.		
Isolepis nodosa	Knotted Clubrush	Jan – March
Notes for planting: Plant in close groups, 30 cm apart in groups of 15 in May/June. They are dormant during winter. Planting later is acceptable.		

Saltmarsh species

Species	Common name	Seed collection time
Halosarcia halocnemoides	Shrubby Samphire	Dec - April
Notes for Planting: Easier to propagate from cuttings because the seed can be difficult to collect. Plant in areas already supporting samphire in close clusters after peak tides in September.		
Sarcocornia quinqueflora	Beaded Samphire	Dec - April
Notes for Planting: Easier to propagate from cuttings because the seed can be difficult to collect. Plant in areas already supporting samphire in close clusters after peak tides in September.		
Cakile maritima	Sea Rocket	Mar - April
Notes for Planting: Plant just above high-water mark at the edge of the vegetation in May/June and protect with tree guards. This species is sometimes considered a weed but currently occurs at the site. It is therefore recommended as a colonising plant to aid initial soil stabilisation.		
Senecio lautus	Variable Groundsel	Nov - Dec
Notes for Planting: Try direct seeding in stockings and plant on top of the primary dune in May/June, protected by tree guards.		

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Additional species for planting

Species	Common name	Seed collection time
Frankenia pauciflora	Sea Heath	All year
Notes for Planting: Easier to take cuttings than propagate from seed. These can be planted on the foredune, riverward of the Coojong plantings and also amongst the samphire in May/June.		
Gahnia trifida	Coast Saw Sedge	Nov - Dec
Notes for planting: Extremely difficult to grow from seed. Plant in the swales and beneath the Paperbark stands where the Shore Rush and Knotted Club Rush are present.		
Lepidosperma gladiatum	Coast Sword Sedge	Mar - Apr
Notes for Planting: Extremely difficult to grow from seed – collect last year's seed, not current. Plant immediately landward of knotted club rush, amongst wattle plantings and upslope beneath Tuart.		
Baumea juncea	Bare Twigrush	Can't propagate from seed.
Notes for planting: Need to planted at depth between 100 mm to 250 mm in sandy sediments with at least 15 cm of leaf above ground. These will do best on the banks of the swales landward of the shore rush.		

The recommended planting densities are intended to provide a guide. It is important the arrangement and density of plants is varied so the area does not look artificial.

Planting riparian species in clusters of the same type is stressed. It is important to note that the sandy rise species recommended for the dryland plantings do not follow this pattern. The sandy rise type vegetation which will be planted amongst the existing Coojong plantings, require planting with only a few representatives of each species spread across the entire area. These plants need wider spacing.

It is also important to note that in extremely harsh areas, the planting density may need to be lowered to reduce the effect of competition.

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Planting times, locations and maintenance

Plant type	When to plant	Suggestions for maintenance
Samphire	Aug – Sept	Supportive watering from Oct – April; weekly if possible. Trial use of baffle boards / tree guards
Rushes and sedges	May-June above high water mark Aug – Oct below high water mark	Plant tubestock in dryland areas in standard planting season, and if within floodway, it mat be worth pegging the plants to protect them from peak flows. Plant instream plants behind large woody debris to protect them from being washed out. Trial use of baffle boards / tree guards.
Shrubs and trees	May - July	Use semi-rigid tree guards with three 10 mm stakes to protect stock from rabbits. These can be recycled every year.

These planting times are a guide and should be finalised in accordance with the prevailing weather.

What to plant

- Plant the sedges and rushes around the seedlings to prevent weed encroachment.
- Group each species together into clusters - this reflects the way they occur naturally with lots of the same type of plant in groups close to the water's edge, then having greater diversity on the sandy rises.
- Use more understorey species as a key component of this program.
- Establish occasional 25 m x 25 m grids to enable monitoring of success annually.
- Collect seeds from local plants all year round. Seed collection times are listed in the table above. General rules of thumb are that seed cases darken when ripe and open slightly to release the seeds. Many species present in the reserve have low viability so it is important to collect as much seed as possible from as many plants as possible.
- Plants can be re-established either by using direct seeding or by planting seedlings. However, it is important that the seed or the vegetative material for the plants is collected from, or close to, the site to be replanted i.e. plants with similar genetic material are used.
- Take care not to mix the species when planting out. This means that in wetland areas, plants should be grown as a mosaic where "like plants" are grouped. As outlined above, the dryland areas will have fewer examples of each species planted as a mixture.

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How to plant successfully

- In salt affected areas, carry out a trial using 95% wind barrier tree guards for one year in areas completely lacking in vegetation or with low planting success rates. In the next year replace the tree guards with 50% barriers and the following year a 20% guard if required. In the fourth year the guards should be removed. The existing guards could be recycled each year for the current planting project.

- Water weekly/fortnightly each year planting in accordance with rainfall and temperature information if feasible. Initiate program after rain has not fallen and temperatures have reached 28°C or greater for longer than 10 days.

- Protect plantings with thick newspaper and mulch 1 m in diameter around each plant.

- Weed control should be carried out for at least a year after planting. An area of 1 to 2 m in diameter around each plant should be kept weed free.

- Plant sedges and rushes 50 cm apart.

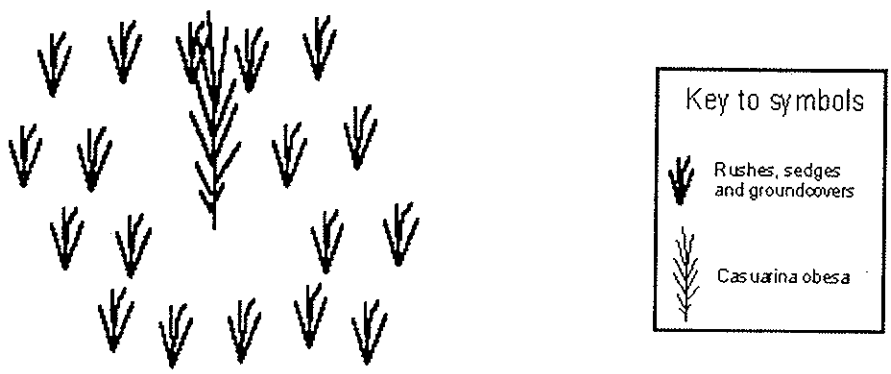
- Try some areas of direct seeding after the first rains in winter. Collect seed and mix with soil mix with slow release fertiliser. Try scratching narrow furrows along contour lines and spreading the seed, covering lightly (0.25 cm) with local sand immediately. Water the seed in.

- Alternatively in winter, try putting the seed and soil mix in lycra/cotton stockings (pantihose) making a sausage. Then take it to the site and spread it out until it is about 1 cm thick. Peg it gently taking care not to rip the pantihose and then lightly water it using buckets of water from the river. Monitor the germination rate over a month.

- For ease of watering, plant understorey species in high densities and shrubs and small trees about 1.5 m apart in clusters of 15 plants.

- Future plantings could be modified following experience gained from plant survival in previous years, and located accordingly in wetter or drier areas.

Example of planting layout and design



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Rushes and sedges can be placed around trees to provide understorey. One tree can be surrounded by up to 15 rushes or sedges.

Preparing the site

Preparation for planting works

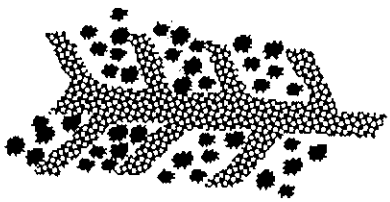
This is linked strongly with weed control. The areas to be weeded must coincide with the areas to be planted each year, except where local infestations of small single-stemmed weeds are removed.

It is important that any mulch added to the site is weed-free and has been stored and turned over for at least six if not 12 months, before introducing it to the site. This significantly reduces the chance of introducing pathogens into the reserve, and/or new or additional weed seed. It would be very disappointing to find that the revegetation efforts have created a worse problem than was previously present.

Herringbone Trails

Defining access tracks to the planting area/weeding zone should be a priority. This can be achieved by installing coloured flags along the sides of the tracks leading to the planting area. This path should follow the existing alignment and then have trails that are perpendicular to the existing path about every 2 m. This will provide the access to the work site. The flags should be installed early in the morning prior to the planting/weeding bee and collected at the end of the visit

Layout of herringbone trails and seedlings.



The herringbone trails are designed to achieve the following:

- Suppress weeds;
- Reduce the area which is disturbed by either little or big feet;
- Define the planting area to assist the watering trucks;
- Reduce the damage done by hoses during watering; and
- Reduce evaporation and provide additional support and organic matter for the newly planted seedlings.

There are a number of different colours of markers available, which allows for teams of students to work in separate colour-coded areas. This is another means of reinforcing ownership of the project by each team of students. It also provides an

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opportunity for teams to compete with the planting, maintenance and success of the revegetation works at each site.

It is not possible to install the pin-flags and leave them in position because they are easily removed by passing recreational users.

Protecting existing local plants

Any local plants in the area should be flagged to ensure these plants or seedlings are not trampled during proposed planting works. Flagging existing plants will also be important during the weeding bees so there is no confusion about what needs to be removed.

Weeding: focus areas

The weeding should only cover the area required for planting clusters, which will vary in accordance with the total number of plants and the recommended density. Note this is where weeds are removed totally. Removing seed-heads from weed plants can occur within the entire area throughout the year.

Newspapers may be used around each newly planted seedling and previous year's plantings beneath the mulch to provide extra protection.

These weeding focus areas need to be monitored to ensure that there is no new weed growth or re-growth. Should weeds continue to appear, they should be removed while they are as small as possible.

Each year the focus planting areas will be the first places where weeds are monitored. In the second year, the new planting area and the previous year's planting area will need to be weeded and monitored, and so on.

Planting

Holes should be made at the recommended spacings. These holes should be the same depth as the height of the treetube so that when planted, the top of the potting mix is level with the ground. Ideally, if there has been sufficient rain the ground should be moist for the top 10 cm. If not, one additional option (non-compulsory) is to fill each hole with fresh water, allowing it to soak in.

The treetube should be tipped upside down and the plant caught between the fingers. It should be placed in the hole as soon as the water has soaked into the sand. The remaining sand should then be placed around the tube to fill the hole. The sand should be lightly pressed on all sides of the plant to hold the plant upright. If using mulch it is important to ensure that a 2 cm gap is maintained on either side of the plants' leaves/stems. This reduces the chance of fungal attack.

A second watering following mulching is preferable but not compulsory.

Should no rain occur within three days of planting, it is preferable for supplementary watering to be undertaken every three to five days until rain occurs or for a period of three weeks.

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Installing tree-guards

It is recommended that semi-rigid tree guards are used to protect the plants. Due to the presence of the introduced white snail along the foreshore, it is recommended that these tree guards should be soaked in 'Socusil', a non-toxic snail and slug repellent, to protect the plantings.

The guards should be installed with three stakes in the shape of a triangle, with the plant directly in the middle. (There should be no gaps between the base of the guard and the sand, which would enable snails to pass beneath the guard.)

The guards should be monitored to ensure that they do not collapse on the plants or cause any other litter problems.

The guards should be removed as soon as the plants have a stem diameter greater than 8 –10 mm, which is usually sufficient to prevent rabbits from breaking the plants. Further, ensure any tree guards within the floodplain are removed before the river runs.

Providing habitat for plant and animal species identified as using the site

The aim of the plantings is to increase the habitat available for fauna, increase the amount of water and nutrient trapped before reaching the river and to maintain the aesthetic and landscape appeal of the region.

The density and width of vegetation limits the level of use and potential use of the area by fauna. Further, stock management needs to be taken into consideration.

The vegetation needs to be very dense to maximise habitat values and help to protect bank stability. One advantage these projects may have is to extend the distributions of many woodland birds. Small brown birds tend to use lower dense shrubs, and by creating dense areas of these plants in the wider sections of revegetation may encourage these small woodland birds to use the area. These birds are generally insectivorous and can help greatly to reduce local mosquito populations.

Nankeen night herons use dense paperbark (*Melaleuca* spp.) groves as roosting areas around the river. It may be possible to entice these birds to the area with the proposed increase in density of paperbarks in areas where they are lacking.

Currently, waterbirds are common users of the area, as they feed on the mudflats. By increasing the plantings on the foreshore, there will be greater protection to encourage breeding along the river lengths. This will provide some improvement in the environment for these species. They are an important part of the river ecosystem.

Increasing the density of saltwater sheoak may also assist native butterflies to use the area more frequently. The butterflies, the red spotted jezebel and amaryllis azure, are attracted to a type of mistletoe which grows on saltwater sheoaks. By increasing the sheoak numbers in the downstream areas, the number of mistletoes is likely to increase, therefore increasing use of the area by butterflies.

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Rationale for design
The density of planting is aimed to increase ease of maintenance, weed control and the rate of success of plantings. As mentioned briefly above, it also intended to reflect the natural occurrence of these communities in other locations around the Lower Moore River.

Concentrating plantings around designated access tracks helps to reduce the level of disturbance to the area as a whole, and ensuring that the planting layout enables access for maintenance works such as weeding helps to restore the vegetation to a more natural community.

Planting the plants in clusters increases the level of protection afforded to each plant – the safety-in-numbers approach. It also increases turbulence, which will increase the rate of sand dropout around the plants, and reduces erosion from around the plants.

Requirements for establishing a plant nursery

The following section outlines how to plant and grow seeds and cuttings in the nursery. It also looks at maintenance issues for the nursery, such as watering, weeding and pest control.

It will be necessary to establish new plants in the nursery each year. Seeding in November will ensure that plants are large enough for planting in May/June the following year. Germination rates are greatly improved by seeding in warm weather at temperatures above 25°C.

Seeds

The simplest and easiest way of obtaining seeds is to buy them. Purchasing small amounts of seed is relatively inexpensive, however the cost of purchasing all of the seed required for this project may exceed available budgets. Further, there are already a number of local residents collecting seeds. These people can contribute seed not only to the nursery environment but to direct seeding projects as well.

A collection permit is required from the Department of Conservation and Land Management to collect seed for any purpose. In addition, it is also compulsory to gain each landholder's permission prior to accessing their land to collect seed.

Collection of seed from local plants can occur all year round with the bulk of seed ripening in the summer months. Some trees, however, hold their seed throughout the year, allowing seed collection to occur at all times. Workshops with staff from government agencies such as the Department of Conservation and Land Management may be able to provide training or help during seed collection. Alternatively, an interested member of the community could provide a coordinating and training role relating to this aspect of the revegetation works.

To determine whether or not seed is ready, there are a number of general characteristics to look for. In most cases seed cases darken when ripe and open slightly to release the seed. As the remnant wetlands and bushland are variable in extent in the study area, it is important that seed is harvested from relatively dense healthy areas and small remnants are left alone. Collecting seeds from small remnants tends to threaten the areas' survival.

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It is highly likely that even the keenest seed collecting expeditions will fail to collect seeds from many plants, especially from smaller (herbaceous) plants. Also, some plants may not be flowering, or their seeds may not be mature when you go out to collect the seeds. It is therefore recommended that you at least try to purchase some seeds to increase species diversity.

The following seed suppliers should have most of the seeds required for this project. Order the seed well in advance of any intended planting, to ensure they have the seed in stock. Always collect information relating to provenance, the area the seed has been collected from, and try to keep the source as close to the lower Moore River as practical.

Kimseed: Australian Revegetation Corporation
42 Sarich Crt
Osborne Park, 6017
Western Australia
Telephone: 9446 4377
Fax: 9446 3444

Seed Centre
Department of Conservation and Land Management
Brain St
Manjimup, 6258
Western Australia.
Telephone: (08) 9772 1288
Fax: (08) 9772 1305

Nindethana
PO Box 2121
Albany, 6331
Western Australia.
Telephone: (08) 9844 3533
Fax (08) 9844 3573

Seed storage

Surplus seed will need to be stored correctly to ensure that it will survive through to the following year(s).

- Remove any husks or plant material that is attached to the seeds.
- Add naphthalene flakes (anti-moth flakes) and a few silica beads to absorb any moisture.
- Place the seeds in a sealed flat container to keep pests out.
- Keep in a dry, dark and cool storage area.

It is also important to ensure that all seed stock is labelled well, with a standard format. The types of information to record include:

Label well; Date
Location/Grid collected from
Collectors
Species

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It is also worthwhile to note the germinability of each seed batch following sowing, particularly if seed is left over and may be used in the next season.

Preparing the seeds for planting

Many native seeds will not grow if the seeds are just pushed into the ground and then water applied. Instead, they may need some treatment that will trigger germination. Many native species will only germinate after a fire, or after many years of being in the soil.

Plants that need to rest in the soil for long periods before they germinate can be encouraged to germinate by soaking them in near boiling water till the water cools, or by 'scarification'. Scarification involves putting lots of fine scratches in the surface of the seeds with a file or sandpaper. Seeds of the following genera will need to be scarified or soaked in near boiling water before planting: *Acacia, Bossiaea, Daviesia, Hardenbergia* and *Kennedia*.

A simple and very effective alternative to having a fire go through the bushland, is to treat the seeds with smoke. There are a number of methods that can be used to achieve this. Many of the seeds should be treated in one of the following ways.

Method One - Soaking in smoked water

Smoked water can be bought from Ecosystem Management Services, Friends of Kings Park or Kimseed. Soak the seeds in the smoked water for 6-12 hours. The seeds should then be placed on drying trays in the sun and out of the wind, and left there until they have dried. The seeds should now be ready to plant.

Broadscale irrigation of a direct seeded area may also be effective although it is difficult to ensure that the water will reach all of the seeds.

Method Two – Using a bee smoker

A smoke machine used to calm bees can also be used to smoke the seeds. If there is an apiarist nearby who has such equipment, it may be possible to come to an arrangement with them to smoke the seeds. This process requires placing the seed in a jar that can be made airtight. Fill the jar with smoke then replace the lid. Do this on three consecutive days. The jars should not be more than one third full with seeds.

Planting seeds in the nursery

It is important that more seeds than total plants required are sown, as not all of the seed will germinate.

- Treat the seeds as described above. If the seeds have been treated with scarification or near boiling water and smoked water, they should be planted within 24 hours. For this reason, only treat these seeds the day before planting them in the nursery or the day before seeds are directly spread in the desired area.
- Prepare some planting containers. Sterilise all pots, trays and benches with bleached water (2.5% bleach/water mix). Pots need to be free draining.
- Prepare the soil mixture as outlined below.

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- Seed should be sown into flat trays containing a seed-raising mix, which is available from most garden centres. It may be beneficial to add one cup of "Osmocote Mini" per barrow load of the seed-raising mixture.
- Wet the soil mixture so that it is damp.
- Lightly sprinkle seed over the surface of the soil mixture. Plant about four seeds for every plant that you want to grow. This is because many seeds will not grow and some plants may die at a later stage.
- Cover lightly with sifted sand so that the seed is buried to a depth about equal to the thickness of the seed.
- Label the tray/pot so that you know what has been planted. It is helpful if you also write the date that the seeds were planted.
- Lightly water the tray/pot with a watering can. While the seed is germinating, it is essential that the soil on the surface of the trays should not dry out. Watering little and often will achieve this result.
- Once the first two leaves of the plant have emerged, it needs to be transplanted into a pot of its own containing regular potting mixture. Add a small amount of slow release fertiliser to the potting mix (such as MacroCote Grey). It is important to ensure that the base soil mix does not contain pathogens or weed seed. Buying the mix from a soil supplier accredited with the Nursery Industry Association should reduce the risk of buying contaminated soil.
- The pots should be filled to about 1 cm from the top of the pot and then well watered prior to transplanting. Transplanting needs to be undertaken very carefully. Seedlings should be gently prised from the seeding tray with a flat butter knife. A seedling should then be placed into a hole made in the centre of each pot. It is very important to try to bury the stem to the same depth it was prior to removal from the seeding tray.
- Label and date the pots.
- Water immediately after transplanting using a fine spray. The watering regime needs to be developed to ensure that the trays are moist throughout the day.
- As the plants germinate and develop, the frequency of watering should be reduced so that the leaves have time to dry out. Failure to do this may result in fungal attacks. As the frequency of watering is reduced, the duration of watering should be increased.
- A 'Previcur' drench from a watering can is recommended to stop pathogens (in particular fungal attacks) attacking the newly transplanted seedlings. This may need to be done by someone who is comfortable using chemicals, as Previcur is quite toxic, and careful handling is essential.

Cuttings

Many of the plants that are to be grown in the nursery can be grown from cuttings. Cuttings are new growth shoots that are taken from older plants and planted into the soil. This cutting will then grow into a plant that is almost identical to the plant from which it was originally taken.

Cuttings can be taken from larger plants in the remnant wetland and bushland for use in the nursery. The number of cuttings collected from different areas should reflect the extent of populations and health of the remnant.

The cuttings taken from the growth tips of plants should be approximately 8-12 cm long. The best time of the year to take cuttings is usually in late spring to early summer, when the plants are growing more rapidly. Cuttings should be made in the morning or evening when the temperature is coolest, and planted as quickly as possible.

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Immediately after cuttings are planted in the nursery they have no roots. Roots are used by the plant to take-up water and nutrients from the soil. Until roots have grown on the cuttings they will need to be kept under hoods that are near airtight, to stop them from drying out.

It may also help to use a growth hormone to encourage root development.

How to take cuttings

The following hints on obtaining plant cuttings have been taken from the Australian Botanical Gardens web page (1998):

- Prepare some planting containers. They need to be free draining. Pots should be washed thoroughly in household detergent diluted in water to reduce the chance of infection. Adding a small amount of bleach may also help.
- Prepare the soil mixture as outlined below.
- Cut growth tips, 8-12 cm long, during the coolest part of the day.
- Place cuttings in an 'Esky' or something else that will keep them cool until they are ready to be planted.
- Carefully remove the leaves, with the leaf stalks, from the bottom half to two thirds of the cutting.
- Recut the bottom of the cutting with a sharp knife (razor blade or surgical knife). The cut should be made at an angle and made at the point where the leaf storks come out of the stem.
- Dip the bottom 2 cm of the cutting into a rooting hormone, use gloves and take care not get any on the skin. If the hormone does come into contact with skin, then rinse it off immediately with water.
- Make a hole in the soil you wish to plant the cutting into with a pencil. The soil should have been watered before the cutting is planted. Place the cutting into the soil and press down firmly around the shoot.
- Plant cuttings 2-5 cm apart in the soil.
- Put the tray in a warm humid place, out of direct sunlight. A 'propagation box' can be made for this purpose by putting a piece of glass over a wooden box.
- The cuttings will take 4-10 weeks to form roots. In this time they will need to be kept in the propagation boxes.

Planting medium (soil)

Seeds and cuttings in the nursery should be planted into a mixture of washed river sand, vermiculite and sawdust. These three ingredients should be mixed in equal parts i.e. 1 bucket of washed river sand to 1 bucket of vermiculite, to 1 bucket of 'Cocopeat'. To this mixture add a handful of 'Osmocote Mini', which is a slow release fertiliser.

Pour boiling water over the soil mix to sterilise the medium. Alternatively a dilute mixture of bleach (2.5% bleach to water) can be used. If the solution of bleach is used then it will need to be rinsed off. If boiling water is used, then it is important to wait until the soil has cooled down before any planting is undertaken.

Hardening-off seedlings prior to planting

Plants grown under shade cloth will need to be 'hardened off' prior to planting. When plants are grown in the nursery, they become acclimatised to this cooler

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environment. They are not exposed to direct sun and are sheltered from the wind. If the plants are taken straight from the nursery environment and planted into the natural environment, they may not survive.

Prior to planting, young plants should be taken from the nursery and placed in a shaded position out of the wind for a week or two. They should then spend a few days in the direct sun and wind before planting out. In the cooler months 'hardening off' can be achieved by removing the shade cloth from the shade house.

Maintaining the Nursery

Pot maintenance

The plants growing in pots will need to be checked monthly so that a weed problem cannot develop. This rule applies especially to flick weed and other prolific seeders, because if these plants are allowed to set seed, they could cause a substantial problem.

The seedlings should be fertilised fortnightly with a half-strength liquid fertiliser suitable for native plants.

The developing seedlings should be regularly checked for any signs of pests or disease.

Aphids

Aphids may be a particular problem and can be diagnosed by the presence of small green insects and a sticky black residue on the leaves and stems. Aphids can be treated with a range of low toxicity pesticides such as synthetic pyrethroids. Further advice should be sought from the Shire's horticultural staff or a registered pesticide operator.

Spider mite

Spider mite is more difficult to identify. However, the most obvious signs of infestation are a very fine mottling of the leaf surface and the presence of mites, which are the size of a pinhead.

Bugs that are natural predators of the spider mite, called predator mites, can be used to control outbreaks of the Spider mite. These can be purchased from BioProtection in Queensland for about $50, and should be enough to control any spider mite outbreaks encountered in the nursery. This technique will not work if pesticides are being used in the nursery, because the pesticides will kill the predator mites.

Chemicals that are most successful in controlling mites are in the medium to high toxicity range and so assistance should be sought from a licensed pesticide operator.

Fungal diseases

In general, it is extremely difficult to identify the presence of fungal diseases before the infection becomes severe. If any individual plant is struggling and does not look healthy, then it should be removed from contact with other plants.

It is best if an experienced or qualified person monitors plant quality.

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Plate 11: Ensuring there is sufficient vegetation on the riverbanks reduces the potential for erosion.



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Issue 6: Stock management

Strategic objective
To control stock access to the foreshore.

Stock access to the foreshore results in varying degrees of damage to the riparian zone and very much reflects the stock management processes used by farmers. The impacts include erosion of the riverbeds and banks, trampling and grazing can result in loss of native vegetation which correspondingly results in a reduction of bank stability and habitat values and providing areas for weed establishment. Seed transportation also occurs through stock movement.

It is generally considered that continual, all year round stock access to the riparian environment is incompatible with sound river management. There is scope for controlled access as part of specific farm management plans. Some landholders actively use rotation and closely monitor the impact of their stock while in the river paddocks. Ensuring grazing does not result in vegetation loss is the most important part of managing the duration and intensity of grazing.

Generally, this management includes fencing, setting aside some areas to protect existing vegetation or excluding stock to enable natural regeneration of plants and utilising stock to control weeds and reduce fuel loads and consequently fire risk periodically.

This issue is a sustainable landuse issue and needs to be addressed throughout the catchment and along all tributaries of the Moore River.

Actions

36. Implement agreed fencing re-alignment and installation of new fences in accordance with site specific recommendations of this document.
37. Provide an information brochure to local landholders relating to stock management practices to encourage them to assess their current management practices.
38. Continue to negotiate with local landholders to encourage them to increase protection of sections of their foreshores, to protect the riverbed and its banks from the impacts that are currently in-stream and moving downstream.
39. Investigate opportunities for planting alley farms.
40. Encourage landholders to consider fire management as part of their grazing schedules within the foreshore areas.
41. Establish perennial pasture trials.
42. Stabilise point source watering holes in areas where there are no alternatives for off-line watering.
43. Establish off-line watering points to prevent de-stabilising of the riverbanks.
44. Monitor effectiveness of solar pump for stock watering, and investigate alternatives.

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Managing Stock in the Riparian Zone

Stock utilise the riparian areas to meet a number of their needs such as watering, grazing, access to shade, protection from wind and sun and quality of forage. As a result, stock grazing impacts on riparian land. The severity of impact depends on the stock type (cattle, sheep, goats, etc.) and the grazing system used (continuous to temporal and/or spatial grazing or total exclusion of stock).

LWRRDC (1999) identified a number of impacts resulting from grazing of stock on riparian areas:

- Degradation of native vegetation as a result of:
  - suppression of regeneration and recruitment of young seedlings
  - reduction of floristic and structural species diversity
  - damage of the vegetation by trampling and breaking stems and branches and browsing on groundcovers, palatable shrubs and trees
  - high level of weed infestation
- Stream and channel banks erosion as a results of:
  - pugging of clay soils around the waterway
  - bank collapse due to stock movement towards, across or along the stream edge
  - trampling and compacting the soil
  - stock trails
- Decreases in water quality as a result of:
  - increased turbidity
  - foul smelling
  - increased algal growth (blue-green and filamentous algae) due to increased nutrient levels from the increased surface runoff (the roots of trees and shrubs and the groundcovers not only bind the soils but also trap nutrients runoff from pastures and adjacent areas, which otherwise enter the waterways); and stock excreta. The degradation of riparian vegetation may increase the amount of light, and thus increase the temperature of the stream, which in combination with increased nutrient levels encourages algal growth. Some algae are toxic to stock.
  - faecal contamination
  - increased growth of aquatic weeds
- Change in the number and/or composition of aquatic and riparian fauna such as fish, birds or insect (may increase the number of mosquitoes).

Critical factors

Critical factors associated with stock grazing and their impacts on the riparian zone:

- Timing, intensity and frequency of grazing
- Grazing systems
- Fencing
- Stock watering
- Stock behaviour

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Guidelines for minimising the impacts of stock on the riparian zone

The riparian zone should be seen as an emergency store of feed that is available for controlled use during times of shortage elsewhere on the property.

There are a number of ways landholders can modify their stock management practices to improve the longevity of foreshore vegetation, improve bank stability and reduce long-term maintenance costs. These include the following principles.

1. Timing, intensity and frequency of grazing

- The riparian land should only be grazed when the most of the native vegetation is dormant (generally winter) and when the soils moisture levels are low (high soils moisture levels increase risk of soil pugging and compaction). In the Moore River, this time would correspond with April – June depending on the break of the season.
- Avoid grazing riparian land in the germinating, growing and flowering seasons (generally spring and summer, after flooding or fire).
- Adjust both the stocking rates and the frequency of use to suit the sensitive nature of the riparian zone.

2. Grazing systems

- Riparian land should be considered as integral component of the whole farm, and managed as a sensitive area with special management requirements.
- Exclude stock when and where damage is likely to occur.
- Avoid continuous grazing systems as it is not suitable for riparian land.
- If necessary to utilise the riparian zone, use cell grazing (time-controlled grazing). The cell system treats the riparian land as a separate paddock, running parallel to the stream, with low level of use. The stock is excluded to allow the plants and the stream banks time to recover. Following the recovery, stock can be excluded or allow to graze on rotational basis or provide shelter and forage during dry periods.

3. Fencing

- Install fences suited both to the flood regime and to keep stock out; generally the fence should be above the annual peak flood level and in position that avoids high flows and associated debris.
- Placement of fencing will depend on several factors: the land use, the topography, and the flood regime. To protect the riparian zone, 30 m (preferably 50 m) from stream banks fenced zone is required.
- Install fencing parallel to the stream and floodplain areas.
- Use type of fence most suitable for your area: drop fences, lay-down fences, electric fences or fencing that can be loosened and the wires pulled to the top of the fence posts.

4. Stock watering

- If fencing excludes the stock from the stream, provide alternative watering sources for stock.
- If the river is used for watering the stock (as the only option available), it is beneficial to restrict number of stock accessing the designated point at one time.

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Access points should have the following features:

- The site should be relatively flat, to reduce erosion and to make it easier to get to the stream edge
- The site should be on the inside of a bend (water movement is slower thus the banks are less prone to erosion)
- Harden the surface of the site with gravel or limestone spoils to prevent erosion and to provide better access for the stock.
- Angle the access point in a downstream direction, which enables the stock to enter the stream in the direction of the water flow.
- Fencing for the access point can be part of the stream fencing.
- The access point should not be sheltered, as it will encourage the stock to camp and loaf around.
- The width of the access point will depend on the number of available access sites and the number of stock watered, preferably ranging form 2-20 m.

Stock behaviour

The general tendency for stock is to use the paddock unevenly. The riparian zone attracts stock as it provides water, good forage and shelter. When designing paddocks ensure that the major attracting points should be present in every paddock.

Further information can be obtained from Agriculture WA, Water and Rivers Commission and the local landholders.

Plate 12: Maintaining large numbers of stock in small areas can result in loss of vegetation cover, increasing the susceptibility of the land to wind and water erosion.



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Issue 7: Recreation

Strategic objective
To provide access to the river and its foreshores that meets management and recreation needs with minimal impact on the environment.

The Lower Moore River is an extremely popular area for water based recreation. There is considerable pressure placed on the river and its foreshores throughout much of the year on both privately owned and public lands. The aesthetic and wilderness values are significant and the proximity to the metropolitan area also makes it attractive to visitors.

Recreation activities are primarily focused on water sports: fishing, water skiing and canoeing, although some users use vessels to find picnic spots and to leave the water for bush walks. Weekend visitors increase the density and total number of users. With an increasing population, pressure on the river and its foreshores will increase. The recreational use can disturb the quiet enjoyment of the freehold land.

The river is a popular location for bream fishermen, fishing either from the shore or boats. The restricted surface area of the river is generally still able to accommodate the diverse mixture of user groups, although the competition for space is greater during long weekends and the Christmas period.

There are extremely high levels of use of the lower reaches of the Moore River, predominantly focused between the river mouth and Caraban Rocks, although people travel upstream in dinghies.

Recreation also impacts on the riparian ecosystem in a number of ways. These include: increasing bank erosion, damaging sand dunes and damage to native vegetation either by removing it for firewood or to enable boat movement, and clearing. Unmanaged recreation also can result in a decline in visual amenity following rubbish dumping, vandalism and lack of wilderness feel due to the number of people.

While it is legal for anyone to navigate the Lower Moore River, in sections where the land ownership has 'middle of the river" boundaries, it is illegal for the boat user to contact the bed or the banks of the river. It is difficult for private landholders to ensure that boat users do not leave their vessels. The legal rights of both visitors and private landholders need to formally documented.

River access can be a significant problem due to the competing demands of river users. Passive recreation activities can be disrupted by activities such as power boating, water skiing and jet skiing. There is also a significant threat to personal safety associated with high-speed boat activities such as water skiing, due to the prevalence of sandbars and submerged snags.

Anecdotal evidence also suggests that powerboats regularly exceed the designated speed limit, with suggestions that there is need for stricter enforcement of speed regulations. These uses are incompatible with the nature of the river and need to be investigated further in a joint process with the Department of Transport. In view of the increasing use of the river and the ready availability of canoes and power boats, it is highly likely that the Department of Transport might need to consider curtailing

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certain activities on the river in the near to mid-term future - particularly the use of motor boats.

There are minimal opportunities for the wider community to gain access to the Lower Moore River and its foreshores. The townsite and reserve upstream of the Lancelin Road Bridge are the focuses for community use.

Access is predominantly restricted due to the presence of private property. Many landholders justifiably have concerns about people that trespass and access the foreshores and river in an uncontrolled manner. These concerns are valid, as there are liability implications in the event that someone damages either property or their person. Further, recreational users may dump litter on the foreshore and there are opportunities for theft. There is considerable and well justified concerns among landholders that the fire risk is greater due to visitors lighting fires on the foreshores, and that controlling such events is very difficult. The disturbance to the wildlife and their habitat by recreation users is another concern expressed by private landholders.

Protecting fishery stocks is another concern among many users of the Lower Moore River. There is interest in supplementing fish stocks and developing a strategy to enforce fishery regulations more strictly.

The Water and Rivers Commission recently released a recreation study of the Moore River estuary.

Actions

45. Investigate the options for increasing the level of control of boating activities in the Lower Moore River.
46. Install signage at the Guilderton and Caraban Road boat ramps advising users of appropriate regulations, boat speeds and providing information about the threat to life and property posed by the submerged snags and frequent sandbars, showing bathymetry.
47. Propose zones for different types of activities and facilities, and identify foreshore access points.
48. Encourage six local residents to join the Volunteer Fisheries Liaison Officers program, and determine possible delegation powers under Department of Transport regulations to help with boating control.
49. Investigate the liability issues associated with the middle of the river titles to determine whether mechanisms need to be put in place to protect landholders.

Issue 8: Rubbish disposal

Strategic objective

To foster the notion of the river as a "rubbish-free zone".

The disposal of rubbish within and on the banks of the river reflects a lack of recognition of the values of the river in general. In some parts, the river is seen as a convenient place to dispose of unwanted machinery and garden prunings (refer Action 20) etc. Further, many recreational boat users access the foreshores for their picnics and leave behind evidence of such activities. A significant educational effort needs to be initiated to improve attitudes to the river. This needs to have two targets: local residents and visitors to the region.

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In the first instance, specific accumulations of rubbish should be removed from the river – which is unlikely to be a major exercise.

It is important that rubbish bins are installed in areas where recreation is encouraged such as adjacent to walk trails.

Actions

50. Provide an additional rubbish bin at the parking area at Lancelin Road Bridge and ensure the bins are emptied regularly and more frequently.
51. Provide two additional rubbish bins on the Guilderton foreshore to encourage appropriate disposal of litter.
52. Install simple signage inviting people to respect the river and its landscape appeal and encouraging them to dispose of unwanted goods appropriately.
53. Involve the community in CleanUp Australia Day and World Environment Day and link such days with sausage sizzles and information stalls to attract more people.

Issue 9: Fire management

Strategic objective
To minimise damage to private property and the river ecosystem resulting from fire.

In the past, fire was a frequently utilised management tool in the Lower Moore River to achieve annual removal of woody debris. The use of this management tool occurred prior to many highly flammable weed species such as African Love Grass, Wild Oats and Tambookie Grass becoming established in the floodplain. The flammability of the riparian zone in areas dominated by native rushes and sedges is much lower than in areas dominated by annual grasses. Over time, the environmental conditions in the floodplain have tended towards systems with greater densities of plants that respond to fire.

Currently, fire is not recommended as a general management technique for riparian zones, particularly in areas with peaty soils. Should fire occur as a result of arson or accident, then advantage should be taken of the increased access to the area for weed control.

Fire, prescribed and wild, is a threat to the river environment and infrastructure. Burning is likely to significantly damage many of the fringing vegetation species, depleting the seed bank of some species and possibly destabilising the foreshore. Excess fire may encourage further weed invasion and the spread of weed species. Autumn burns are particularly risky in river environments due to the loss of vegetation cover prior to the winter flows, however, are considered best in terms of minimising the impact on native fauna and protecting the diversity of flora. Autumn is the preferred time for burning dryland environments, if burning is absolutely necessary.

Fire can be useful in small areas where woody debris accumulation is impacting on river flow dynamics, however, broadscale use does not enable selective removal of the debris. The dominance of paperbarks in the floodplain is another factor. These plants tend to re-sprout from all parts of their trunks and branches when exposed to fire. This can result in an increased ability to trap debris during flow events two years or so following the fire. Selective manual removal of suspended woody debris is preferred, and the selective approach can minimise the labour requirements.

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Areas deemed to be at risk of fire should have a detailed fire management plan in place. This plan should detail actions required in the event of a fire, locations of water available for fire fighting and access routes for fire fighters to enter the area. This is especially important if foreshore areas have been fenced off to prevent stock access, or unauthorised access, thus hindering fire services from entering the area. The fire management plan should be created in conjunction with representatives from FESA (Fire and Emergency Services Association).

A policy of 'no burn and active suppression' is recommended for revegetated/rehabilitated areas. This means that any areas subject to weed control and planting through this program should be managed without the use of fire, and that work is undertaken to ensure these sites are protected from wildfires.

Actions

54. Establish a sub-committee under the Lower Moore River Rehabilitation Group to develop regional fire management strategies that fits in with the Bush Fire Plan provided by the Shire of Gingin. Note this committee must include local volunteer fire fighters and the Council to be effective.
55. Implement a policy of 'no burn and active suppression' in any sites revegetated or rehabilitated as part of this project.

Plate 13: Frequent fires can encourage annual grasses to spread. While many native species such as *Banksia ilicifolia* can be assisted with occasional fire, too frequent fires can kill them.



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COMMUNITY AWARENESS AND PROMOTION

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Plate 14: Panoramic views of the Lower Moore River such as this are a major attraction of this area for residents, visitors and tourists.



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Issue 10: Environmental, economic and social values

Strategic objective
To highlight at every opportunity the importance and value of the Moore River to landholders, townspeople and visitors.

The Lower Moore River Estuary dominates the town of Guilderton and is a primary attraction for many tourists and visitors. The river upstream to the confluence with Gingin Brook is an area of great natural beauty, although sections are somewhat degraded. The aesthetic appeal of the river is recognised and highly valued by landholders. The love and respect for the river needs to be pursued to encourage maintenance of its values in the long term.

There is a need and opportunity for the local community and visitors to the river to appreciate and understand more about its values. Signs will also be important to advise visitors that much of the area is private land and encourage visitors to respect private landholders rights. These could be installed near any walk trails, boat launching areas and locations where recreation users congregate.

Actions

56. Continue to develop promotional material that provides information about the physical and biological attributes of the river, restoration activities and the history of the region in relation to the current situation.
57. Establish a program of boat tours, guided walks and tours of landcare projects quarterly to encourage local residents and visitors to take an interest in the river and the restoration activities.
58. Investigate opportunities to link Guilderton into the eco-tour groups that leave from Perth by offering environmental tours.

Issue 11: Raising community awareness

Strategic objective
To encourage a greater understanding of the river and its functions as an ecological system by providing interpretive material about the river in the form of signs, demonstration sites and information sheets.

Rivers are complex and dynamic systems. Restoration and effective management of this environment, even armed with knowledge and understanding of its functions, will be difficult as some actions may result in greater changes that are difficult to manage (refer to management of in-stream woody debris).

The range of information that may benefit local residents and visitors to the area includes:

- Features of the physical and biological environment
- Impact of uncontrolled access, dumping of garden waste and weeds on the vegetation and fauna of the area; and
- Importance of protecting remnant vegetation and the characteristics that makes it important in this environment.
- Importance of letting the sandbar function naturally and the impact of opening the bar on the ecosystems in the estuary and upstream.

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There are a number of programs that are being run government authorities including FrogWatch (WA Museum), Ribbons of Blue (Water and Rivers Commission) and non-government bodies such as the Bird Atlas project through Birds Australia. Many local residents are already actively involved in these projects and there is an opportunity to coordinate this work to maximise the benefit and enable greater community contact.

Marketing the valuable work that is currently being done and will be achieved in the future is another key role of the Lower Moore River Rehabilitation Working Group. There is considerable discussion about establishing an information shelter in the short-term, providing information about the Moore River, estuary and biological attributes.

This project could provide a foundation for a more ambitious project to establish a larger, more formal Information centre for the region; however, such a project will need considerable work to identify alternative sources of funding. Ensuring commitment from all levels of the local comminute and gaining support from visitors would strengthen the argument for such a centre.

Actions

59. Prepare an annual diary to enable the Lower Moore River Rehabilitation Working Group to have monthly speakers providing technical information about pertinent issues.
60. Link the rehabilitation and revegetation programs with other community activities to make them more of a standard.
61. Develop a series of information sheets based on the technical parts of this report and provide them to interested landholders.
62. Continue to investigate opportunities to gain an information centre in addition to the proposed shelter.
63. Encourage the preparation of a local photographic record for use in posters, possibly postcards and other awareness raising activities that may result in income.
64. Investigate the feasibility of extending floodlighting of the bar from dusk to dawn to reduce artificial breaches.
65. Establish a list of all available relevant literature of interest to the Lower Moore.

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PLANNING

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Issue 12: On-ground projects

Strategic objective
To develop an integrated, holistic planning system that can be implemented.

Successful planning at a local level requires a process that enables individual team members to share responsibility for tasks within their skill level, and work in such a way that limits the burden of implementation.

The formation of the Lower Moore River Rehabilitation Working Group was a significant step along this path as it provides a foundation for the local community to get together to resolve common issues.

The group currently has had very few meetings however a considerable amount of work has been occurring behind the scenes. There is a need to develop a sub-committee approach to enable effective communication and liaison across all levels. Defining timelines for actions, responsible members and dividing up funds and scheduling existing resources such as labour is critical for success.

Those involved, however, need to share a positive vision and be prepared to contribute time, energy and funds to the needs of the river. A stable, healthy and functioning river increases land values and therefore landcare works can be mutually beneficial.

Gaining and maintaining trust and cooperation are the keys to succeeding with this project in the short term and protecting and enhancing the river in the short to long term.

The need for improved communication has been recognised within the local community, and meetings/workshops have been held to develop strategies to improve communication. This process needs to be extended to involve all local community groups, the Shire and the farming community.

Actions

66. Organise training in appropriate meeting protocols and how to hold effective meetings to improve the way the group functions.
67. Develop a communication strategy to ensure two-way communication between local community groups, State and local government authorities and provide an effective means of sharing and receiving information.
68. Hold regular (the recommendation is bi-monthly meetings) of the whole Lower Moore River Rehabilitation Working Group to enable sub-committees to meet on a more regular basis to organise projects.
69. Encourage team leaders in each key area of action to improve coordination of information gathering and disseminating.
70. Provide copies of this report and others such as the recreation survey relating to the region to the local community.
71. Source training in all aspects of meeting processes to ensure an understanding of expectations of all participants.

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Issue 13: Changing landuses

Strategic objective

To determine alternative landuse opportunities that may enable landholders to protect and enhance the landscape attributes that attract them to the area.

Adjacent landuse can have a considerable impact on the riparian zone and waterway health. Different landuses have different implications for stream health and therefore the appropriate management regimes required will vary.

Riparian zones are often highly degraded. Foreshore vegetation is frequently reduced to a few metres either side of the watercourse. It is important to provide information to landholders and land managers about the benefits of undertaking remedial works along foreshores, emphasising the importance of fencing off riparian areas and excluding stock for at least some parts of the year. Obtaining funds, such as the current revegetation program and providing support, may encourage interested landholders to undertake intensive weed control and revegetation works.

Foreshores in townships are frequently high use recreation sites. Traditionally large open areas of maintained lawn were favoured over dense stands of native vegetation. Advertising campaigns and signage around project sites are useful tools to increase community awareness. Providing detailed information on the benefits of replanting native species (such as stabilising foreshore banks and increasing stream cover and habitat diversity) will increase awareness and may encourage local residents to become involved in the projects.

Sedimentation of watercourses is generally an indication of erosion occurring further upstream. No system can be considered in total isolation, as there will always be impacts from activities further upstream. When undertaking any projects it is essential that groups have a clear understanding of the surrounding landuse and the condition of any tributaries feeding into the main waterway.

The impact of new subdivisions or earthworks upstream should be carefully monitored. Weeds may invade from nearby residential housing. Subdivisions can also have a huge impact on water regimes and sediment loads entering streams and tributaries. Early detection of potential threats minimises the impact on foreshore health in the long term if remedial action is undertaken immediately.

Farming is a relatively difficult profession in which to maintain an income. Many of the landholders are utilising the land predominantly for non-agricultural uses, while others are focused on other activities from which to maintain an income. Alternative landuses such as ecotourism are real possibilities given the proximity of the Lower Moore River to Perth. The need to investigate different uses and means of managing the land in a manner that reduces the impact on the river and its catchment is an important part of this project.

Actions

72. Continue to develop promotional material that provides information about the physical and biological attributes of the river, restoration activities and the history of the region in relation to the current situation.
73. Continue to encourage local landholders with significant bushland areas to investigate alternative landuses for these areas to protect the natural values.

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Issue 14: Strategic planning

Strategic objective
To ensure that all planning provisions and processes reflect sound management of the Moore River and its catchment.

River management involves many agencies from both state and local government authorities. Sound river management requires a good information base, and typically this has been provided by State agencies such as the Water and Rivers Commission, Department of Transport and Agriculture WA. The responsibility for promoting, supporting and commissioning research and other investigations on the river by professional and amateur groups has occurred in a generally ad-hoc way until the late 1990s.

The Shire of Gingin has a number of planning documents that guide development and management within their municipality. These include the local town planning scheme, local rural strategy and a series of policies relating to management of the Shire.

These plans are currently under review. There is a need to ensure community involvement in the development of the new plans and policies to improve acceptance and understanding within the community.

Local government plays an important role in the conservation of bushland. Perth's Bushplan accepts the principle that local government should have no additional financial responsibility for the acquisition and maintenance of regionally significant sites unless a specific negotiated agreement to that effect has been reached. The extent of reserved land that is currently vested in the Shire of Gingin is minimal.

Actions

74. Ensure good communication channels are established through existing community groups to facilitate comment on changes to the local town planning scheme and local rural strategy.
75. Develop a mechanism whereby all community groups are notified of proposals to change vesting, landuse or zoning to enable them to comment and be involved in the process throughout. This can occur at a regional, catchment and/or local scale.

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MONITORING AND EVALUATION

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Issue 15: Monitoring and evaluation

Strategic objective

To evaluate and monitor the success of different components of the project on a regular basis, and in terms of its impact on the environment.

A number of actions and outcomes were required in obtaining the NHT funds for this project. These evaluations should occur once yearly.

Action	Description of parameters to be evaluated
Fencing	Length of fencing re-aligned or new fencing constructed. Regeneration rates, plant cover and diversity, bird counts, photopoints.
Revegetation	Seedling survival rates, density of plant cover.
Rubbish removal	Number of bags collected in CleanUp days.
Weed control	Density of weeds in targeted areas.
Vermin control	Fox and rabbit counts from nighttime transects.
Bank stabilisation	Sediment loss from banks, photopoints, extent of slumping.
Buffer strips	Nutrient levels in runoff, seedling survival rates and photopoints.

The monitoring program to determine the effectiveness of the works on improving the river ecosystem can be summarised as:

Parameter	Characteristics to be monitored	Timing
Water quality	Algal blooms, nutrient levels, salinity levels and sediment suspension	Yearly
Bacterial contamination	Samples at defined points upstream and downstream of the townsite	Weekly or fortnightly
Flora and fauna	Abundance and diversity of plants and birds at 10 different sites	Seasonally
Bank stability	Monitoring the success of restoration of blowouts near Lancelin Road Bridge and Catholic Church Land.	Bi-annually (winter and summer)

Actions

76. Implement monitoring programs to assess the effectiveness of works and the expenditure of Natural Heritage Trust funds.
77. Monitor the level of community awareness annually to determine whether or not there has been attitudinal change resulting from the process and projects.

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OTHER GOVERNMENT STUDIES RELEVANT TO THE LOWER MOORE RIVER

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Other relevant studies

Several studies are underway to further understanding of the Moore River and its catchment as a basis for future protection and management. These studies cover eight local government authorities, and are being coordinated by the Water and Rivers Commission and the Moore Catchment Group. They include studies of surface hydrology, groundwater hydrology and hydrogeology, flood management, water quality, nutrient enrichment, sediment movement and deposition, and bathymetry.

Eight studies will be staged over a four-year period and details of the studies and project managers are set out in the table below.

Project	Status	Project Manager
Definition of Catchment Boundaries.	Completed, maps available.	Ross Carew, GIS Regional Support at Agriculture WA
Discharge from the Yarra Yarra Lakes.	Completed, final report due.	Phil Commander and Cahit Yesertner at WRC.
Hydrodynamics of the Moore River Estuary. • Water Quality Study • Sedimentation Study • Bathymetry Study	Ongoing. Report of first stage of water quality finished. Sedimentation and bathymetry studies to commence soon.	Mischa Cousins at WRC
Streamflow Characteristics of the Moore River.	Ongoing.	Peter Muirden at WRC
Impact of Pumping or Drainage Diversion into Natural Lakes.	Process commenced.	Syl Kubicki at WRC.
Risk Assessment for Groundwater Pollution.	2000 - 2001	Steve Appleyard at WRC.
Water Balance Model for the Moore Catchment.	2000 - 2001	Peter Muirden at WRC.
Flood Mitigation Strategies (Moora)	Consultant has begun work.	John Ruprecht and Mark Pearcy at WRC.
Gingin and Lennard Brooks Environmental Water Requirements	Commence 2000 - 2001	WRC
Moore Catchment Group Strategic Plan	Ongoing.	Jonelle Black at WRC

All of these studies will aid the development of management strategies for the lower Moore River.

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SITE SPECIFIC MANAGEMENT ISSUES AND RECOMMENDATIONS

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SITE SPECIFIC MANAGEMENT ISSUES AND RECOMMENDATIONS

This chapter deals with recommendations for specific areas of the foreshore, to enable ready implementation by private landholders, Shire of Gingin officers, interested school groups and the wider community with the support of State government authorities. Considerations of planning, development and use of the foreshores are listed.

A summary map is provided in Map A.

For ease of reading the maps are presented with associated planning considerations and area recommendations on the page opposite each map.

The planning considerations for each map area include:

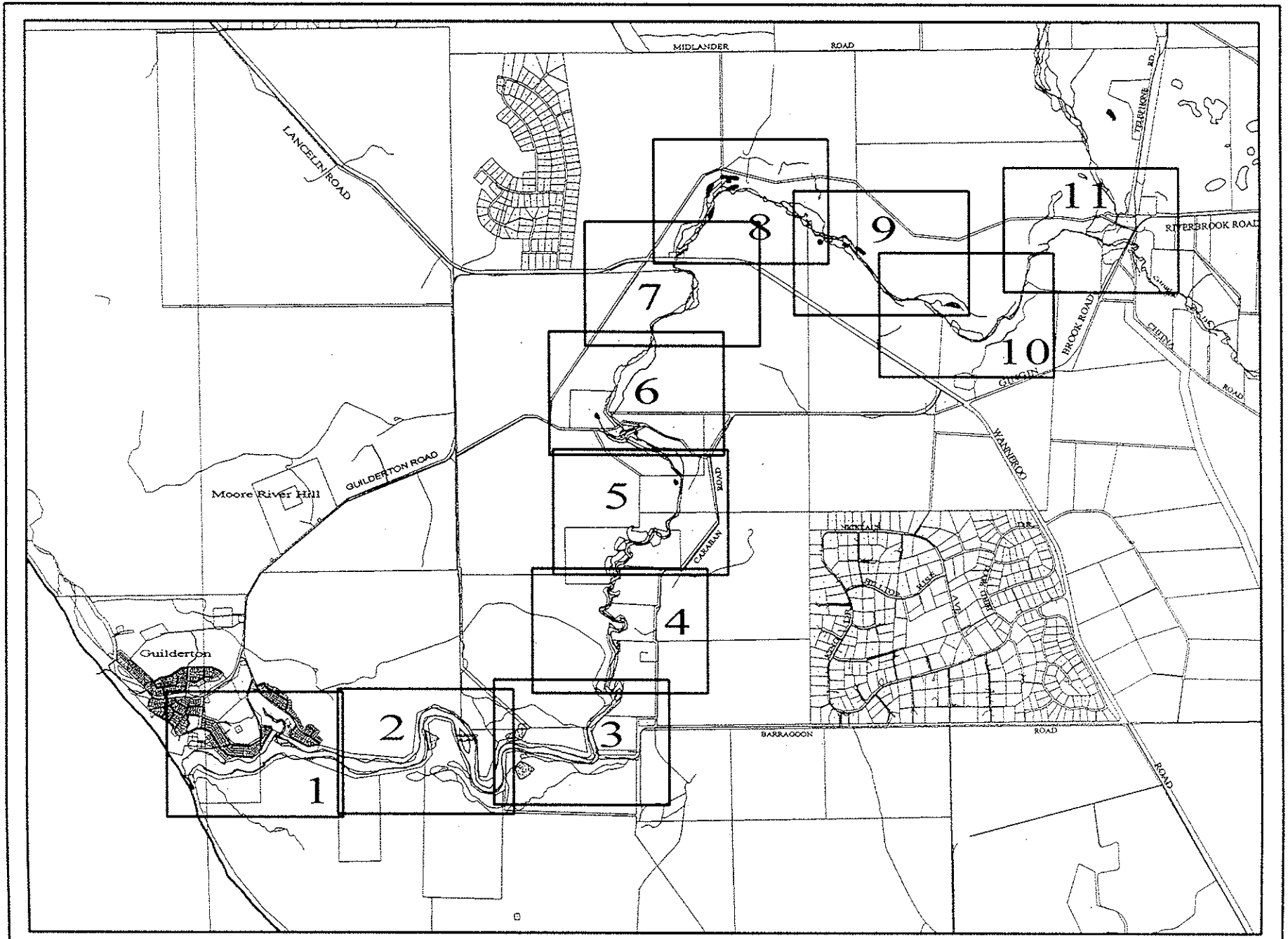
- Physical resources
- Human use
- Opportunities for land use activities
- Biological and conservation resources
- Land tenure
- Restraints such as land capability.

Recommendations have then been developed regarding initiatives required to achieve the objectives of this river action plan. These have taken into account the results of the community meetings and submissions.

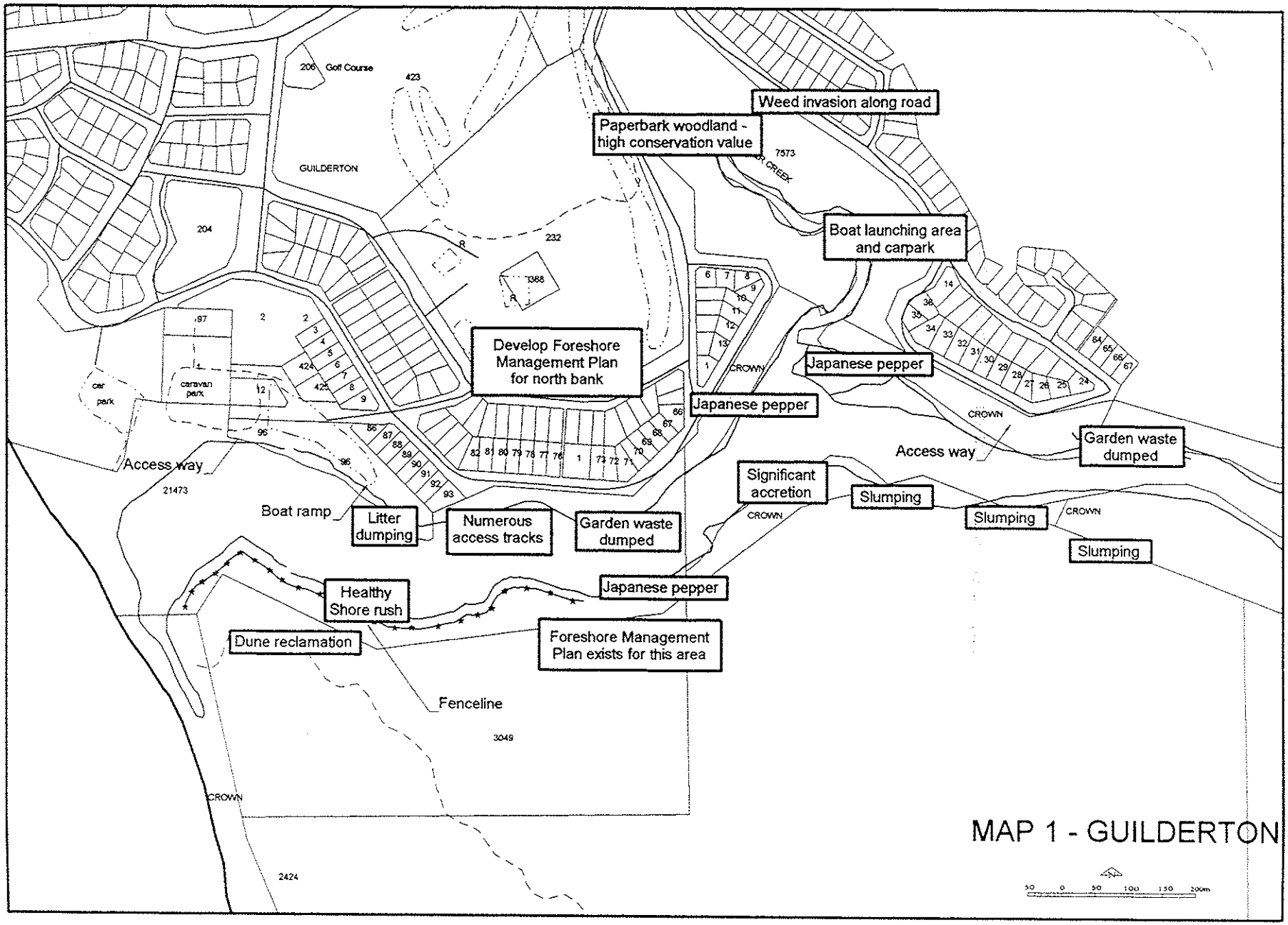
Some of the recommendations are actions that have been agreed with the landholders, while others are suggested however, no negotiations have taken place to encourage involvement in the Rivercare project to date.

When reading this section of the document it is important to respect the privacy and rights of all landholders and other interested parties.

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MIDLANDER ROAD
LANGELIN ROAD
Moore River Hill
GUILDERTON ROAD
Guilderton
BARRAGOON ROAD
RIVERBROOK ROAD
BROOK ROAD
WANNEROO ROAD
1
2
3
4
5
6
7
8
9
10
11

MAP A: KEY MAP


Weed invasion along road
Paperbark woodland - high conservation value
Boat launching area and carpark
Develop Foreshore Management Plan for north bank
Japanese pepper
Japanese pepper
Garden waste dumped
Access way
Significant accretion
Slumping
Slumping
Slumping
Access way
Boat ramp
Litter dumping
Numerous access tracks
Garden waste dumped
Japanese pepper
Healthy Shore rush
Dune reclamation
Foreshore Management Plan exists for this area
Fenceline
GUILDERTON
Golf Course
caravan park
car park
CROWN
MAP 1 - GUILDERTON

1.0 Guilderton Townsite

Lot Nos: Res 25007, Res 25006, Res 21473, Res 17949 and Res 26561

Management and rehabilitation considerations:

In river

- Considerable numbers of recreational boat users and some commercial use of the estuary.
- Popular tourist attraction for water based activities.
- Significant sedimentation resulting from artificial breaching of the bar and greater sediment load from the catchment.

North Bank

- Weed species such as Japanese Pepper, Kikuyu and Pelargonium on both north and south banks of the river.
- Lack of formalised trails through limestone cliffs is resulting in significant levels of disturbance.
- Boat launching ramp, car park and toilet facilities heavily used.
- Inadequate demarcation between foreshore reserve and private property resulting in dumping of rubbish, extending of gardens and associated issues.
- An extensive area of weeds, particularly annual and perennial grasses is encroaching on areas of healthy, diverse riparian and limestone vegetation.
- Foreshore reserve is very narrow.
- Steep slopes difficult for residents and Council to manage and have safety considerations when implementing rehabilitation works.
- Fire threat due to annual grasses, dumping of garden waste and steepness of banks.

South Bank

- Uncontrolled access across some sections of the dune system resulting in slumping.
- Foreshore Management Plan for the southern bank of the river will be implemented as part of the Moore River Company development.
- Foreshore Reserve fencing and dune stabilisation work through brushing has been moderately effective in protecting the vegetation.

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RECOMMENDATIONS

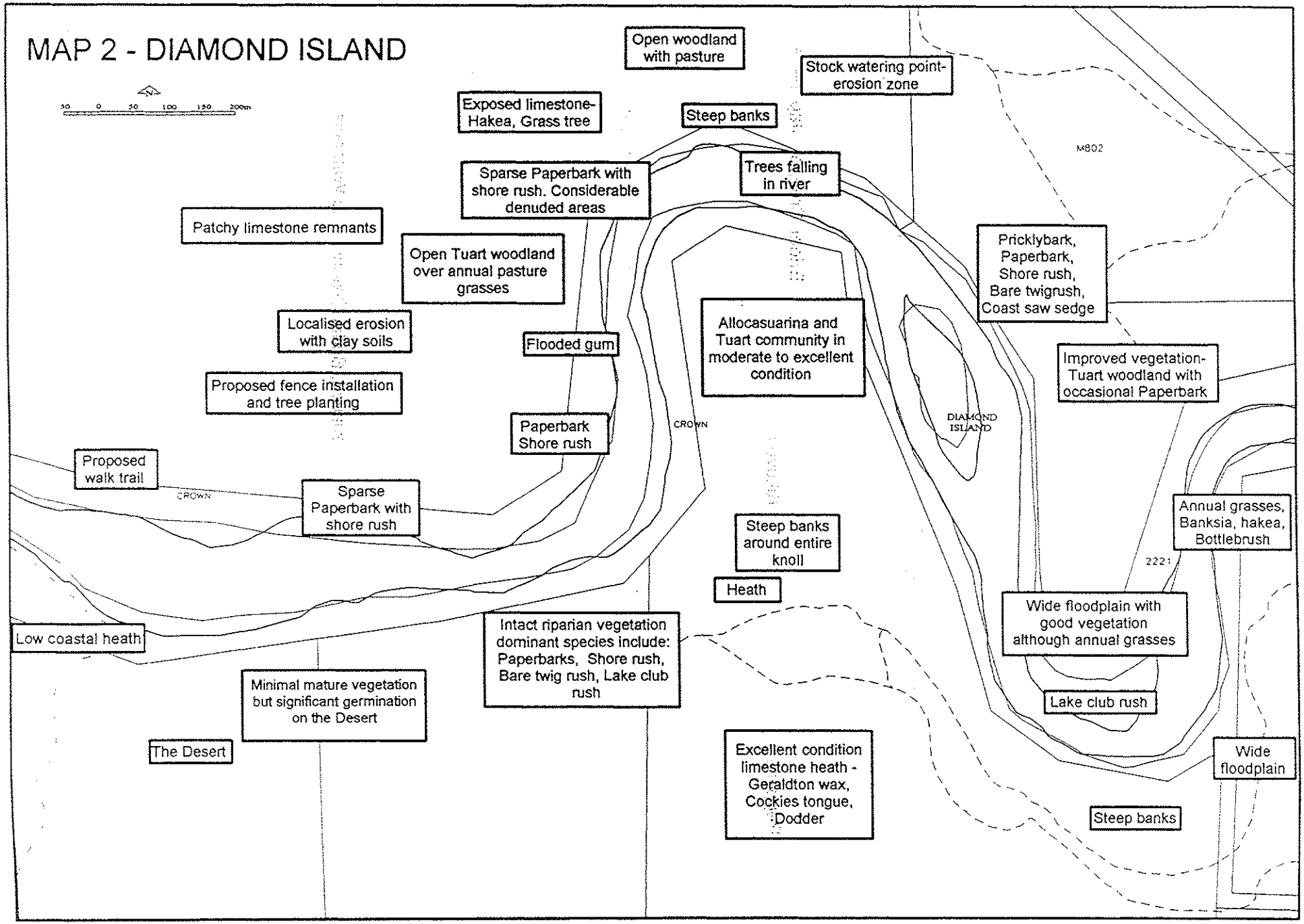
Issues	Comments and management advice
Access	Develop a foreshore management plan for the north bank during the process of developing walk trails, which addresses issues such as weed management, rationalises access tracks including the 'Art Trail' concept, revegetation and other issues.
	Install signs encouraging users to keep to paths as the are managed for the purposes of conservation and further to request users respect the rights of private landholders.
	Construct some limestone paths to enable access to the water's edge.
	As part of the foreshore management plan recommended above, determine management and upgrading of the Silver Creek recreation area. Install crushed limestone hard stand parking areas and bollards to control access.
	Develop and distribute a pamphlet to encourage an interest in the foreshore that provide information about: ♦ the impact of dumping waste on the foreshores, ♦ importance of ensuring backyards are kept free of debris on the ground to discourage rats and reduce the frequency of snakes visiting and ♦ using standard access ways to help protect the natural environment.
Weeds	Implement intensive weed control as a HIGH PRIORITY focussing on annual grasses, herbaceous and tree weeds on limestone cliff; and perennial and annual grasses and bulbs in the riparian zone. Garden plants that have migrated due to dumping should also be removed.
	Continue intensive revegetation program – limestone cliff and riparian zone including all strata of vegetation.
Erosion and sedimentation	Consider the feasibility of dredging some sections of the estuary to enhance water flow.
	Prepare a sign providing bathymetry data (Current DOT and WRC project) to discourage high-speed water sports.
	Determine feasibility of maintaining lighting across the bar to discourage artificial opening. This needs to occur concurrently with an education campaign about the importance of allowing the estuary to function naturally.
General management issues	Monitor implementation of the foreshore and coastal management plans required as a condition of development for the Moore River Company development on the south bank.
	Determine feasibility of declaring the waterway for passive recreation purposes (DOT).
	Liaise with Shire of Gingin and Department of Transport to determine feasibility of increasing ranger presence during peak usage times.

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Plate 15: The wide estuary with dense fringing vegetation provides an attractive recreation area for canoeing, fishing, swimming and other recreation pursuits. Many visitors tie their vessels to trees to find a picnic spot throughout this river stretch, often disturbing the plants and wildlife. Litter and illegally lit fires also cause problems.



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MAP 2 - DIAMOND ISLAND
Open woodland with pasture
Stock watering point-erosion zone
Exposed limestone-Hakea, Grass tree
Steep banks
Sparse Paperbark with shore rush. Considerable denuded areas
Trees falling in river
M802
Patchy limestone remnants
Open Tuart woodland over annual pasture grasses
Pricklybark, Paperbark, Shore rush, Bare twigrush, Coast saw sedge
Localised erosion with clay soils
Flooded gum
Allocasuarina and Tuart community in moderate to excellent condition
Improved vegetation-Tuart woodland with occasional Paperbark
Proposed fence installation and tree planting
DIAMOND ISLAND
Paperbark Shore rush
CROWN
Proposed walk trail
CROWN
Sparse Paperbark with shore rush
Annual grasses, Banksia, hakea, Bottlebrush
Steep banks around entire knoll
2221
Heath
Wide floodplain with good vegetation although annual grasses
Low coastal heath
Intact riparian vegetation dominant species include: Paperbarks, Shore rush, Bare twig rush, Lake club rush
Lake club rush
Minimal mature vegetation but significant germination on the Desert
The Desert
Excellent condition limestone heath - Geraldton wax, Cockies tongue, Dodder
Wide floodplain
Steep banks

2.0 Diamond Island region
Lot Nos: Lots 2144, Part M802, Part 2221, Part 2802, Part 2424 and Part 2481

Management and rehabilitation considerations:

In river

- Popular fishing spot also used for power boating and canoeing.
- Considerable accretion around Diamond Island.

North bank

- Parts of the limestone cliffs subject to grazing and are eroding as a result of loss of vegetation and trampling.
- High conservation and landscape values particularly on Lots 2221 and 2481, with Lot 2144 retaining significant populations of Tuart.
- Agreed area for fencing off new foreshore reserve, with a walk trail linking the foreshore reserve in Lot 2144 with Guilderton.
- Indiscriminate access to private property by people recreating on the river.
- Weed invasion of concern in particular small infestations of Bridal Creeper, Japanese Pepper and widespread incursions of Kikuyu and annual grasses.
- Disused stock watering holes adjacent fenceline actively eroding and threatens livestock health and fences.

South bank

- Access to 'The Desert' is continuing, and while there is significant natural regeneration there is an ongoing issue of people trampling and eroding the face. This maintains minimal vegetation cover on the sand dunes.
- Trees fallen in river.
- There is a need for protection of vegetation that shows very little disturbance e.g. Lot 2481.
- Site for new development by Moore River Company, with a foreshore management plan provided to ensure protection of the natural environment.
- Indiscriminate access to private property by people recreating on the river and using four-wheel drive vehicles.
- Local infestations of a range of weed species requires frequent monitoring and treatment to ensure the populations do not spread e.g. Kikuyu, Bridal Creeper and Watsonia.

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RECOMMENDATIONS

Issue	Comments and management advice
Physical environment	Continue to monitor water quality with officers of the Water and Rivers Commission, trying to involve other community members to become involved in the Ribbons of Blue Program.
	Install local erosion control where gully erosion is occurring using fencing materials installed parallel with the contours to create a stepped environment.
Weeds	Implement weed control program – focussing on perennial grasses in the riparian zone and annual grasses in the *Banksia* woodlands.
Revegetation	Implement a revegetation program focusing on eroding riparian zones including all strata of vegetation. In *Banksia* woodland areas, the focus should be on re-establishing trees and shrubs, the Tuart woodland on the shrub layer while the riparian zone should focus on understorey. Note the planting ratio in Tuart woodland should be overstorey : middlestorey : understorey at: 1:6:3. Note the planting ratio in riparian woodland should be overstorey : middlestorey : understorey at: 4:1:5.
Access	Install a walk trail within foreshore reserve, keeping it upslope to use the trail as a barrier between revegetation areas and neighbouring pasture.
	Install a group of benches beneath shade to enable groups of people to meet.
	Prepare signage providing information about the physical environment, flora and fauna of the Moore River, management of pests including weeds and providing contact details if people wish to become involved. (WRC and groups: Printing approx. $1500 per sign.)
	Install CALM style information shelters with displays that can be used at all Shire of Gingin managed reserves. These displays can then be rotated on a three-monthly cycle. (Shelters approx. $3500)
Stock management	Install fencing along alignment agreed onsite, which minimises the effort required to install the fencing.
	Install off-line watering point at agreed location.
	Investigate the feasibility of planting two perennial pasture trials, one using *Sporobolus virginicus* and other more traditional approaches (refer Agriculture WA booklets).
	Plant alleys of *Acacia saligna* to improve bank stability and soil structure where fencing can be agreed.

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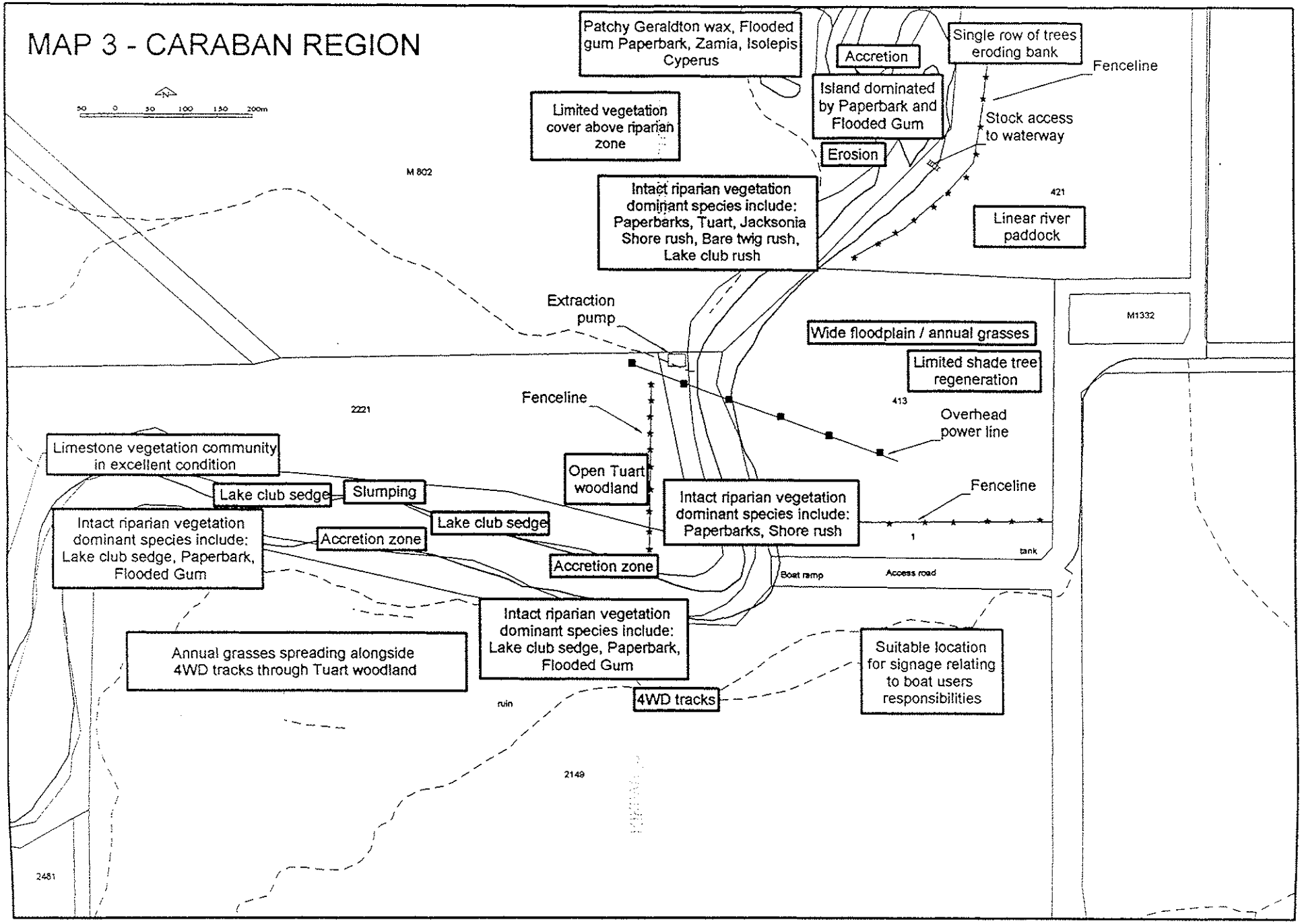
Plate 16: The difference in vegetation between a heavily stocked paddock and one that had minimal stocking rates in the past can be clearly seen. There are shrubs and some understorey plants on the right side of the fence, while the left retains very patchy vegetation with predominantly tall trees. Suggestions about possible stock management techniques are contained in Section 6 of this document. Note that the grazing on the left side of the fence reduces fire risk.



Plate 17: Gully erosion resulting from water runoff along sheep tracks.



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MAP 3 - CARABAN REGION
Patchy Geraldton wax, Flooded gum Paperbark, Zamia, Isolepis Cyperus
Accretion
Single row of trees eroding bank
Fenceline
Island dominated by Paperbark and Flooded Gum
Stock access to waterway
Limited vegetation cover above riparian zone
Erosion
M 802
Intact riparian vegetation dominant species include: Paperbarks, Tuart, Jacksonia Shore rush, Bare twig rush, Lake club rush
421
Linear river paddock
Extraction pump
M1332
Wide floodplain / annual grasses
Limited shade tree regeneration
Fenceline
2221
413
Overhead power line
Limestone vegetation community in excellent condition
Open Tuart woodland
Lake club sedge
Slumping
Intact riparian vegetation dominant species include: Paperbarks, Shore rush
Fenceline
Lake club sedge
Intact riparian vegetation dominant species include: Lake club sedge, Paperbark, Flooded Gum
Accretion zone
Accretion zone
tank
Boat ramp
Access road
Intact riparian vegetation dominant species include: Lake club sedge, Paperbark, Flooded Gum
Annual grasses spreading alongside 4WD tracks through Tuart woodland
Suitable location for signage relating to boat users responsibilities
4WD tracks
ruin
2149
2481

3.0 Caraban region
Lot Nos: Part Lot 2221, Part Lot 2149, Lot 1/413 Lot 421 and part M802

Management and rehabilitation considerations:

In-river

- Middle of the river land titles.
- Water skiing and other activities occur, with anecdotal evidence that boat speeds often exceed 8 knots.
- Significant levels of snags in river.
- Boat wash may be contributing in part to erosion.
- Boat speeds may be dangerous because of the presence of large woody debris, snags and other material in the river.
- Popular fishing and canoeing location.
- Extensive areas of emergent rushes such as the Lake Club Sedge colonising accretion zones.

North Bank

- High conservation and aesthetic values for riparian vegetation, Tuart woodland and *Banksia* woodland.
- Indiscriminate access by people using boats, tying up on the foreshore and going for walks is increasing the spread of weeds and also interferes with private landholders enjoyment of their land.
- Presence of small infestations of highly invasive weeds, such as Bridal Creeper and Kikuyu in Lot 2221.
- Diverse fauna in particular bird and reptile species, and presence of a rare mammal.
- Severe bank erosion and limited vegetation cover in Lot M802 to be restored using foreshore fencing and revegetation works to protect foreshore.
- Some areas currently unstocked and actively regenerating.
- Weed invasion.
- Slumping of bank and increased rate of sediment build up.
- Disused stock watering point continuing to erode in Lot 2221, as well as enabling access by people boating.

South Bank

- Middle of the river land titles.
- High conservation and aesthetic values for riparian vegetation, Tuart woodland and *Banksia* woodland in Lot 2149.
- Uncontrolled vehicle access through private land (Lot 2149).
- Fencing along foreshore in variable condition and in some locations is too close to the top of the bank to be stable. There may be some stock access to foreshore in some lots.
- Opportunities to consider perennial pastures or pasture improvements.
- Possible site for CALM Walk trail linkage to Gnangara Park via Wilbinga.

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RECOMMENDATIONS

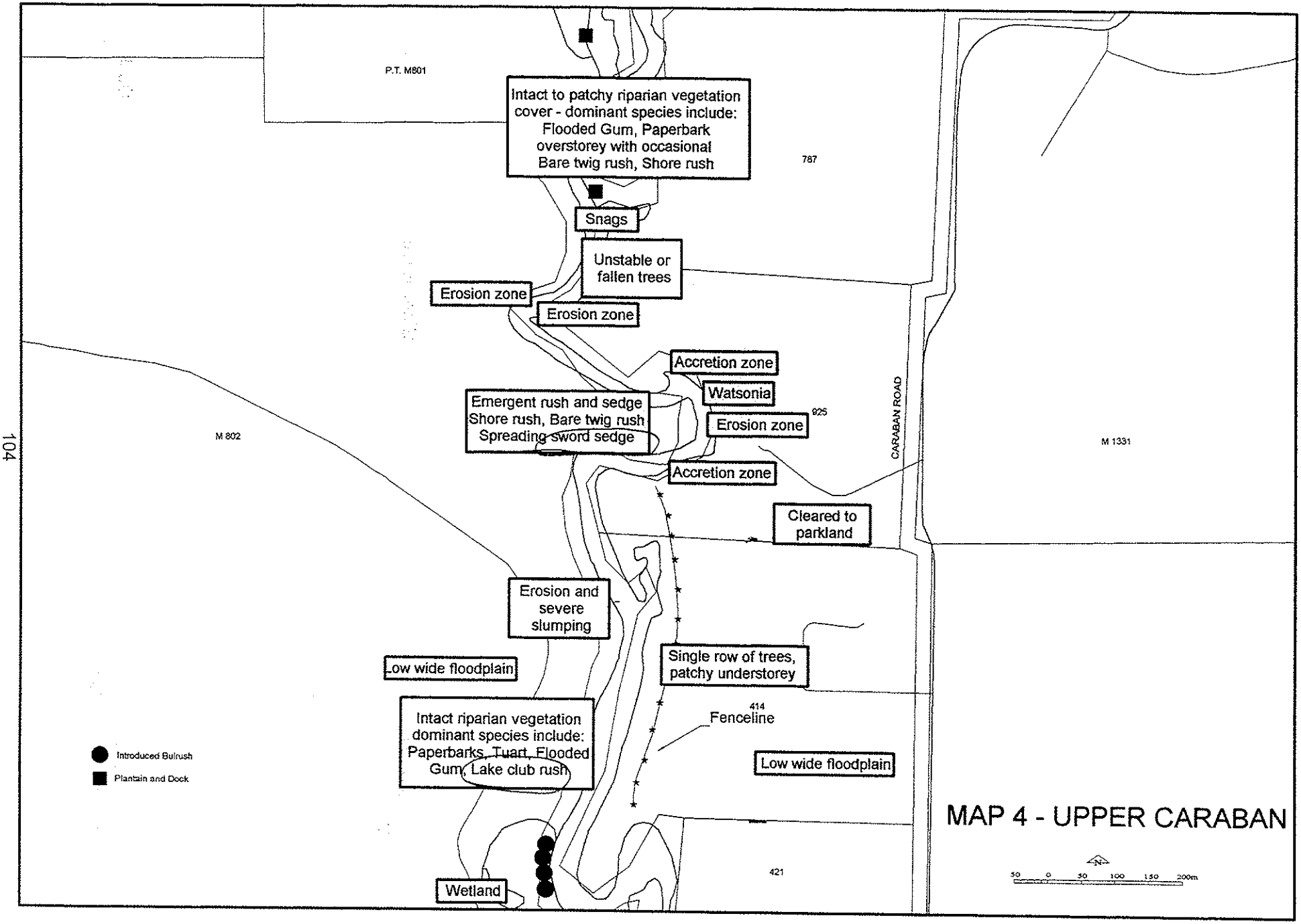
Issue	Comments and management advice
Access	Install signs at Caraban Road launching area describing the environment, and the importance of minimising access to the bush areas due to the potential to spread weeds, fire hazard, and the need to respect landholders rights, particularly in relation to boating. This should be a collaborative project between Shire of Gingin and local community groups with the support of the Water and Rivers Commission and Department of Transport.
	Stabilise the entry into the small boat-launching ramp with a focus on controlling sheet runoff and managing the parking area.
	Block 4WD access through Lot 2149 to help landholders protect environmental values on the south bank.
Weeds	Implement localised weed control and revegetation program focusing on eroding riparian zones, including all strata of vegetation.
	Provide information to local residents to discourage dumping of garden waste.
Erosion and accretion	Construct mini-interceptor banks parallel with the river's edge set back at least 10 m from the top of the floodplain to trap faecal material, seed and reduce sheet runoff from the paddocks.
	Re-align some of the large woody debris to reduce erosion of the bank.
Revegetation	Plant more trees, focussing in areas where the trees are dying or dead or there is only a single row of trees along the foreshore.
	Plant Flooded Gum, Tuart and Freshwater Paperbark seedlings at a rate of 1 plant every 25 m^2 between the fence and the high water mark.
	Plant dense clumps of emergent sedges at the base of actively eroding banks, pegging them in place with 600 mm 'U-shaped' steel pegs. Site selection must be considered carefully to ensure plant survival.
	Plant buffer planting of groundcover and low shrub species along Barragoon Road and Caraban Road where the width between the base of the table drain and the fences is greater than 5 m.
Stock management	Re-align fences that occur close to the narrow strip of foreshore trees to reduce trampling by stock, and enable regeneration.
	Continue low number stocking practices and responsible management.
	Consider using perennial grasses such as Native Saltwater Couch to help stabilise and improve vegetation cover (refer Agriculture WA publications).

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Plate 18: The Caraban boat launching area is popular for many powerboat users. It is an appropriate location for signage providing recreation users with information about the threats of submerged snags, advising them of private landholder's rights and the relevant boating regulations for the river.



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P.T. M801
Intact to patchy riparian vegetation cover - dominant species include: Flooded Gum, Paperbark overstorey with occasional Bare twig rush, Shore rush
787
Snags
Unstable or fallen trees
Erosion zone
Erosion zone
Accretion zone
Watsonia
Emergent rush and sedge Shore rush, Bare twig rush Spreading sword sedge
925
Erosion zone
M 802
CARABAN ROAD
M 1331
Accretion zone
Cleared to parkland
Erosion and severe slumping
Low wide floodplain
Single row of trees, patchy understorey
414
Fenceline
Intact riparian vegetation dominant species include: Paperbarks, Tuart, Flooded Gum, Lake club rush
Low wide floodplain
Introduced Bulrush
Plantain and Dock
421
Wetland
MAP 4 - UPPER CARABAN
N
50 0 50 100 150 200m

4.0 Upper Caraban
Lot Nos: Part M802, Lot 414, Lot 925 and Lot 787

Management and rehabilitation considerations:

In-river

- Middle of the river land titles.
- Water skiing and other activities occur, with anecdotal evidence that boat speeds often exceed 8 knots.
- Significant levels of snags and large woody debris in river.
- Boat wash may be contributing to erosion.
- Boat speeds can be dangerous because of the presence of large woody debris, snags and other material in the river.
- Significant levels of sediment and suspended woody debris accumulation within and between paperbark groves.
- Large grove of the Introduced Bulrush colonising sand banks, reducing available habitat for native plants, and slowing flow while increasing the accretion rate further.

North Bank

- High conservation and aesthetic values for riparian vegetation and mature Tuart and Flooded Gum.
- Indiscriminate access by people using boats, tying up on the foreshore and going for walks is increasing the spread of weeds and not respecting private landholders rights.
- Severe erosion and slumping of river embankment in areas lacking fencing and accessed by sheep for watering.
- Groundcovers and understorey are particularly sparse in this area and there is limited regeneration of native species. There is a narrow band of trees lining the foreshore with isolated clumps of rushes and sedges.
- Current project to control stock access down and across river banks and within foreshore area, through construction of fencing.
- Number of trees instream may be suitable for re-alignment to encourage scouring of the riverbed rather than the banks of the river.

South Bank

- Limited occurrences of highly invasive weeds such as Giant Reed (*Arundo donax*) and Watsonia (*Watsonia bulbillifera*) in residential gardens.
- Severe erosion zones on power bends and on floodplain where flow is being deflected by instream debris.
- Stock has controlled access to the foreshore in a linear paddock and is causing localised compaction and pugging of clay banks, and slumping of sandbanks. Fencing generally set well back from the foreshore.
- Significant numbers of Rainbow Bee-eaters breeding on foreshore banks.
- Significant wetland remnants with considerable regeneration within floodplain in some areas. This indicates overall low to moderate grazing.
- Loss of pasture and fodder values within floodplain due to increased levels of Dock, Fleabane and Stinking Roger following flood event.

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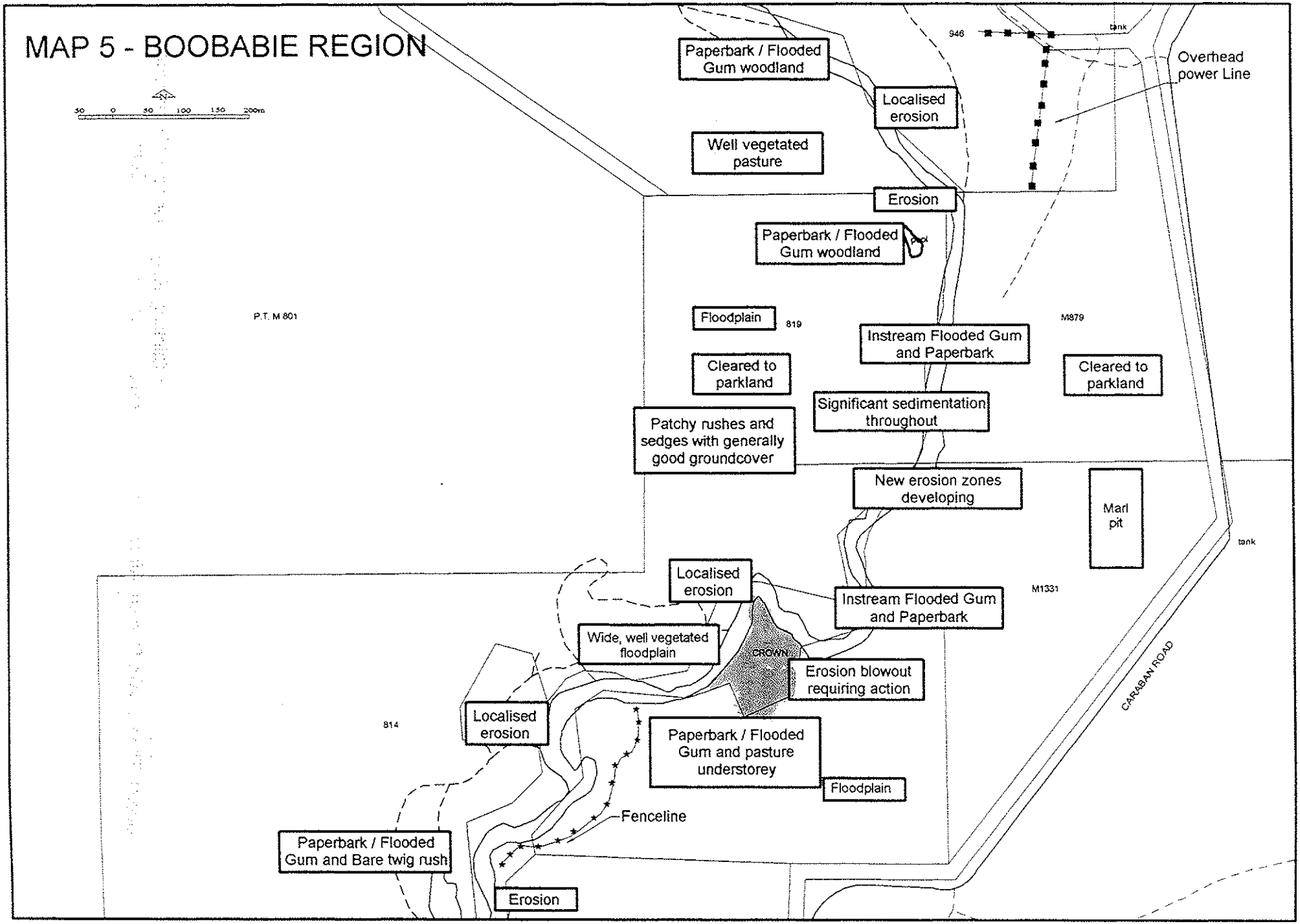
RECOMMENDATIONS

Issue	Comments and management advice
Physical environment	Consider constructing mini-interceptor banks parallel with the river's edge set back at least 10 m from the top of the floodplain to trap faecal material, seed and reduce sheet runoff from the paddocks. This can be achieved when installing fire access tracks.
	Re-align some of the large woody debris to reduce erosion of the bank. Note this needs to be extremely selective and undertaken with advice, approval and support onsite from officers of the Water and Rivers Commission, or following training.
	Remove the sections of suspended fine to medium branchlets that are between 1 m and 3 m from low water level to help facilitate water flow and reduce sedimentation. Note this needs to be extremely selective and undertaken with advice, approval and support onsite from officers of the Water and Rivers Commission or following training.
	Formalise stock access down steep river verges by creating a stepped environment where possible. This needs to be stabilised and only used on the upstream end of powerbends, not located facing the main flows.
Weeds	Implement weed control focusing on sections of the floodplain where weeds such as Dock, Fleabane and Stinking Roger are becoming dominant and reducing fodder availability.
	Remove isolated patches of highly invasive weeds such as Watsonia, Giant Reed and other garden plants that are able to spread rapidly.
	Provide information to local residents to discourage dumping of garden waste.
	Brushcut or graze, if possible, Introduced Bulrush in May to reduce sedimentation in this reach of river.
Revegetation	Continue to encourage natural regeneration by minimising the frequency and duration of stock access to the foreshore (refer to Riparian Zone Management section).
	Install fencing at the top of the verge where bank collapse is occurring, to protect stock. These areas should be re-planted following weed control, provided this is not going to impact on bank stability.
	Plant localised areas of Freshwater Paperbarks and rushes including Shore Rush and Bare Twig Rush on the lower part of the bank once fencing above high water mark is installed and following peak water flow events (August/September). The planting ratio should be 2:8 trees: rushes. Plant selection for the upper parts of the bank should include Coojong, Red-eyed Wattle, Stinkwoods and Cottonheads at an average density of 1 plant per m^2. These need to be planted in May-June above high water mark.
	Protect existing remnant vegetation to minimise future effort required and to maintain aesthetic appeal in case of future landuse changes.
	Plant additional Tuart and Coojong within property boundaries along Caraban Road to screen market garden extensions and provide a buffer between this development and the river. This will require additional fencing.

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	Intensively plant northern bank between the new fence and river foreshore to reduce the future potential for blowouts.
	Plant clay bank, following fencing at the top of the verge, as agreed.
Stock management	Install off-line watering points on north bank and install fencing along agreed alignment. Ensure that the watering points are well designed to minimise erosion in these areas
	Install fencing at eroding steep verge banks where the clay and sandbanks are becoming increasingly unstable, set back at least 10 m from the eroding face.
	Consider reinforcing existing pasture with perennial grasses and additional annual crops to improve pasture cover. Trial native couch *Sporobolus virginicus*.
	Fence off some areas of Tuart to encourage natural regeneration, which will ensure shade trees are available for stock in the future.
	Plant an alley farm of Coojong along northern boundary of Lot 787 to provide a vegetated linkage between the river and roadside buffer plantings.
	Continue installing off-line watering points in every paddock to reduce the need for stock to drink from the river, ensuring these points are effectively stabilised and not likely to cause an erosion problem.

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MAP 5 - BOOBABIE REGION
50 0 50 100 150 200m
Paperbark / Flooded Gum woodland
Localised erosion
Overhead power Line
Well vegetated pasture
Erosion
Paperbark / Flooded Gum woodland
Pool
946
tank
P.T. M 801
Floodplain
819
M879
Instream Flooded Gum and Paperbark
Cleared to parkland
Cleared to parkland
Significant sedimentation throughout
Patchy rushes and sedges with generally good groundcover
New erosion zones developing
Marl pit
tank
Localised erosion
M1331
Instream Flooded Gum and Paperbark
Wide, well vegetated floodplain
CROWN
Erosion blowout requiring action
814
Localised erosion
Paperbark / Flooded Gum and pasture understorey
Floodplain
CARABAN ROAD
Fenceline
Paperbark / Flooded Gum and Bare twig rush
Erosion

5.0 Boobabie region
Lot Nos: Part M801, Lot 819, Lot 909, Part Lots 1331 and M879

Management and rehabilitation considerations:

In-river

- Significant levels of snags and large woody debris in river.
- Significant levels of sedimentation with narrow, steep sided braided channels between 1.5 m and 2.0 m deep.
- Braided channel with many areas of severe scouring.
- Little natural regeneration of native flora, probably the result of quantity of mobile sediment.
- Significant levels of sediment accumulation within and between paperbark groves.
- Middle of the river land titles.
- Excellent fish breeding and resting area.

North Bank

- High conservation and aesthetic values for riparian vegetation and mature Tuart and Flooded Gum. Note conservation outcomes continue to be achieved where there is good stock management.
- Localised areas of severe erosion and blowouts where vegetation cover is lacking.
- Significant undermining of mature trees leaving trees at risk of collapsing into the river.
- Limited diversity of native understorey species.
- Some highly invasive weeds that are toxic to stock being actively controlled.
- Some fencing close to channel bank and floodplain bank. Local areas have stock tracks parallel with the fence alignment, which has resulted in loss of vegetation adjacent to the fenceline. This increases the susceptibility of the riverbank to slumping.
- Significant *Banksia* woodland remnant that has not been grazed due to the presence of significant levels of toxic native plants, and presents an opportunity for an alternative landuse such as ecotourism.
- Some managed stock access to riverbanks and within foreshore area.

South Bank

- New localised blowout following flood.
- Some severe erosion zones on power bends and on floodplain where flow is being deflected by instream debris.
- Stock has controlled access to the foreshore however are causing localised compaction and pugging of clay banks. This is increasing the susceptibility of the bank to erode.
- Significant levels of Rainbow bee-eaters breeding on foreshore banks.
- Presence of some highly invasive weeds such as Stinking Roger, Deadly Nightshade, Scotch Thistle, Wild Radish, African Lovegrass, Pelargonium and Double Gees. Some of these species can be toxic to stock.
- Extremely diverse understorey persisting in some parts of the floodplain, while other sections have limited value for stocking due to dense Dock and other unpalatable weeds.

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This reflects the low to moderate rotational stocking practices employed by the landholders.

- 12 species of native rush and sedge present.

RECOMMENDATIONS

Issue	Comments and management advice
Physical environment	Consider constructing mini-interceptor banks parallel with the river's edge set back at least 10 m from the top of the floodplain to trap faecal material, seed and reduce sheet runoff from the paddocks. This can be achieved when installing fire access tracks.
	Re-align selected large woody debris to reduce erosion of the bank. Note this needs to be undertaken with advice, approval and support onsite from officers of the Water and Rivers Commission, or following training.
	Remove the sections of suspended fine to medium branchlets that are between 1 m and 3 m from low water level to help facilitate water flow and reduce sedimentation. Note this needs to be undertaken with advice, approval and support onsite from officers of the Water and Rivers Commission, or following training.
	Re-align fences above severe slump to protect stock and plant tubestock to reinforce bank stability, where agreed.
	Re-align fences that are close to high water mark where they are currently exacerbating bank erosion – in areas lacking sufficient vegetation cover to keep the soil in place.
Weeds	Continue to implement selective weed control focusing on sections of the floodplain where weeds such as Dock and Stinking Roger are becoming dominant and reducing fodder availability.
	Continue to remove isolated patches of highly invasive weeds such as Pelargonium, Arum Lily, African Lovegrass, False Wanderrie Grass and other species that are able to spread rapidly.
	Control weeds in areas where planting and/or direct seeding is proposed and agreed to by all stakeholders.
Revegetation	Continue to facilitate the process of natural regeneration by minimising the frequency and duration of stock access to the foreshore (refer Riparian Zone Management).
	Install fencing at the top of the verge in areas where bank collapse is occurring, if necessary.
	Plant localised areas of Freshwater Paperbarks, Flooded Gum and rushes including Shore Rush and Bare Twig Rush on the lower part of the bank once fencing is installed and following peak water flow events (August/September). The planting ratio should be 2:8 trees: rushes. The upper parts of the bank should be planted with Coojong, Red-eyed Wattle, Stinkwoods and Cottonheads at an average density of 1 plant per m^2. These need to be planted in May-June above high water mark. This needs to be undertaken selectively to ensure that plantings will not affect the flow characteristics of the river.
	Protect existing remnant vegetation to minimise future effort required and

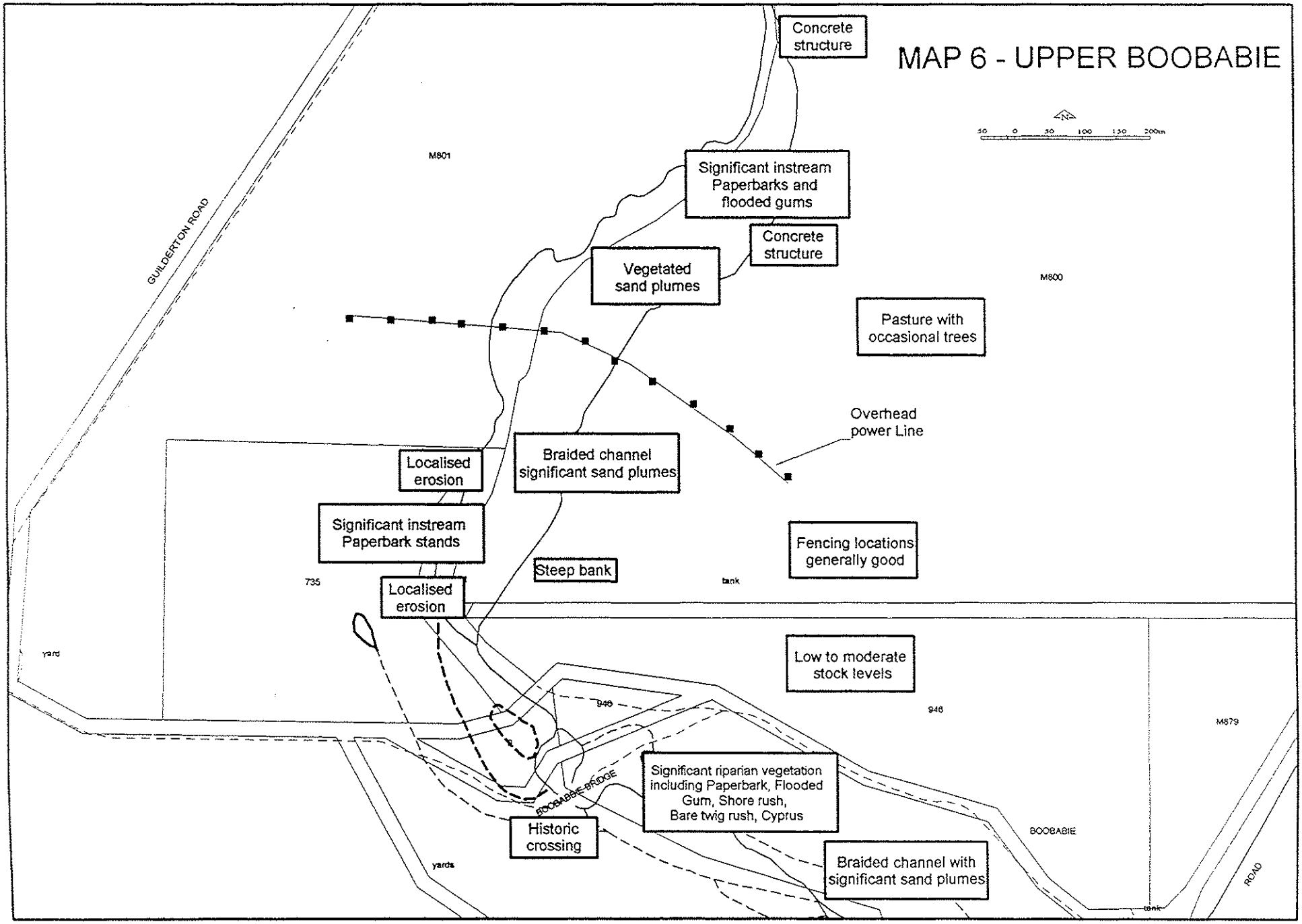
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	to maintain aesthetic appeal in case of future landuse changes.
	Intensively plant southern verge banks following weed control to encourage turtle breeding and birds' use, and improve aesthetics as agreed.
Stock management	Stabilise popular watering holes with limestone spalls.
	Continue low to moderate stocking practices including the rotation that ensures sufficient vegetation in the floodplain
	Install fencing at eroding steep verge banks where the clay and sandbanks are becoming increasingly unstable, set back at least 10 m from the eroding face.
	Consider reinforcing existing pasture with perennial grasses and additional annual crops to improve pasture cover.
	Fence off some verge areas with regenerating Tuart, Freshwater Paperbark and Flooded Gum to ensure shade trees persist in the future, and where fencing will not interfere with river flow dynamics.
Fauna	Continue to protect Rainbow Bee-eaters nests by installing fallen debris above the nests or fencing the areas off from stock, where necessary.
	Consider becoming involved in the Birds Australia Bird Atlas Program to provide monthly data on species seen in the area to maximise the sharing of knowledge.
	Consider becoming involved in the project to monitor the success of fox baiting and shooting programs by walking along an east-west fence and recording the number of animals seen on a quarterly basis.

Plate 18: Dense Paperbark groves trap considerable amounts of woody debris, deflecting the water into the neighbouring banks and causing scouring under the trees. Selective removal would help restore river process.



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MAP 6 - UPPER BOOBABIE
Concrete structure
Significant instream Paperbarks and flooded gums
Concrete structure
Vegetated sand plumes
Pasture with occasional trees
Overhead power Line
Braided channel significant sand plumes
Localised erosion
Significant instream Paperbark stands
Steep bank
Localised erosion
Fencing locations generally good
Low to moderate stock levels
Significant riparian vegetation including Paperbark, Flooded Gum, Shore rush, Bare twig rush, Cyprus
Historic crossing
Braided channel with significant sand plumes
GUILDERTON ROAD
BOOBABIE BRIDGE
BOOBABIE
ROAD
M801
M800
M879
735
946
949
yard
yards
bank
50 0 50 100 150 200m

6.0 Upper Boobabie
Lot Nos: Part Lots M801 and M800, Lot 735, Lot 946 and M879

Management and rehabilitation considerations:

In-river

- Middle of the river land titles.
- Historic formal crossing point affecting water flow.
- Significant levels of snags and large woody debris in river.
- Extensive Freshwater Paperbark wetland creating braided channels.
- Significant levels of sediment accumulation within and between paperbark groves.
- Unexpectedly high levels of sedimentation as a result of the 1999 floodwaters dumping extensive islands of sand. A 2.5 m deep hole was dug on an island through pure silica drift sand before last year's vegetation growth was found.
- Presence of a Priority 4 declared rare and endangered plant species.

North Bank

- High conservation and aesthetic values for riparian vegetation, *Banksia* woodland and mature Tuart woodland. The persistence of these significant remnants reflects stock management practices and is important for stock protection when unfavorable winters are experienced.
- Localised areas of severe erosion and slumping of sandy and clay banks.
- Limited diversity of native understorey species, although cover is generally sufficient to protect the floodplain from erosion.
- Stock access down and across riverbanks and within foreshore area periodically throughout the year.
- Foreshore fencing design using five barbs parallel with the bank on riverbank effective as the wire is lifted during winter months to reduce the amount of debris trapped. This is to prevent stock from crossing to neighbours properties.
- Fencing that is perpendicular to flow difficult and costly to manage due to the amount of debris that is trapped along the fenceline.
- Some sections of fencing above the floodplain use local tree stock as fence posts and strainers, which is likely to result in death of these plants.

South Bank

- Limited occurrences of highly invasive weeds including African Lovegrass (*Eragrostis curvula*).
- Occasional zones of severe erosion on power bends and on floodplain where flow is being deflected by instream debris.
- Stock has controlled access to the foreshore. Grazing of the foreshore occurs periodically throughout the year
- Point source stock watering point is resulting in one section of a clay bank becoming unstable. The river may continue to scour out this unstable clay, ultimately resulting in the loss of the neighbouring tree if no action taken. This can be improved by installing limestone spalls to help protect clay structure.
- Excavation of clay material in the past has modified the landscape. This pit has been used for several decades. In the late 1920s or early 1930s, the pit provided material to

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construct sections of the Old Guilderton Road. The army used this pit during the Second World War. During the 1970s, the Shire of Gingin also extracted material for use on Caraban Road.

RECOMMENDATIONS

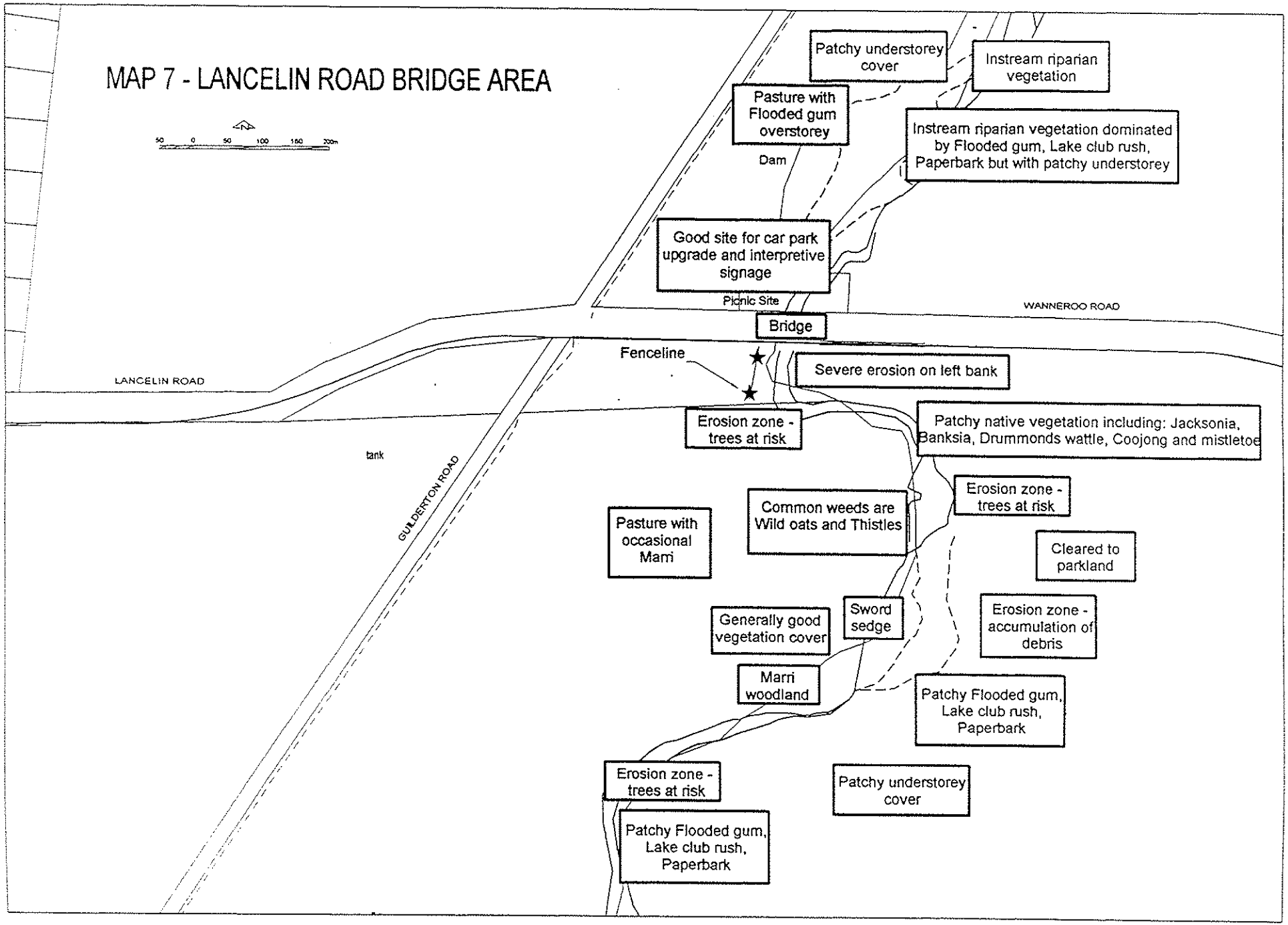
Issue	Comments and management advice
Stock management	Stabilise the stock watering point by dumping limestone spalls, compact in place and covering with topsoil.
	Continue the moderate stock management based on a rotation system to maintain sufficient vegetation cover, particularly groundcovers and rush and sedge species within the floodplain.
	Consider additional fencing on the south bank to fence off floodplain and enable trials of different stock management approaches (refer Riparian Zone Management).
	Consider pasture reinforcement opportunities.
Access	Investigate options for managing the historic crossing to improve its stability and help to maintain this crossing in the long term.
Weed control and revegetation	Continue to implement localised weed control and revegetation programs, focusing on the verge away from active erosion or accretion zones.
	Protect declared flora and significant bushland remnants from stock by using existing fencing to exclude them.
	Consider planting some areas with additional plant stock and protecting them from stock in areas where there are only single trees remaining. Site selection needs to take into account potential impact on stream flow dynamics.
	Continue to investigate alternative landuses to protect the current extent of vegetation that is appreciated for its aesthetic values and benefit to stock such as eco-tourism, if desired.
Erosion and accretion	Following training or with assistance and approval from the WRC, re-align some of the instream large woody debris that is exacerbating erosion (refer River stabilisation) to improve water flows and facilitate erosion of new accretion zones.
	Fence above severe erosion zones at least 10 m back from the top of the slumping verge banks, and direct seed and plant tubestock to reduce the potential for future blowouts. This needs to be low plants, not trees and large shrubs, and any fencing should not impact on river flow.
	Selectively remove some of the suspended fine woody debris from the central parts of main channels to encourage sediment movement through the river system. Note this needs to be extremely selective and undertaken with advice, approval and support onsite from officers of the Water and Rivers Commission, or following training. This is to ensure that a greater problem is not created.

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Plate 19: In some places, excellent understorey persists beneath dense paperbark groves.



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MAP 7 - LANCELIN ROAD BRIDGE AREA
50 0 50 100 150 200m
Patchy understorey cover
Instream riparian vegetation
Pasture with Flooded gum overstorey
Instream riparian vegetation dominated by Flooded gum, Lake club rush, Paperbark but with patchy understorey
Dam
Good site for car park upgrade and interpretive signage
Picnic Site
WANNEROO ROAD
Bridge
Fenceline
Severe erosion on left bank
LANCELIN ROAD
Erosion zone - trees at risk
Patchy native vegetation including: Jacksonia, Banksia, Drummonds wattle, Coojong and mistletoe
tank
GUILDERTON ROAD
Erosion zone - trees at risk
Common weeds are Wild oats and Thistles
Pasture with occasional Marri
Cleared to parkland
Sword sedge
Generally good vegetation cover
Erosion zone - accumulation of debris
Marri woodland
Patchy Flooded gum, Lake club rush, Paperbark
Erosion zone - trees at risk
Patchy understorey cover
Patchy Flooded gum, Lake club rush, Paperbark

7.0 Lancelin Road Bridge region

Lot Nos: Part Lots M801 and M800 and Lot 1

Management and rehabilitation considerations:

In-river

- Braided channels with significant amounts of large woody debris, accumulation of coarse sand and limited understorey and bank vegetation persisting.
- Significant levels of snags and large woody debris in river.
- Significant levels of sediment accumulation within and between paperbark groves.
- Anecdotal evidence indicates that the river course has changed within the last 50 years.
- Middle of the river land titles.

North Bank

- Small reserve provides car parking and rest point for travellers.
- Large amounts of rubbish left by travellers because there is only one rubbish bin.
- Indiscriminate access by people launching boats, tying up on the foreshore and going for walks is increasing the spread of weeds, and reducing the enjoyment of the freehold land for private landholders.
- Severe erosion and slumping resulting from runoff from the car park.
- High conservation and aesthetic values for small patches of riparian vegetation, *Banksia* and Tuart woodlands.
- Sparse or absent groundcover, and limited natural regeneration in some sections.
- Localised areas of severe erosion and slumping with several large trees being undermined.
- Limited extent and diversity of native understorey species.
- Some stock access to riverbanks and within foreshore area.

South Bank

- Stock access to riverbanks and within foreshore area, with irregular monitoring to prevent overgrazing.
- Severe blowout that is subject to a process of restoration in the year 2000 including recontouring of bank, installation of erosion control materials and replanting by students from a Metropolitan school.
- Most of the floodplain is cleared to parkland with limited understorey diversity and minimal or no natural regeneration. Significant areas lacking continuous groundcover.
- Severe erosion zones on power bends and on floodplain where flow is being deflected by instream debris.
- Some localised compaction and pugging of clay banks, and slumping of sandbanks resulting from significant livestock traffic in sections currently stocked with large numbers of animals.

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Issue	Comments and management advice
Erosion and accretion	Consider feasibility of implementing localised sediment removal due to significant build up of coarse sediment in this zone following the floods of 1999.
	Re-align instream large woody debris that is exacerbating erosion (see River stabilisation) to improve water flows and facilitate erosion of new accretion zones. This work should only be done with the advice onsite of a WRC officer or following training.
	Fence off severe erosion zones at least 10 m back from the top of the slumping bank, and direct seed and plant tubestock to reduce the potential for future blowouts.
	Selectively remove some of the suspended fine woody debris from the central parts of main channels to encourage sediment movement through the river system. This needs to occur with the onsite advice and approval from Water and Rivers Commission officers.
	Implement proposed works at the Blowout on the southern bank as described in the project plan.
	Implement localised bank stabilisation works on northern end of car park by installing fencepost retaining structures, hemp matting and subsequently planting densely.
Revegetation	Instream revegetation works are precluded in this area, as this section is acting as a flood channel.
	Implement direct seeding of top of banks, using parallel mini-interceptor banks to keep the seed in these areas to try to restore some vegetation cover.
	Control African Lovegrass to reduce the rate of spread of this weed.
	Revegetate the Blowout in accordance with the plan developed by WRC. Plant the dryland plants during May-June and the rushes and sedges near high water mark in September.
Fencing	Maintain existing fencing that limits stock contact with the foreshore area on the northern bank until sufficient understorey vegetation has recolonised the area.
	Install fencing on the floodplain verge to exclude sheep from the river on the southern bank to allow groundcovers to recolonise the area. This alignment needs to be agreed onsite.
	Investigate opportunities to fence off significant bushland area beyond the floodplain to protect the land values and aesthetic appeal for people travelling on Lancelin Road.
Other management issues	Determine accepted name for the Bridge across the Moore River: Moore River Bridge or Lancelin Road Bridge.
	Install signage at the parking area pointing out features of the local district of interest, aspects of the biological and physical environment, and the works currently underway to improve the lower Moore River.
	Prepare a management plan for the small reserve that is aimed at reducing runoff from the car park, improving the vegetation, enhancing the rest

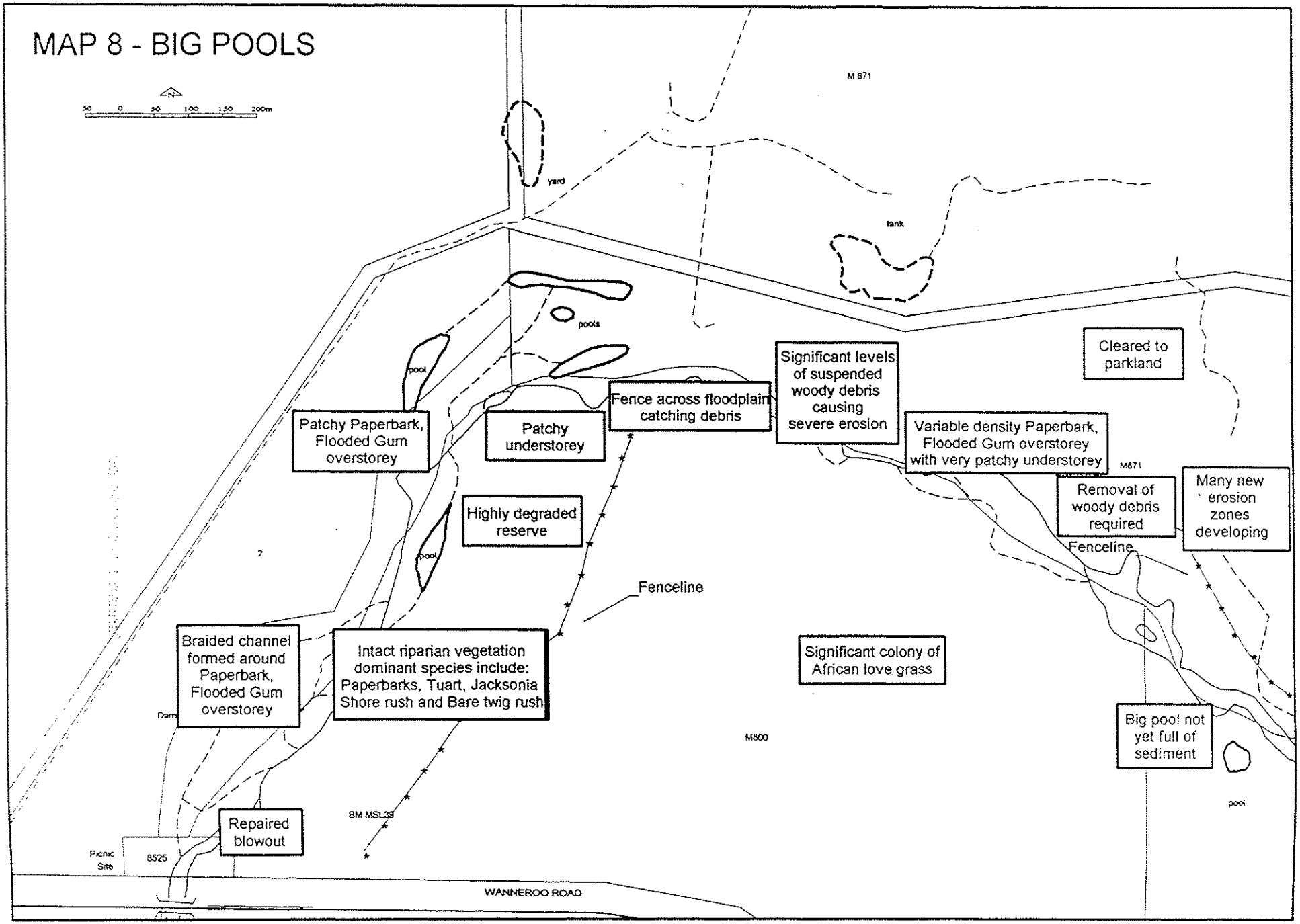
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	facilities (i.e. picnic tables), and increasing the frequency of emptying the rubbish bins.
Access	Upgrade parking and rest area within reserve to manage sheet runoff and the resulting erosion of the bank as mentioned above.
	Improve the picnic facilities and provide additional rubbish bins to reduce dumping of litter into river.

Plate 20: Mobile sand is deposited following every river event. There is considerable amounts of mobile sand in the Moore River, originating from both upstream catchment areas and the river banks within the study area.



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MAP 8 - BIG POOLS
50 0 50 100 150 200m
M 871
yard
tank
pools
pool
Patchy Paperbark, Flooded Gum overstorey
Patchy understorey
Fence across floodplain catching debris
Significant levels of suspended woody debris causing severe erosion
Cleared to parkland
Variable density Paperbark, Flooded Gum overstorey with very patchy understorey
M871
Removal of woody debris required
Many new erosion zones developing
Fenceline
Highly degraded reserve
pool
2
Fenceline
Braided channel formed around Paperbark, Flooded Gum overstorey
Intact riparian vegetation dominant species include: Paperbarks, Tuart, Jacksonia Shore rush and Bare twig rush
Significant colony of African love grass
Big pool not yet full of sediment
M600
pool
BM MSL39
Repaired blowout
Picnic Site
8525
WANNEROO ROAD

8.0 Big Pools

Lot Nos: Reserves 31410 and 8525, Part Lots 2 and 871

Management and rehabilitation considerations:

In-river

- Significant levels of snags and large woody debris in river, and considerable suspended woody debris.
- Extensive Freshwater Paperbark thickets creating a braided channel.
- Pools occur periodically, however, some have poor water quality and support phytoplankton blooms that may impact on stock health.
- Significant levels of sediment accumulation within and between paperbark groves.
- Middle of the river land titles.
- Anecdotal evidence that this section is the last remaining section of the study area where significant river pools still persist.

North Bank

- High conservation and aesthetic values for riparian vegetation, although for the majority of the area it is limited to a narrow band of trees beyond the floodplain with poor to excellent cover within the section.
- Generally, a limited diversity of native understorey species.
- Paddock design allows stock access down and across riverbanks and within foreshore area throughout much of the year. This continual grazing results in loss of grasses, rushes and sedges in some areas, increasing the susceptibility of the floodplain to erosion. There are frequent occurrences of severe erosion.
- Fence too close to the high water mark in some areas and absent in others, with many of the fenced sections aligned perpendicular to the river flow.
- Evidence of owls and possums frequently encountered in this area.
- Some use of perennial grasses such as Couch (*Cynodon dactylon*) for fodder assists in stabilising the paddocks.
- Large numbers of off-line wetlands and swales in variable condition although some retain significant understorey and overstorey cover.
- Limited availability of shade trees beyond floodplain encourages stock to camp within foreshore area.

South Bank

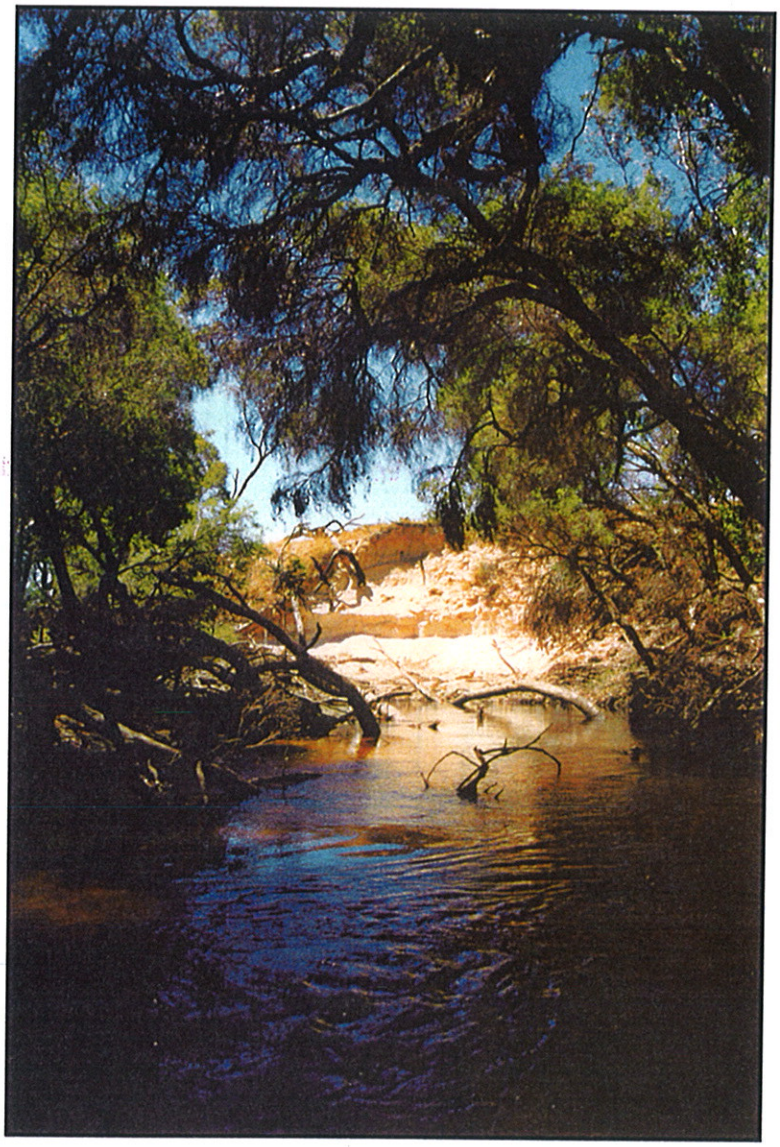
- Fences across the floodplain, perpendicular to the river flow are trapping and accumulating debris and resulting in erosion beneath the fence posts.
- Stock have uncontrolled access to the foreshore and are causing compaction and pugging of clay banks, and slumping of sand banks. Some of the banks are extremely steep.
- Some river pools contain significant levels of phytoplankton blooms that may be toxic to stock.
- Severe infestation of African Lovegrass poses a significant environmental threat, loss of fodder value in the paddocks and a severe fire risk as it is too developed to be palatable to stock.

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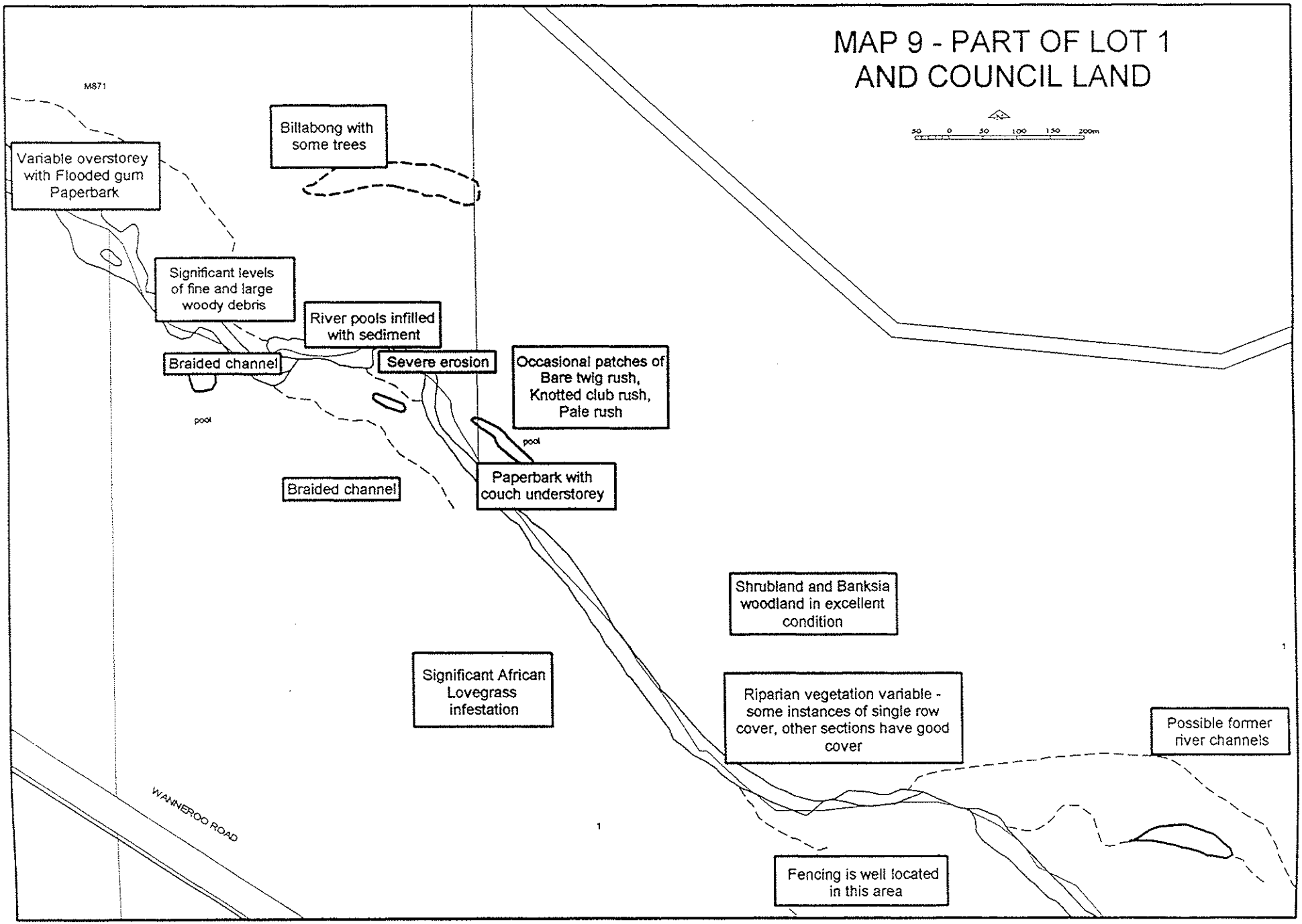
Issue	Comments and management advice
Accretion	Monitor the sediment plume as it nears the Big Pools to determine whether or not the system will be able to self-scour.
Erosion	Construct mini-interceptor banks on verge to control sheet runoff, trap seeds and segments of pasture species to reduce their spread and to slow water movement across the landscape. This will also help to retain nutrients within the paddock by trapping most faecal material.
	Fence off severe erosion zones at least 10 m back from the top of the slumping bank, and direct seed and plant tubestock to reduce the potential for future blowouts.
	Selectively remove some of the suspended fine woody debris from the central parts of main channels to encourage sediment movement through the river system. This needs to occur with the onsite advice from WRC officers.
	Realign some instream large woody debris to reduce scouring landward of the bases of the trees.
Weeds	Target weed control on highly invasive species such as Geraldton Carnation Weed, African Lovegrass, Deadly Nightshade and Apple of Sodom.
	Implement mini-interceptor bank (as above) to contain these species on site.
	Work to establish Couch or Saltwater Couch (*Sporobolus virginicus*) in the floodway to help protect the river banks.
Stock management	Construct fencing at the top of the verge (not top of riverbank) to reduce maintenance costs as debris will not be trapped and to manage stock access to the river.
	Consider implementing a modified stock management approach to enable native plants to set seed (refer Riparian Zone Management).
Fencing	Fence off severe erosion and steep zones to protect stock from falling into these areas.
	Realign fencing parallel with water flow using fence structures that enable lifting during winter months.
Revegetation	Plant nodes of trees and fence them off for the medium term to increase cover for stock in the longer term.
	Protect areas within the floodplain that have significant rush and sedge cover as a source of seed for the property and the river.
	Plant tubestock, Tuart and Flooded Gum upslope of existing trees and protect from stock to improve bank stability and increase survival of existing trees.
Other issues	Consider selective pruning of live trees that are currently being undermined through erosion to restore the balance of the trees upslope and away from the riverbank. This needs to occur with onsite advice from officers of the WRC or following training.

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Plate 21: Trapped woody debris is deflecting high water flows into banks that lack vegetation, causing slumping.



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MAP 9 - PART OF LOT 1 AND COUNCIL LAND
50 0 50 100 150 200m
M871
Billabong with some trees
Variable overstorey with Flooded gum Paperbark
Significant levels of fine and large woody debris
River pools infilled with sediment
Braided channel
Severe erosion
Occasional patches of Bare twig rush, Knotted club rush, Pale rush
pool
pool
Braided channel
Paperbark with couch understorey
Shrubland and Banksia woodland in excellent condition
Significant African Lovegrass infestation
Riparian vegetation variable - some instances of single row cover, other sections have good cover
Possible former river channels
WANNEROO ROAD
Fencing is well located in this area

9.0 Part Lot 1 and Council land

Lot Nos: Part Lot 1 and Council

Management and rehabilitation considerations:

In-river

- Occasional snags and large woody debris in river.
- Extensive Freshwater Paperbark thickets creating a braided channel.
- Some shallow river pools contain significant levels of phytoplankton blooms that may be toxic to stock.
- Lots of juvenile fish present.
- Significant levels of sediment accumulation in secondary flow channels.
- Middle of the river land titles.
- Evidence that the river is working to change its course.

North Bank

- Extremely high conservation and aesthetic values for some areas of riparian vegetation and *Banksia* woodland with an intact understorey.
- Stocking rates appear to be moderate, with goats grazed periodically.
- Variable extent of tree and groundcovers with blowouts common where no vegetation persists.
- Occasional areas of severe erosion and slumping pose a threat to livestock.
- Some extensive paddocks do not enable management of the floodplain as a sensitive environment. There appears to be all year access down and across riverbanks and within foreshore area.
- Some stock trails eroding and may require action.
- Fences generally use existing vegetation for posts and strainers which is impacting on plant health.
- Fence very close to high water mark in several areas.
- Kangaroos and emus frequently encountered in this area.

South Bank

- Some fences across the floodplain, perpendicular to the river flow or too close to the high water mark are trapping and accumulating debris and resulting in erosion beneath the fence posts.
- Significant levels of African Lovegrass and other weeds suppressing natural regeneration and posing a significant fire hazard
- Clay quarry in the Council property provides an opportunity for an alternative landuse and creation of an environmental attraction.
- Current leasing arrangement managed with a light stocking program to manage the land, however, current management technique appears to be unable to control the spread of African Lovegrass.
- Modifications to the existing fencing alignment and additional may improve some areas of this property.

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RECOMMENDATIONS

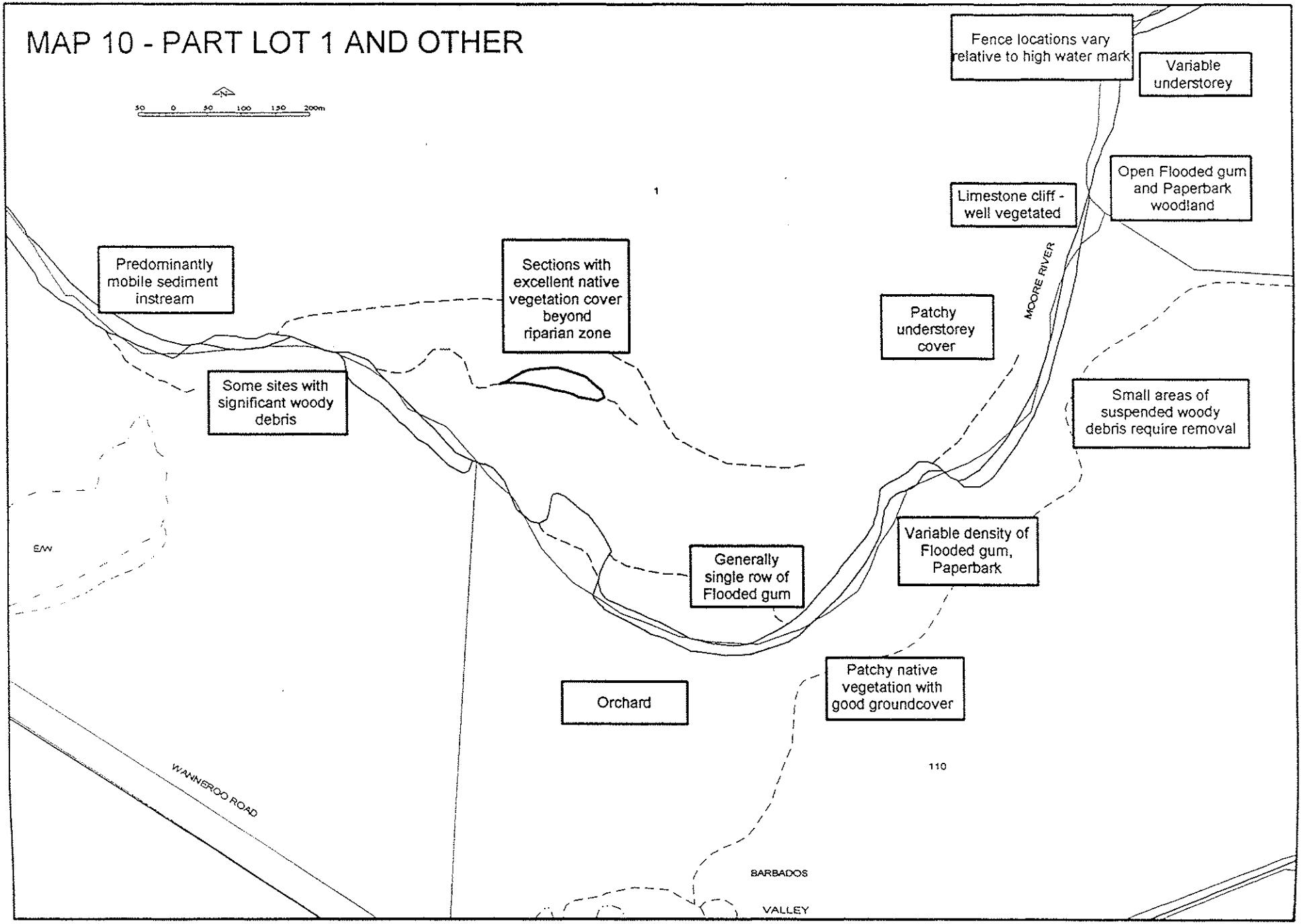
Issue	Comments and management advice
Accretion	Monitor the sediment plume as it nears the Big Pools to determine whether or not the system will be able to self-scour.
Weeds	Target weed control on highly invasive species such as Geraldton Carnation Weed, African Lovegrass, Deadly Nightshade and Apple of Sodom. African Lovegrass requires significant effort, as the fire risk posed by this species is extremely high. A fire could cost the community in terms of lost fences and infrastructure.
Revegetation	Implement a direct seeding program in riparian zone in areas protected by fencing to establish seedlings.
Fencing	Fence off secondary river channels to protect vegetation in areas where new sediment plumes and scours occurred following the 1999 floods.
	Maintain existing fencing but realign away from the bank to continue to limit stock contact with the foreshore area on the northern bank.
	Fence off significant bushland areas to protect the land values and aesthetic appeal.
	Discontinue the current practice of using living trees as fence posts, and commence replacing fence posts.
Other management issues	Investigate long-term ecotourism opportunities for use of the land, which could be based around upgrading the clay pits to create a bird sanctuary.
	Investigate mechanisms to protect the existing closed and open *Banksia* woodland areas for the long term.
	Liaise with the landholder to determine whether it would be possible to collect seed and cuttings from the woodlands in the property.

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Plate 22: Some sections of the river have many off-line wetlands within the floodplain that are only filled during peak flows. The level of vegetation cover varies depending on land management practices.



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MAP 10 - PART LOT 1 AND OTHER
50 0 50 100 150 200m
Fence locations vary relative to high water mark
Variable understorey
Open Flooded gum and Paperbark woodland
Limestone cliff - well vegetated
MOORE RIVER
Predominantly mobile sediment instream
Sections with excellent native vegetation cover beyond riparian zone
Patchy understorey cover
Some sites with significant woody debris
Small areas of suspended woody debris require removal
E/W
Generally single row of Flooded gum
Variable density of Flooded gum, Paperbark
Orchard
Patchy native vegetation with good groundcover
WANNEROO ROAD
110
BARBADOS
VALLEY

10.0 Part Lot 1 and other
Lot Nos: Part Lot 1 and other

Management and rehabilitation considerations:

In-river

- Occasional snags and large woody debris in river.
- Freshwater Paperbark thickets creating a braided channel.
- Large numbers of fingerlings moving throughout the area.
- Large sediment plumes within the river and beyond high water mark.
- Anecdotal evidence indicates that there used to be river pools that are now in-filled.
- Middle of the river land titles.

North Bank

- High conservation and aesthetic values for riparian vegetation and some significant *Banksia* woodlands.
- Variable diversity and integrity of native understorey species with greater natural regeneration then seen in many bushland areas.
- Some significant numbers of stock accessing riverbanks and foreshore area.
- Fences aligned very close to river in many places and many sections use established trees for fence posts.
- Some significant patches of remnant vegetation that provide information for people wishing to restore vegetation in similar areas.
- There is evidence of the river starting to work to change direction and the location of the main channel.
- Historic home site offers an opportunity.

South Bank

- Boundary fences crossing the floodplain perpendicular to the river flow, are trapping and accumulating debris and resulting in erosion beneath the fence posts.
- Orchards present within the floodplain.
- The extent of Flooded Gum and Freshwater Paperbarks ranges from a single row to relatively healthy stands up to 15 m wide.
- African Lovegrass, Stinkweed and other weeds are present occasionally.

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RECOMMENDATIONS

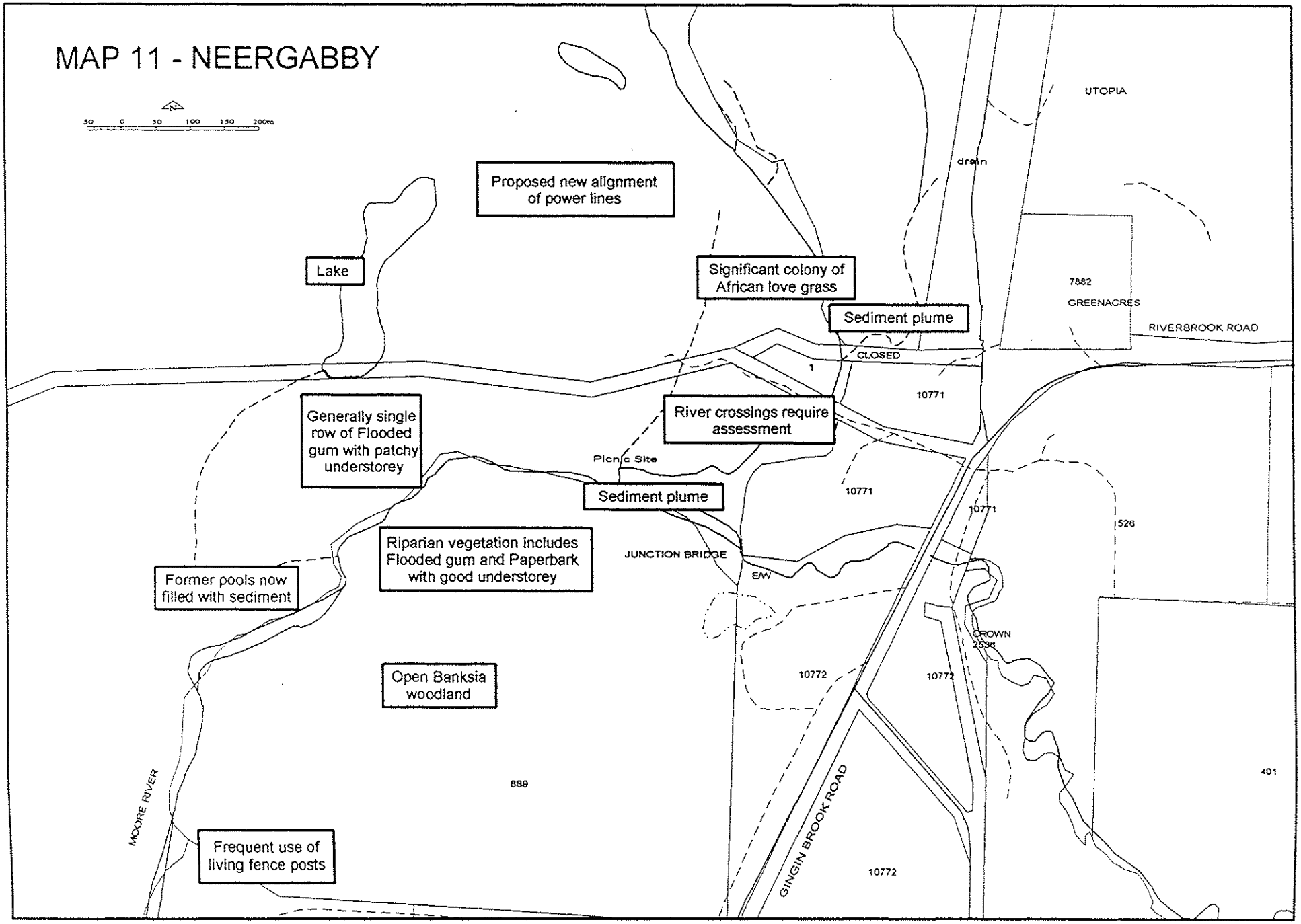
Issue	Comments and management advice
Fencing	Realign fences where they occur within the floodplain to the top of the verge to reduce maintenance required.
	Investigate alternative fencing materials to ensure there is no further use of existing trees for fence posts.
	Consider extending new fencing around significant areas of remnant vegetation and the secondary channels (lakes and damplands).
Stock management	Exclude stock from parts of the foreshore between February and April if possible to enable the rushes and sedges to set seed to help the immediate area and to provide seed for downstream.
Weeds	Develop a strategy to focus on African Lovegrass control to manage its spread and fire risk.
Revegetation	Liaise with landholders to determine the feasibility of additional tree planting or direct seeding where there is no evidence of natural regeneration.
Other management issues	Investigate the potential for other landuses that conserve the high value woodland and wetlands for purposes that ensure their survival in the longer term.

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Plate 23: There are many instances of individual trees being undermined and collapsing into the river. This tends to occur where vegetation cover has been lost. Selective lopping may encourage such trees to re-shoot vertically.



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MAP 11 - NEERGABBY
50 0 50 100 150 200m
Proposed new alignment of power lines
Lake
Significant colony of African love grass
Sediment plume
Generally single row of Flooded gum with patchy understorey
River crossings require assessment
Picnic Site
Sediment plume
Riparian vegetation includes Flooded gum and Paperbark with good understorey
Former pools now filled with sediment
Open Banksia woodland
Frequent use of living fence posts
MOORE RIVER
889
UTOPIA
drain
7882
GREENACRES
RIVERBROOK ROAD
CLOSED
1
10771
10771
10771
526
JUNCTION BRIDGE
EW
CROWN
2536
10772
10772
10772
GINGIN BROOK ROAD
401

11.0 Neergabby - Junction of Gingin Brook and the Moore River

Lot Nos: Part Lot 1, Lot 889 and various

Management and rehabilitation considerations:

In-river

- River pools being filled in.
- Water entering the Moore River from Gingin Brook has greater tannin levels.
- Significant sediment plume where the two waterways meet.
- Significant levels of sediment and fine woody debris accumulating within and between paperbark groves.
- Middle of the river land titles.
- Anecdotal evidence that the junction of the waterways has moved downstream approximately 300 m.

North Bank

- Some fencing set well back from the river, however, supports many other sections are set exactly at the top of the riverbank. Where fencing set well back there is only weed populations.
- Considerable use of mature trees as living fence posts.
- Sections retain only a single row of trees.
- Limited diversity of native understorey species.
- Some sections appear that stock is able to access the river banks and foreshore area.
- A large marl (clay) bank is exposed, but generally stable and supports a different type of vegetation.

South Bank

- Currently no stock on the property.
- Foreshores generally have only trees and Couch with some secondary river channels retaining significant populations of native rushes and sedges.
- Patches of significant snags in river with lots of fine suspended debris that may be suited to minor modifications.
- Opportunities for revegetation works in stable areas to enhance vegetation cover and improve the resilience of the banks.

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RECOMMENDATIONS

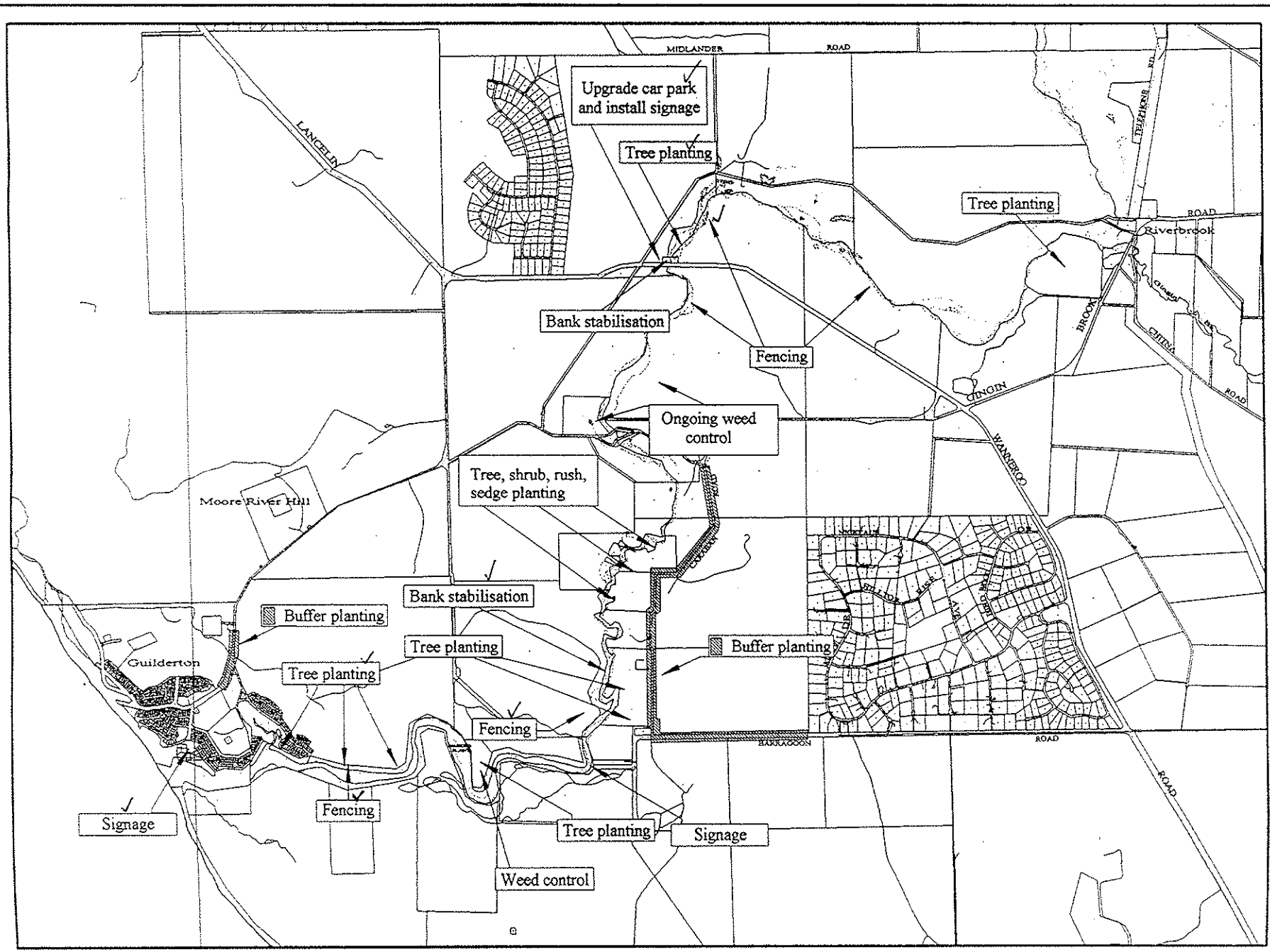
Issue	Comments and management advice
Fencing	Re-align fencing to parallel with river flow and beyond flood levels to reduce maintenance costs, loss of materials and protect foreshore.
Stock management	Provide off-line watering points for stock to reduce the need for stock to drink from river pools during summer.
	Consider modifying stock management program to exclude stock from the floodplain while native plants are seeding.
Revegetation	Commence planting program to assist the overstorey and middlestorey in the riparian zone.
	Plant emergent rushes downstream of areas where snags are deflecting water flows into banks, ensuring that plants are large stock and pegged using 600 mm 'U-shaped' steel pegs.
Weed control	Spray 2 m diameter circles in areas proposed for tubestock planting, marking the sprayed areas with wire pin flag markers that can be readily removed at completion.
	Slash annual grasses around persistent healthy areas of native vegetation in the *Banksia* woodland section, spray and maintain to encourage natural regeneration.
Other issues	Encourage the landholder to discuss the crossover and determine if there are any potential improvements that could be made to reduce sedimentation.

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Plate 24: Single rows of trees are common on this section of the river. The lack of regeneration in these areas, means that as these trees die and fall into the river there will be nothing to hold the banks.



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MAP 12 : PROPOSED REHABILITATION PROJECTS FOR THE LOWER MOORE RIVER

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Making it happen

During the preparation of this action plan, it became apparent that the Lower Moore River is under threat from a number of changes to the environment. These changes are facilitating weed encroachment and the loss of indigenous vegetation, loss of fauna diversity, severe erosion and accretion processes and conflicting recreation and landuse demands. The threat to infrastructure from these changing conditions could cost the region significantly in the event of a natural disaster, particularly fire and flood.

A lot of this degradation pressure arises outside the study area, however, it is important that appropriate management strategies are implemented to help the river ecosystem function with this pressure from the catchment. In many cases, the management issues are the result of earlier management decisions when the function and use of the river were never identified or anticipated. Often only the impacts are recognised. It is important that remedial actions are implemented because they may help prevent or manage problems in the future.

Broadly speaking it is critical to keep in mind that decisions having the potential to transform an area from its natural condition need to be considered carefully, because of the relative inability to reverse such decisions.

Successful implementation of action plans is determined by the willingness of participants to cooperate. Issues in river management are often considered separately and remedial actions used to treat single issues. This approach will not help the Lower Moore River cope with the changing environment. It is important that all works are considered in terms of the changing river environment that recognises that the river is a dynamic system.

Various methods of encouraging informed cooperation can be used involving all levels of government and the community. Community awareness is essential to develop an understanding of the management problems associated with the rationale behind the steps to correct the problems.

Commitments for current funding will ensure implementation of many of the projects proposed in this document. Commitments for funding will need to be documented and agreements signed to enable expenditure of the Natural Heritage Trust funds to ensure that the works occur in the agreed manner.

The role of the Lower Moore River Rehabilitation Working Group is critical to the success of this project. The proposal to delegate responsibility for managing and implementing specific projects will be a key to the success of the works. This group can then maximise the usefulness of the skills and knowledge of members of the group, and achieve tangible outcomes.

Monitoring the success of the project is an essential part of the implementation of this plan, as with all plans. Should monitoring show that the agreed management objectives are not being achieved, then the plan should be re-evaluated and modified where necessary.

This plan is intended to provide a framework and sufficient information to enable all landholders, residents of Guilderton and the region and visitors to gain an improved understanding of the river, its form and its function. The list of potential actions and projects is not exhaustive and should be used as foundations on which to build management of the river in the medium to long term.

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APPENDIX 1

APPENDIX 1:

PLANT SPECIES LIST FOR THE LOWER MOORE RIVER AREA

Family	Species name	Common name	Growth form	Location & soil type	Banksia Low Woodland	Tuart Woodland	Limestone Heath	Riparian zone	Wetland/ Billabongs
GYMNOSPERMAE									
ZAMIACEA	*Macrozamia riedlei*	Zamia	Tree (cycad) 0.5-3 m high, fls. Sep-Oct	Sandy soils	■	■	■		
MONOCOTYLEDONAE									
ANTHERICACEAE	*Corynotheca micrantha*	Sand Lily	Tufted, tangled shrub-like herb 0.1-0.3 m, fls. white-pink-purple, Jun-Dec		■		■	■	
	Corynotheca micrantha var. acanthoclada			Sandy soils on limestone which outcrops	■				
	Corynotheca micrantha var. elongata		Round straggling clumps	Moore River Bridge: deep sand of river bed & banks			■	■	
	Corynotheca micrantha var. micrantha			Coastal heath: limestone Grey/yellow sand			■	■	
	Sowerbaea laxiflora	Purple Tassels	Tufted perennial herb 0.15-0.5 m high, fls. purple, Aug-Nov	Grey/orange-brown sand, loam	■	■			
	Thysanotus patersonii		Twining leafless herb 0.15-0.5 m high, fls. purple, Jun-Nov	Grey/yellow/red sandy, clay		■			
	Thysanotus sparteus		Twining leafless herb 0.2-1 m high, fls. purple, Oct-Feb	Grey/white lateritic sand, occasionally damp	■				
	Tricoryne elatior	Yellow Autumn Lily	Perennial herb 0.1-0.5 m tall, fls. yellow, Jan-Dec	Sand, loamy & lateritic soils, sometimes wet			■	■	■

Family	Species name	Common name	Growth form	Location & soil type	Banksia Low Woodland	Tuart Woodland	Limestone Heath	Riparian zone	Wetland/ Billabongs
COLCHICAEAE	*Burchardia umbellata*	Milkmaids	Perennial herb to 0.7 m tall, fls. white, Aug-Oct	Sand, laterite, sandy clay	■	■			
CYPERACEAE	*Baumea articulata*	Jointed Rush	Rush 1-2.6 m tall with pendulous inflorescences	Waterlogged soils				■	■
	Baumea juncea	Bare Twigrush	Sedge 0.2-1 m tall, fls. Oct-Feb	Waterlogged soils				■	■
	Baumea rubiginosa		Robust sedge to 4 m tall, fls. Aug-Feb	Streams, rivers				■	■
	Bolboschoenus caldwellii	Marsh Club Rush	Rush 0.3-1.2 m tall	Swamps, brackish river edges,				■	■
	Cyperus gymnocaulos	Spiny Flat Sedge	Tufted sedge 0.4-1 m tall, fls. Jul-Feb	Along watercourses, swamps				■	■
	Gahnia trifida	Coast Saw Sedge	Tussocky plant to 1.5 m tall	Swamps, creeks				■	■
	Isolepis cernua	Nodding Club Rush	Annual rush to 0.2 m tall	Swamps, pools, estuary margins			■	■	■
	Isolepis nodosa	Knotted Club Rush	Sedge to 1 m tall, fls. Aug-Mar	Creek and river edges, coastal sand dunes				■	■
	Isolepis setiformis		Sedge to 0.3 m tall, fls. Sept-Dec	Winter wet flats, swamps				■	■
	Lepidosperma costale		Clumped sedge 0.2-0.7 m high				■	■	■
	Lepidosperma effusum	Spreading Sword Sedge	Sedge to 2.5 m tall	Creek & river edges, swamps				■	■
	Lepidosperma gladiatum	Coast Sword Sedge	Clumped sedge to 1 m tall	Calcareous sand			■	■	■

Family	Species name	Common name	Growth form	Location & soil type	Banksia Low Woodland	Tuart Woodland	Limestone Heath	Riparian zone	Wetland/ Billabongs
CYPERACEAE	*Mesomelaena pseudostygia*		Tufted sedge to 1 m tall	White/grey/yellow sand	■	■	■	■	■
	Schoenoplectus validus	Lake Club Rush	Robust rush 0.8-2 m tall	Fresh or brackish waters, estuaries, swamps				■	■
	Schoenus latitans		Forming dense mats sedge to 0.04 m tall	Coastal plain	■	■			
DASYPOGONACEAE	*Acanthocarpus preissii*		Shrub-like tufted herb 0.2-0.7 m tall, fls. white, Apr-May	Sand, limestone, sandstone, coastal dunes		■	■	■	■
	Lomandra hermaphrodita		Tufted perennial to 0.2 m tall, fls. purple & yellow, Apr-Jun	White/grey sand	■				
HAEMODORACEAE	*Anigozanthos humilis*	Catspaw	Herb to 1 m high, fls. yellow-red, Jul-Oct		■		■	■	■
	Anigozanthos manglesii	Mangles Kangaroo Paw	Herb to 1 m tall, fls. green&red, Aug-Nov	Yellow/white sand	■				
	Conostylis aculeata	Prickly Conostylis	Grass-like plant to 0.3 m tall, fls. Aug-Nov	Costal sand	■		■	■	■
	Conostylis candicans	Grey Cottonhead	Grass-like herb to 0.4 m tall, fls. yellow, Jul-Nov	Sand over limestone, N of Guilderton	■		■	■	■
	Haemodorum laxum		Herb 0.6-1.4 m tall, fls. black-brown-green, Oct-Nov	Dry or seasonally damp areas	■	■	■	■	■
	Haemodorum spicatum	Mardja	Herb 0,3-2 m tall, fls. black/yellow-brown, Oct-Jan	Sand, dry & seasonally wet areas	■		■	■	■
IRIDACEAE	*Orthrosanthus laxus*	Morning Iris	Perennial 0.15-0.5 m tall, fls. blue, Aug-Nov		■				
	Patersonia occidentalis	Purple Flag	Clumped herb 0.25-0.7 m tall, fls. blue-purple, Apr-Dec	Seasonally wet areas, dunes	■	■	■	■	■

Family	Species name	Common name	Growth form	Location & soil type	Banksia Low Woodland	Tuart Woodland	Limestone Heath	Riparian zone	Wetland/ Billabongs
JUNCACEAE	*Juncus kraussii*	Sea Rush	Perennial rush to 1 m tall					■	■
	Juncus pallidus	Pale Rush	Robust rush 0.5-2 m tall, fls. Oct-Dec	Swamps, watercourses				■	■
JUNCAGINACEAE	*Triglochin trichophorum*		Tufted herb to 0.15 m tall	Mouth of Moore River				■	■
ORCHIDACEAE	*Caladenia arenicola*	Carousel Spider Orchid	Herb 0.3-0.6 m tall, fls. pink-purple, Aug-Oct		■	■			
	Caladenia flava	Cowslip Orchid	Perennial herb, fls. yellow, Jul-Dec		■	■	■	■	■
	Caladenia georgei	Tuart Spider Orchid	Perennial herb 0.25-0.5 m tall, fls. cream-green & purple, Sep-Oct	Consolidated sand dunes	■	■	■	■	
	Caladenia latifolia	Pink Fairies	Herb 0.2—0.45 m tall, fls. pink, Aug-Oct		■	■	■	■	
	Caladenia longicauda subsp. albella	Small-lipped Spider Orchid	Herb 0.25-0.45 m tall, fls. white-cream, Aug-Oct	Winter wet habitats			■	■	
	Caladenia variegata	Ruby Spider Orchid	Plant 0.15-0.3 m tall, fls. red & white, Aug-Sep	Deep calcareous soils	■	■	■		
	Caladenia sp.	Spider Orchid					■	■	■
	Diuris sp.	Donkey Orchid					■	■	■
	Microtis sp.	Mignonette Orchid					■	■	■
	Leporella fimbriata	Hare Orchid	Perennial herb to 0.2 m tall, fls. green-brown-red				■	■	■
	Prasophyllum sp.	Leek Orchid					■	■	■
	Pterostylis sp.	Greenhoods					■	■	■
	Pyrorchis nigricans (was Burnettia nigricans)	Red Beaks, Elephants' Ears	Perennial herb 0.1-0.3, fls. white & red, Aug-Oct		■				
	Thelymitra sp.	Sun Orchid					■	■	■

Family	Species name	Common name	Growth form	Location & soil type	Banksia Low Woodland	Tuart Woodland	Limestone Heath	Riparian zone	Wetland/ Billabongs
PHORMIACEAE	*Dianella revoluta*	Blueberry Lily	Herb to 1.5 m high, fls. blue-purple, Aug-Jan		■		■	■	■
POACEAE	*Austrodanthonia acerosa*		Perennial grass	N of Guilderton, sandy soils			■	■	■
	Austrostipa flavescens		Tufted perennial grass to 1 m tall		■	■	■	■	■
	Austrostipa elegantissima	Feather Speargrass	Tufted grass to 2 m tall				■	■	■
	Poa drummondiana	Knotted Poa	Tufted grass to 0.8 m tall	Sand dunes, scree slopes, outcrops	■	■	■		
	Sporobolus virginicus	Marine Couch	Grass o.1-0.5 m tall, fls. green-purple	Beach dunes, tidal flats, salt marshes				■	■
RESTIONACEAE	*Alexgeorgea nitens*		Sedge to 0.3 m tall	White/grey/yellow sand	■				
	Hopkinsia anoectocolea Priority 3		Sedge 0.5-1 m tall	Sandy soils, often saline, floodplains, winter wet flats				■	■
	Hypolaena exsulca		Tussocky sedge to 0.75 m tall	Grey/black sand, winter wet depressions				■	■
	Hypolaena pubescens (Meeboldina pubescens)		Perennial sedge 0.2-1 m tall	Winter wet flats, swampy depressions				■	■
	Desmocladus flexuous (Meeboldina flexuosa)		Perennial sedge 0.2-1.5 m tall					■	■
TYPHACEAE	*Typha domingensis*	Cumbungi	Emergent perennial 1.5-3 m tall	Creeks & rivers				■	■
	*Typha orientalis**	Introduced Bulrush	Emergent perennial 2-5 m tall	Creeks & rivers, swampy depressions				■	■
XANTHORRHOEACEAE	*Xanthorrhoea brunonis*		Tree-like monocot to 1.5 m tall, fls. white-cream, Oct-Dec		■	■			

Family	Species name	Common name	Growth form	Location & soil type	Banksia Low Woodland	Tuart Woodland	Limestone Heath	Riparian zone	Wetland/ Billabongs
	Xanthorrhoea preissii	Grass Tree	Tree-like monocot to 5 m tall, fls. white-cream, Jan-Nov	Grey sand, laterite	■	■	■	■	■
DICOTYLEDONAE									
AMARANTHACEAE	*Ptilotus drummondii*	Narrowleaf Mulla Mulla or Pussytail	Perennial herb to 0.8 m tall, fls. white-cream to pink, Aug-Dec	Often gravelly sandy soils			■		
	Ptilotus manglesii	Pom Poms	Prostrate herb to 0.3 m tall, fls. pink, Sep-Dec	Sandy gravelly soils			■		
	Ptilotus polystachyus	Prince of Wales Feather	Herb 0.15-1.5 m tall, fls. green/white/yellow, May-Jan			■	■	■	■
APIACEAE	*Homalosciadium homalocarpum*		Annual herb to 0.1 m tall, fls. green/white, Aug-Dec	Often winter wet depressions	■				
	Hydrocotyle hispidula		Herb to 0.2 m tall, fls. white	Mouth of Moore River Sand dunes, limestone ridges			■	■	■
	Trachymene pilosa	Native Parsnip	Annual herb to 0.3 m tall, fls. white, Aug-Nov	Sandy soils	■	■	■	■	■
	Xanthosia pusilla	Southern Cross	Perennial herb to 0.2 m tall, fls. yellow-cream	Collection south of Perth	■	■			
ASTERACEAE	*Calocephalus brownii*				■	■	■	■	
	Lagenophora hugely (was Lagenifera huegelii)		Rosetted herb to 0.3 m tall, fls. white/pink-purple, Jul-Dec	Frequently moist areas	■	■	■	■	
	Millotia tenuifolia	Soft Millotia	Annual herb to 0.1 m tall, fls. yellow-cream, Sep-Oct		■		■	■	
	Olearia axillaris	Coastal Daisybush	Dense shrub to 3 m tall, fls, white-cream, Jan-Jul	Coastal sand			■		

Family	Species name	Common name	Growth form	Location & soil type	Banksia Low Woodland	Tuart Woodland	Limestone Heath	Riparian zone	Wetland/ Billabongs
	Podolepis canescens	Grey Podolepis	Annual herb 0.06-0.7 m high, fls. yellow, Aug-Dec				■	■	
ASTERACEAE	*Podotheca angustifolium*	Sticky Longheads	Viscid annual herb 0.03-0.3 m tall, fls. yellow, Aug-Dec		■	■	■	■	
	Senecio lautus	Variable Groundsel	Annual or perennial herb 0.1-1 m tall, fls. yellow				■	■	
	Senecio lautus subsp. maritimus	Coastal Groundsel	Annual or perennial herb 0.1-1 m tall, fls. yellow	Coastal limestone & dunes			■	■	
	Siloxerus humifusus	Procumbent Siloxerus	Decumbent to erect annual herb, fls. white-cream, Sep-Dec	Moist areas	■				
	Rhodanthe citrina (was Waitzia citrina)		Annual herb to 0.3 m tall, fls. yellow, Aug-Dec		■				
	Waitzia suaveolens	Fragrant Waitzia	Annual herb to 0.6 m tall, fls. white-pink/yellow, Sep-Jan		■	■	■	■	■
AIZOACEAE	*Carpobrotus virescens*	Coastal Pigface	Succulent, prostate herb, flower pink or white, Jun-Dec	N Guilderton, dune, sand over limestone			■	■	■
CAMPANULACEAE	*Wahlenbergia preissii*		Slender annual herb to 0.4 m tall, fls. blue/white/pink, Sep-Nov		■		■	■	■
CASU	*Allocasuarina fraseriana*	Sheoak	Tree 0.5-15 m tall		■	■	■	■	■
	Allocasuarina humilis	Dwarf Sheoak	Shrub to 2 m tall	Sandplains, sand dunes			■	■	■

Family	Species name	Common name	Growth form	Location & soil type	Banksia Low Woodland	Tuart Woodland	Limestone Heath	Riparian zone	Wetland/ Billabongs
	Allocasuarina lehmanniana subsp. lehmanniana	Dune Sheoak	Shrub 1-4 m tall	Coastal dunes, winter-wet depressions			■	■	■
CHENOPODIACEAE	*Rhagodia baccata*	Berry Saltbush	Spreading shrub to 2 m tall, fls. cream-yellow	White/grey sand, coastal limestone & granite		■	■	■	■
	Threlkeldia diffusa	Coast Bonefruit	Prostate plant to 0.4 m tall, fls. green	Coastal areas, saline flats			■	■	■
CRASSULACEAE	*Crassula colorata*	Dense Stonecrop	Annual herb to 0.15 m tall		■		■	■	■
DASYPOGONACEAE	*Acanthocarpus preissii*		Shrub-like herb to 0.7 m tall, fls white, May	Guilderton, sand			■	■	■
	Lomandra maritima		Plant to 0.6 m tall, fls. yellow-purple, Aug-Nov	Calcareous soils			■	■	■
DILLENIACEAE	*Hibbertia huegelii*		Shrub 0.1-0.6 m high fls. yellow	Sandy or lateritic gravelly soils	■				
	Hibbertia hypericoides	Yellow Buttercups	Spreading twiggy shrub to 1 m tall, fls. yellow, Apr-Dec		■		■	■	■
	Hibbertia racemosa	Stalked Guinea Flower	Spreading shrub 0.1-0.75 m tall, fls. yellow	Coastal areas	■		■	■	■
DROSERACEAE	*Drosera erythrorhiza*	Red Ink Sundew	Flat rosetted herb to 0.12 m tall, fls. white, Apr-Jun		■				
	Drosera sp.				■				
EP	*Leucopogon polymorphus*		Shrub to 1 m tall, fls. white, Jun-Oct	Sandy soils over limestone or laterite		■			
	Leucopogon capitellatus		Shrub, to 1 m tall, fls. white	Grey sand	■				

Family	Species name	Common name	Growth form	Location & soil type	Banksia Low Woodland	Tuart Woodland	Limestone Heath	Riparian zone	Wetland/ Billabongs
	Leucopogon racemulosus		Rigid shrub to 1.5 m tall, fls. white, Feb-Jul	Sandy soils	■				
EUPHORBIACEAE	*Euphorbia* sp.				■		■	■	■
	Phyllanthus calycinus	False Boronia	Shrub 0.2-1.2 m tall, fls. white-cream, Jun-Dec		■		■	■	■
GOODENIACEAE	*Lechenaultia linarioides*	Yellow Leschenaultia	Tangled shrub 0.15-1.5 m tall, fls. yellow & red, Jun-Dec	Coastal limestone hills & sandplains			■	■	■
	Scaevola canescens	Grey Scaevola	Prostrate shrub to 0.5 m tall, fls. white-purple, Mar-Oct	Sand over limestone			■	■	■
	Scaevola crassifolia	Thick-leaved Fan-flower	Shrub to 1.5 m tall, fls. blue-white, Jul-Feb	Coastal dunes & limestone			■	■	■
	Verreauxia reinwardtii	Common Verreauxia	Shrub 0.5-2 m tall, fls. yellow, Jul-Feb	Sandy soils	■				
GYROSTEMONAC	*Tersonia cyathiflora*	Button Creeper	Prostrate annual herb to 0.5x1.5 m, fls. yellow-brown/brown-red, Jun-Dec	Sand, coastal limestone ridges, sandplains			■	■	■
LAMIACEAE	*Hemiandra pungens*	Snakebush	Prostrate shrub, fls. pink-white,	Limestone, sand			■	■	■
	Westringia dampieri		Dense shrub to 1.5 m tall, fls. white-purple, Jun-Jan	Coastal areas			■	■	■
LAURACEAE	*Cassytha glabella*		Climbing parasite, fls. white	Found on Melaleuca or Casuarina			■	■	■
	Cassytha melantha	Large Dodder-laurel	Climbing parasite	Found mostly on Eucalyptus			■	■	■

Family	Species name	Common name	Growth form	Location & soil type	Banksia Low Woodland	Tuart Woodland	Limestone Heath	Riparian zone	Wetland/ Billabongs
LOBELIACEAE	*Lobelia tenuior*	Slender Lobelia	Slender annual 0.15-0.5 m tall, fls. blue, Oct-Dec	Coastal limestone, sand dunes, low-lying areas			■	■	■
LORANTHACEAE	*Nuytsia floribunda*	Christmas Tree	Tree to 8 m tall, root parasite, fls. yellow-orange, Oct-Jan	sand		■	■	■	■
MALVACEA	*Alyogyne huegelii*	Lilac Hibiscus	Shrub 1-3 m tall, fls. pale blue-purple, Aug-Dec	Costal limestone and sand dunes			■	■	
MIMOSACEAE	*Acacia cochlearis*	Rigid Wattle	Pungent shrub to 3 m tall, fls. yellow, Jul-Oct	Coastal sandplains & sand dunes	■				
	Acacia cyclops	Coastal Wattle	Dense shrub to 4 m tall, fls. yellow, Sep-Jan	Coastal sand dunes & limestone	■	■			
	Acacia lasiocarpa var. lasiocarpa		Pungent shrub to 1.5 m tall, fls. yellow, Jun-Oct	White sand over limestone, dune			■	■	■
	Acacia rostellifera	Summer-scented Wattle	Dense shrub or tree to 6 m tall, fls. yellow	Consolidated sand dunes, Guilderton			■	■	■
	Acacia pulchella	Prickly mosses	Spinescent shrub, fls. yellow				■	■	■
	Acacia saligna	Orange Wattle	Dense, often weeping shrub/tree to 6 m tall, fls. yellow, Jul-Nov				■	■	■
	Acacia xanthina	White-stemmed Wattle	Shrub or tree to 4 m tall, fls. yellow, Aug-Oct	1km NE of Guilderton, grey sand	■		■	■	■
MYOPORACEAE	*Eremophila glabra*	Tar Bush	Low shrub, fls. orange-red	Yellow sand over limestone, near lighthouse Guilderton			■	■	■

Family	Species name	Common name	Growth form	Location & soil type	Banksia Low Woodland	Tuart Woodland	Limestone Heath	Riparian zone	Wetland/ Billabongs
MYRTACEAE	*Agonis flexuosa*	Peppermint	Tree or shrub to 1- m tall, fls. white, Sep-Dec	Mostly limestone soils			■	■	
	Beaufortia squarrosa	Sand Bottlebrush	Shrub to 2 m high, fls. red-orange, Jan-May	Sandplains, winter-wet depressions	■				
	Calothamnus quadrifidus	One-sided Bottlebrush	Shrub 0.9-2 m tall, fls. red, Jun-Dec				■	■	■
	Calothamnus rupestris	Mouse Ears	Shrub 1-4 m tall, fls. pink-red, Jul-Dec	Skeletal soils	■	■			
	Calytrix angulata	Yellow Starflower	Shrub 0.2-1 m tall, fls. yellow, Aug-Jan	Sand	■	■			
	Calytrix flavescens	Summer Starflower	Shrub 0.3-0.8 m tall, fls. yellow, all year	Sandplains, sometimes swampy areas			■	■	■
	Calytrix fraseri	Pink Summer Calytrix	Shrub to 1 m tall, fls. pink, Nov-Aug	Sandplains, coastal dunes	■				
	Chamelaucium uncinatum	Geraldton Wax	Shrub to 4 m tall, fls. white-pink, Jul-Nov	Sand over limestone			■	■	■
	Corymbia calophylla	Marri	Tree 3-40 m tall, bark rough, fls. white, Dec-May		■	■			
	Eremaea pauciflora		Spreading shrub 0.3-2 m tall, fls. orange, Jul-Jan	Sand	■				
	Eucalyptus decipiens	Redheart	Mallee to 15 m tall, fls. white, Aug-Jan		■	■			
	Eucalyptus gomphocephala	Tuart	Tree to 40 m tall, fls. white, Jan-Apr	Sand over limestone		■			
	Eucalyptus rudis	Flooded Gum	Tree to 20 m tall, bark rough box-type, fls. white, Jul-Sep						

Family	Species name	Common name	Growth form	Location & soil type	Banksia Low Woodland	Tuart Woodland	Limestone Heath	Riparian zone	Wetland/ Billabongs
MYRTACEAE	*Eucalyptus todtiana*	Coastal Blackbutt	Mallee to 8 m tall, fibrous bark, fls. white-cream, Jan-Apr	Coastal sandplains	■				
	Kunzea ericifolia	Spearwood	Shrub 1-4 m tall, fls. yellow/cream-white	South distribution	■		■	■	■
	Leptospermum spinescens		Spinescent shrub 0.3-1.5 m tall, fls. white-cream, Sep-Dec		■				
	Melaleuca cardiophylla	Tangling Melaleuca	Spreading shrub 0.4-2 m tall, fls. white-cream, Aug-Jan	Limestone ridge, sand dunes					
	Melaleuca huegelii	Chenille Honeymyrtle	Shrub or tree, fls. pink-white, Oct-Jan	Limestone cliffs & coastal plains	■		■	■	■
	Melaleuca rhaphiophylla	Swamp Paperbark	Tree or shrub to 10 m tall, fls. white-cream, Jul-Dec	Along watercourses			■	■	■
	Melaleuca systena (was Melaleuca acerosa)	Coastal Honeymyrtle	Shrub ca 0.6 m, fls. pale yellow	Yellow sand, coastal plain			■	■	■
	Melaleuca scabra	Rough Honeymyrtle	Shrub 0.2-1.5 m tall, fls. pink-red		■				
	Melaleuca thymoides		Shrub to 2 m tall, fls. cream-yellow, Sep-Jan	Winter wet depressions, sand dunes			■	■	
	Melaleuca viminea	Mohan	Shrub or tree to 5 m tall, fls. white-cream, Jul-Nov	Along watercourses			■	■	■
	Verticordia densiflora	Compact Featherflower	Shrub 0.3-2 m tall, fls. pink-white/purple, Oct-Feb	Often on low lying flats	■		■	■	

Family	Species name	Common name	Growth form	Location & soil type	Banksia Low Woodland	Tuart Woodland	Limestone Heath	Riparian zone	Wetland/ Billabongs
PAPILIONACEAE	*Bossiaea eriocarpa*	Common Brown Pea	Straggly spreading shrub to 1 m tall, fls. yellow & brown, Jul-Nov	Sandy soils	■				
	Daviesia decurrens	Prickly Bitter Pea	Shrub to 1 m tall, fls. orange & red, Jun-Sep		■				
	Daviesia divaricata	Marno	Spiny shrub to 2 m tall, fls. orange & red, Jun-Nov	Sandplains, 1km NE of Guilderton	■		■	■	■
	Gompholobium tomentosum	Hairy Yellow Pea	Shrub 0.3-1 m tall, fls. yellow, Jun-Jan	Coastal limestone & sand dunes	■		■	■	■
	Hardenbergia comptoniana	Native Wisteria	Climber, fls. blue-purple, Jul-Oct	Coastal limestone, sandplains		■	■	■	■
	Jacksonia calcicola ms		Prostrate or erect shrub, fls. yellow-oranges	Limestone soils			■	■	■
	Jacksonia fasciculata (was Jacksonia stricta)		Spiny shrub 0.3-2 m tall, fls. yellow-orange, Sep-Jan	Sand, salt flats	■		■	■	
	Jacksonia furcellata	Grey Stinkwood	Prostrate or weeping erect shrub 0.4-4 m tall, fls. yellow-orange-red, Oct-Mar	Swampy depressions, riverbanks	■		■	■	
	Jacksonia sternbergiana	Stinkwood	Weeping shrub 1.5-5 m tall, fls. yellow-orange, all year	Along creeks, near swamps, dunes	■				
	Jacksonia sp.						■	■	■
	Nemcia reticulata		Spreading shrub to 1 m tall, fls. yellow-brown, May-Nov	Yellow sand over limestone, Lighthouse Guilderton			■	■	■
	Kennedia prostrata	Scarlet Runner	Prostrate shrub, fls. red, Apr-Nov	Sandy soils	■	■	■	■	■
	Sphaerolobium medium		Leafless shrub to 0.6 m tall, fls. yellow/red, Aug-Dec		■				
	Templetonia retusa	Cockies Tongues	Shrub to 2 m tall, fls, red Apr-Nov	Coastal sand dunes		■	■	■	■

Family	Species name	Common name	Growth form	Location & soil type	Banksia Low Woodland	Tuart Woodland	Limestone Heath	Riparian zone	Wetland/ Billabongs
PITTOSPORACEA	*Marianthus erubescens* (was Billardiera erubescens)		Climber, fls. red, Aug-Dec	Collected from Guilderton			■		
POLYGALACEAE	*Comesperma calymega*	Blue-spike Milkwort	Herb to 0.5 m tall, fls. blue, Aug-Jan	Flats, rocky outcrops, dunes	■				
PORTULACAEAE	*Calandrinia liniflora*	Parakeelya	Succulent decumbent annual herb, fls. pink, Sep-Jan	Coastal dunes & plains	■	■	■	■	■
PROTEACEAE	*Banksia attenuata*	Slender Banksia	Tree to 10 m, fls. yellow, Oct-Feb		■	■	■	■	
	Banksia grandis	Bull Banksia	Tree to 10 m tall, fls. pale yellow, Sep-Jan		■				
	Banksia ilicifolia	Holly-leaved Banksia	Tree or shrub 0.7-10 m tall, fls. Cream-pink-yellow or red, Mar-Jan	Sandy soils, consolidated dunes or low lying flats	■		■	■	
	Banksia menziesii	Firewood Banksia	Tree/shrub to 7 m tall, fls. pink-red-yellow, Feb-Oct		■				
	Banksia prionotes	Acorn Banksia	Tree/shrub to 8 m tall, fls. orange-yellow, Jan-Aug	Sandplains, sand dunes	■	■			
	Conospermum canaliculatum		Shrub to 2 m tall, fls. white, Jul-Nov	sand			■	■	
	Conospermum stoechadis	Common Smokebush	Shrub to 2.5 m tall, fls. white-grey, Jul-Dec				■	■	■

Family	Species name	Common name	Growth form	Location & soil type	Banksia Low Woodland	Tuart Woodland	Limestone Heath	Riparian zone	Wetland/ Billabongs
PROTEACEAE	*Dryandra lindleyana*		Prostrate shrub to 0.3 m high, fls. Jun-Sep	Sand over limestone or laterite		■	■	■	■
	Dryandra nivea subsp. *nivea*	Couch Honeypot	Prostrate shrub, fls. cream-yellow-brown, Jul-Nov	Sandy soils			■	■	
	Dryandra sessilis	Parrot Bush	Shrub/tree 0.5-5 m tall, fls. cream-yellow, Apr-Nov	Grey sand			■	■	
	Grevillea crithmifolia		Shrub to 2 m tall, fls. white-pink, Aug-Nov	Grey sand, limestone soils	■				
	Grevillea pressii		Shrub, fls. red	Yellow sand, Lighthouse Guilderton			■	■	■
	Grevillea thelemanniana	Spider Net Grevillea	Spreading shrub 0.3-1.5 m tall, fls. pink-red, May-Nov	Winter wet low lying flats			■	■	■
	Hakea candolleana		Spreading shrub to 1.5 m high, fls. white-cream, Jun-Sep			■			
	Hakea costata	Ribbed Hakea	Shrub to 2 m high, fls. white-cream, Aug-Oct	White, yellow or red sand	■				
	Hakea lissocarpha	Honey Bush	Pungent shrub 0.4-1.5 m tall, fls. white-yellow or pink, Jun-Oct		■	■	■	■	■
	Hakea prostrata	Harsh Hakea	Erect or prostrate shrub 0.3-4 m high, fls. white-cream, Aug-Oct			■	■	■	■
	Hakea ruscifolia	Candle Hakea	Shrub to 43 m tall, fls. white, Jan-Apr		■				
	Hakea trifurcata	Two-leaf Hakea	Open shrub to 4 m tall and 3.5 m across, fls. white-cream, May-Oct	Sand over limestone or laterite	■		■	■	■
	Persoonia comata		Shrub to 1.5 m tall, fls. yellow, Nov-Feb	Sandy soils			■	■	

Family	Species name	Common name	Growth form	Location & soil type	Banksia Low Woodland	Tuart Woodland	Limestone Heath	Riparian zone	Wetland/ Billabongs
PROTEACEAE	*Petrophile brevifolia*		Erect shrub 0.2-1 m tall, fls. yellow-cream, May-Dec			■			
	Petrophile linearis	Pixie Mops	Shrub 0.2-1 m tall, fls. pink-grey, Aug-Dec		■	■			
	Petrophile macrostachya		Prickly shrub 0.3-1.2 m tall, fls. cream-yellow, Jun-Nov		■		■	■	■
	Petrophile media		Shrub 0.1-0.5 m tall, fls. cream, Aug-Dec		■				
	Petrophile serruriae		Prickly shrub 0.265-1.5 m tall, fls. yellow, Jul-Dec				■	■	■
	Stirlingia latifolia	Blueboy	Shrub 0.2-1.5 m tall, fls. yellow-brown, Aug-Oct		■				
	Synaphea spinulosa		Shrub to 1 m tall, fls. yellow	Sandy soils			■	■	■
RANUNCULACEAE	*Clematis linearifolia* (was Clematis microphylla)		Climber, fls. white-cram, Jul-Oct	Coastal limestone & sand dunes		■			
RHAMNACEAE	*Spyridium globulosum*	Basket Bush	Shrub 0.6-6 m tall, fls. white, Jun-Nov	Coastal sand dunes, limestone	■		■	■	
RUBIACEAE	*Opercularia spermacocea*		Plant to 0.4 m tall, fls. green-white, Jul-N0v	Coastal cliffs, sand dunes			■	■	■

Family	Species name	Common name	Growth form	Location & soil type	Banksia Low Woodland	Tuart Woodland	Limestone Heath	Riparian zone	Wetland/ Billabongs
RUTACEAE	*Diplolaena angustifolia*	Yanchep Rose	Shrub to 1.5 m tall, fls. red-orange, Jun-Oct	Sand dune, rocky ridges yellow sand, mouth of Moore R			■	■	■
SANTALACEAE	*Exocarpos sparteus*	Broom Ballart	Shrub, fls. yellow	dunes			■	■	■
SOLANACEAE	*Anthocercis ilicifolia*		Shrub to 3 m tall, fls. yellow, Apr-Nov	Limestone soils	■		■	■	■
STACKHOUSIACEAE	*Stackhousia monogyna* (was Stackhousia huegelii)		Perennial herb to 0.7 m tall, fls. white-cream, Jun-Dec		■		■	■	■
	Tripterococcus brunonis	Winged Stackhousia	Perennial herb to 0.8 m tall, fls. yellow-green, Jul-Mar		■				
STYLIDIACEAE	*Levenhookia stipitata*	Common Stylewort	Annual herb to 0.1 m tall, fls. pink, Aug-Jan		■				
	Stylidium brunonianum	Pink Fountain Trigger Plant	Rosetted herb 0.2-0.5 m tall, fls. pink-purple, Sep-Nov		■	■			
	Stylidium calcaratum	Book Triggerplant	rosetted annual herb to 0.2 m tall, fls. white/pink		■	■			
	Stylidium repens	Matted Triggerplant	Perennial herb to 0.1 m tall, fls. white-pink		■				
	Stylidium schoenoides	Cow Kicks	Perennial herb to 0.4 m tall, fls. white-cream, Aug-Oct		■				

Family	Species name	Common name	Growth form	Location & soil type	Banksia Low Woodland	Tuart Woodland	Limestone Heath	Riparian zone	Wetland/ Billabongs
THYMELEACEAE	*Pimelea ferruginea*		Dense shrub 0.3-1.5 m tall, fls. pink, Aug-Feb	Coastal sand dunes, rocky headlands	■		■		
	Pimelea sulphurea	Yellow Banjine	Spindly shrub to 0.7 m tall, fls. yellow, Jul-Nov		■				
VIOLACEAE	*Hybanthus calycinus*	Wild Violet	Straggly herb 0.1-0.6 m tall, fls. blue-purple, Jun-Nov	Red sand, bank of Moore River (10m E of Guilderton)	■	■			

The information is based on number of sources:]

1. Vegetation surveys:
   - Nicole Siemon (November-December 1999 surveys)
2. Literature
   - Griffin, E.A. (1994);
   - Griffin & Keighery (1989);

APPENDIX 2

APPENDIX 2: WEEDS OF THE LOWER MOORE RIVER

The information is based on number of sources:

1) Vegetation surveys:

- Nicole Siemon (November-December 1999 surveys)
- Weeds Control Priority based on Draft Environmental Weed Strategy for WA (CALM) 1999

Family	Scientific name	Common name	Control priority
MONOCOTYLEDONS			
AGAVACEAE	*Agave americana*	Century Plant	
AMARYLLIDACEAE	*Agapanthus sp.*		
ASPARAGACEAE	*Asparagus asparagoides*	Bridal Creeper	HIGH
CYPERACEAE	*Carex divisa*	Divided Sedge	MODERATE
HYACINTHACEAE	*Ornithogalum arabicum*	Arab's Eye	LOW
IRIDACEAE	*Watsonia bulbillifera*	Watsonia	HIGH
POACEAE	*Ammophila arenaria*	Marram Grass	
	Avena spp.	Wild Oats	MODERATE
	Briza maxima	Blowfly grass	MODERATE
	Bromus diandrus	Great Brome	HIGH
	Eragrostis curvula	African Lovegrass	HIGH
	Lolium spp.	Rye grass	MODERATE
	Pennisetum clandestinum	Kikuyu	MODERATE
	Stenotaphrum secundatum	Buffalo Grass	MODERATE
TYPHACEAE	*Typha orientalis*	Bulrush	HIGH
DICOTYLEDONS			
AIZOACEAE	*Tetragonia decumbens*	Sea Spinach	MODERATE
ANACARDIACEAE	*Schinus terebinthifolia*	Japanese Pepper	MODERATE
ASTERACEAE	*Arctotheca calendula*	Cape Weed	MODERATE
	Carduus tenuiflorus	Sheep Thistle	
	Carduus sp.	Thistle	MODERATE
	Gazania linearis	Gazania	
	Lactuca serriola	Prickly Lettuce	MODERATE
	Soliva pterosperma	Bindii	LOW
	Taraxacum officinale	Dandelions	LOW
BRASSICACEAE	*Raphanus raphinustrum*	Wild Radish	LOW
	Rorippa nasturtium-aquaticum	Watercress	MODERATE
	Rorippa palustris	Marsh Watercress	
CACTACEAE	*Opuntia* sp.	Cacti	
CUCURBITACEAE	*Citrullus lanatus*	Afghan melon, Wild melon	LOW
GERANIACEAE	*Pelargonium capitatum*	Rose pelargonium	HIGH
MORACEAE	*Ficus carica*	Common Fig	MODERATE
		Moreton Bay Fig (?)	
ONAGRACEAE	*Oenothera drummondii*	Beach Evening Primrose	
OXALIDACEAE	*Oxalis pes-caprae*	Soursob	MILD
PAPILIONACEAE	*Lupinus angustifolius*	Narrowleaf Lupin	MILD
	Medicago spp.	Medics	MILD
	Trifolium arvense	Hare's Foot Clover	MODERATE
PLANTAGINACEAE	*Plantago lanceolata*	Ribwort Plantain	LOW
	Schinus terebinthifolia	Japanese Pepper	

Family	Scientific name	Common name	Control priority
POLYGONACEAE	*Rumex spp*	Dock	HIGH
	Rumex vesicarius	Ruby Dock, Rosy Dock	LOW
PRIMULACEAE	*Anagallis arvensis*	Pimpernel	MODERATE
TROPAEOLACEAE	*Tropaeolum majus*	Nasturtium	LOW

APPENDIX 3

APPENDIX 3: SUGGESTED WEED CONTROL METHOD

Some of the information contained in this report has been taken from Dixon and Keighery (1995) in Managing Perth's Bushlands or referenced to Kings Park Board.

		Control Priority	Location	Habit	Form
Species Name:	**Aloe spp; Agave spp**	2	Dryland ☑ Riparian ☑ Aquatic ☐	Bulb/Corm ☐ Perennial ☑ Annual ☐	Tree ☐ Shrub ☑ Herb ☐ Rush/Sedge ☐ Grass ☐ Climber ☐
Common Name:	Cactus				
Seed Form:	Sterile or non seed producing				
Seeding Time:					
Method of Spread:	Spreads from suckers				
Best Time of Control:	All year				
Method of Control:	Remove all living plant material. Monitor for regrowth and remove as it emerges. Glyphosphate may be useful to aid in control.				

		Control Priority	Location	Habit	Form
Species Name:	**Arctotheca calendula**	3	Dryland ☑ Riparian ☐ Aquatic ☐	Bulb/Corm ☐ Perennial ☐ Annual ☑	Tree ☐ Shrub ☐ Herb ☑ Rush/Sedge ☐ Grass ☐ Climber ☐
Common Name:	Capeweed				
Seed Form:	Coarse seed				
Seeding Time:					
Method of Spread:	Spreads mostly from seed				
Best Time of Control:	Oct - Feb				
Method of Control:	Hand weeding small populations of this plant is effective. Rotary hoeing broadscale infestations repeatedly can also work. Kings Park Board recommends glyphosate at 100ml in 15l water. Lontrel 1 in 100 has been successful on larger plants in areas without any native vegetation.				

		Control Priority	Location	Habit	Form
Species Name:	**Asparagus asparagoides**	1	Dryland ☑ Riparian ☑ Aquatic ☐	Bulb/Corm ☑ Perennial ☑ Annual ☐	Tree ☐ Shrub ☐ Herb ☐ Rush/Sedge ☐ Grass ☐ Climber ☑
Common Name:	Bridal Creeper				
Seed Form:	Light seed				
Seeding Time:	Oct - Dec				
Method of Spread:	Spreads from both seed and vegetative growth				
Best Time of Control:	Jul - Sept				
Method of Control:	Remove young plants by hand as they appear. If spraying, remove the bulk of the plant material prior to spraying then treat the smaller biomass of plants approximately a fortnight later. Kings Park currently recommends using either Glyphosate 360 at a rate of 1 in 100, or 2.5 to 5g per ha in 250l of water. Repeat applications will be required for either chemical. Kings Park may have more up to date control measures. It is essential to take extreme care when treating this plant as it generally occurs within close proximity of native plants, and casuing the unintentional death of non-target plants is possible.				

Control priority 1 - Major environmental weed, urgent control required
Control priority 2 - Nuisance weed, control as soon as possible
Control priority 3 - Minor weed, control as resources become available

		Control Priority	Location		Habit		Form	
Species Name:	***Avena spp.***							
Common Name:	Wild Oats	2	*Dryland*	☑	*Bulb/Corm*	☐	*Tree*	☐
Seed Form:	Light, easily spread by wind		*Riparian*	☐	*Perennial*	☑	*Shrub*	☐
Seeding Time:	March - June		*Aquatic*	☐	*Annual*	☑	*Herb*	☐
Method of Spread:	Spreads mostly from seed						*Rush/Sedge*	☐
Best Time of Control:	Aug - Oct						*Grass*	☑
Method of Control:	Hand weeding small plants in winter is effective for small populations. Blanket/Spot spraying at 2l Fusillade per ha is effective. Brushcutting plants with immature seed heads will aid control in the longer term by minimizing seed spread. Dense populations represent a significant fire hazard and threat to remnant vegetation, so repeated brushcutting also assists in reduction of fire hazard.						*Climber*	☐

		Control Priority	Location		Habit		Form	
Species Name:	***Briza maxima***							
Common Name:	Blowfly grass	2	*Dryland*	☑	*Bulb/Corm*	☐	*Tree*	☐
Seed Form:	Light, easily spread by wind		*Riparian*	☐	*Perennial*	☐	*Shrub*	☐
Seeding Time:	Sept - Nov		*Aquatic*	☐	*Annual*	☑	*Herb*	☐
Method of Spread:	Spreads mostly from seed						*Rush/Sedge*	☐
Best Time of Control:	June - Aug						*Grass*	☑
Method of Control:	Hand weeding is effective. Control may be achieved by spot/blanket spraying Sertin or similar at 2l per ha.						*Climber*	☐

		Control Priority	Location		Habit		Form	
Species Name:	***Bromus diandrus***							
Common Name:	Great brome	2	*Dryland*	☑	*Bulb/Corm*	☐	*Tree*	☐
Seed Form:	Coarse seed		*Riparian*	☐	*Perennial*	☐	*Shrub*	☐
Seeding Time:	Sept - Nov		*Aquatic*	☐	*Annual*	☑	*Herb*	☐
Method of Spread:	Spreads mostly from seed						*Rush/Sedge*	☐
Best Time of Control:	June - Aug						*Grass*	☑
Method of Control:	Hand weeding is easy and effective for small populations. The most frequently recommended treatment is Fusillade at between 2-4l per ha, when the plants are actively growing in winter. Repeated brushcutting can also be effective. Note: Correct identification of grasses is important to protect native grasses from removal. The presence of native grasses should be investigated prior to spraying herbicides.						*Climber*	☐

		Control Priority	Location		Habit		Form	
Species Name:	***Carduus spp***							
Common Name:	Thistles	2	*Dryland*	☑	*Bulb/Corm*	☐	*Tree*	☐
Seed Form:	Light, easily spread by wind		*Riparian*	☐	*Perennial*	☐	*Shrub*	☐
Seeding Time:	April - July		*Aquatic*	☐	*Annual*	☑	*Herb*	☑
Method of Spread:	Spreads mostly from seed						*Rush/Sedge*	☐
Best Time of Control:	Spring / summer						*Grass*	☐
Method of Control:	Hand weeding is very effective for this group of plants. Vigilance to ensure removal prior to seeding is essential. Some people have adverse reactions to the sap that results from handling these plants. Care should be taken to minimise contact with bare skin and eyes. The prickles at the base of the plants can also prove difficult to remove from your hands so wear golves.						*Climber*	☐

Control priority 1 - Major environmental weed, urgent control required
Control priority 2 - Nuisance weed, control as soon as possible
Control priority 3 - Minor weed, control as resources become available

		Control Priority	Location		Habit		Form	
Species Name:	**Carthamus spp**							
Common Name:	Thistles	2	*Dryland*	☑	*Bulb/Corm*	☐	*Tree*	☐
			Riparian	☐	*Perennial*	☐	*Shrub*	☐
Seed Form:	Light, easily spread by wind		*Aquatic*	☐	*Annual*	☑	*Herb*	☑
Seeding Time:	April - July						*Rush/Sedge*	☐
							Grass	☐
Method of Spread:	Spreads mostly from seed						*Climber*	☐
Best Time of Control:	Spring / summer							
Method of Control:	Hand weeding is effective for this group of plants. Vigilance to ensure removal prior to seeding is essential. Some people have adverse reactions to the sap and prickles of these plants. Care should be taken to minimise contact with bare skin and eyes.							

		Control Priority	Location		Habit		Form	
Species Name:	**Centaurea spp**							
Common Name:	Thistles	2	*Dryland*	☑	*Bulb/Corm*	☐	*Tree*	☐
			Riparian	☐	*Perennial*	☐	*Shrub*	☐
Seed Form:	Light, easily spread by wind		*Aquatic*	☐	*Annual*	☑	*Herb*	☑
Seeding Time:	April - July						*Rush/Sedge*	☐
							Grass	☐
Method of Spread:	Spreads mostly from seed						*Climber*	☐
Best Time of Control:	Srping / summer							
Method of Control:	Hand weeding is effective for this group of plants. Vigilance is required to ensure removal prior to seeding. Some people have adverse reactions to the sap and prickles of these plants. Care should be taken to minimise contact with bare skin and eyes.							

		Control Priority	Location		Habit		Form	
Species Name:	**Conyza spp**							
Common Name:	Fleabane	3	*Dryland*	☑	*Bulb/Corm*	☐	*Tree*	☐
			Riparian	☐	*Perennial*	☐	*Shrub*	☐
Seed Form:	Light, easily spread by wind		*Aquatic*	☐	*Annual*	☑	*Herb*	☑
Seeding Time:	April - Dec and July - Feb						*Rush/Sedge*	☐
							Grass	☐
Method of Spread:	Spreads mostly from seed						*Climber*	☐
Best Time of Control:	Oct - Mar							
Method of Control:	Hand weeding is effective prior to seeding. Needs to be ongoing. Ensure any seed heads present are bagged prior to removal if hand weeding has not occurred prior to this time. Common on roadsides and disturbed areas as a primary coloniser. This species is tolerant of salt, wind and is adaptable to variable soil types and therefore represents a long term problem. It is easy to control and a difference can easily be seen when controlled in bushland communities.							

Control priority 1 - Major environmental weed, urgent control required
Control priority 2 - Nuisance weed, control as soon as possible
Control priority 3 - Minor weed, control as resources become available

		Control Priority	Location		Habit		Form	
Species Name:	**Cynodon dactylon**	1	Dryland	☑	Bulb/Corm	☐	Tree	☐
Common Name:	Couch		Riparian	☑	Perennial	☑	Shrub	☐
Seed Form:	Light seed		Aquatic	☐	Annual	☐	Herb	☐
Seeding Time:	May, April						Rush/Sedge	☐
							Grass	☑
Method of Spread:	Spreads readily from rhizome growth						Climber	☐
Best Time of Control:	Oct - Feb and April - May							
Method of Control:	Hand weeding is very difficult, labour intensive and rarely effective. The most effective method is to spot/blanket spray in late spring - autumn using Fusillade or Targa at 4l per ha. Brushcutting and raking off bulk of plant material prior to treatment often improves ease of removal and spraying. Do not spray over winter as this plant does not actively grow at this time. Flauzifop-butyl can be used on couch occurring amongst native rushes and sedges as they are tolerant of this chemical. Ensure that the population requiring treatment is not Sporobolus virginicus, the native salt water couch.							

		Control Priority	Location		Habit		Form	
Species Name:	**Eragrostis curvula**	1	Dryland	☑	Bulb/Corm	☐	Tree	☐
Common Name:	African love grass		Riparian	☐	Perennial	☑	Shrub	☐
Seed Form:	Light, easily spread by wind		Aquatic	☐	Annual	☐	Herb	☐
Seeding Time:	June - Nov						Rush/Sedge	☐
							Grass	☑
Method of Spread:	Spreads mostly from seed						Climber	☐
Best Time of Control:	Nov - March							
Method of Control:	Hand weed small infestations prior to mulching. Kings Park have found complete foliar spraying after fire or in summer months using Glyphosate 1l in 100l water and wetter e.g. Agral 60, X77 to be effective. Repeated brushcutting can be effective combined with herbicide treatment of regrowth. This minimises herbicide required by a reducing the amount of leaf material. This plant represents a significant fire hazard and therefore a major threat to native vegetation. Do not set fire to on purpose but take advantage of easier access should any wildfire occur over summer.							

		Control Priority	Location		Habit		Form	
Species Name:	**Lolium spp.**	2	Dryland	☑	Bulb/Corm	☐	Tree	☐
Common Name:	Rye grass		Riparian	☐	Perennial	☑	Shrub	☐
Seed Form:	Light, easily spread by wind		Aquatic	☐	Annual	☑	Herb	☐
Seeding Time:	March - June						Rush/Sedge	☐
							Grass	☑
Method of Spread:	Spreads mostly from seed						Climber	☐
Best Time of Control:	Dec - Mar							
Method of Control:	Handweeding is preferred, except for extensive populations. Spot spraying of Sertin, Targa or similar at 4l per ha prior to flowering can be effective. In areas where steep banks are present and this species is dominant removing the seed heads to limit spread is preferred to complete removal, in order to ensure that bank stability is protected.							

Control priority 1 - Major environmental weed, urgent control required
Control priority 2 - Nuisance weed, control as soon as possible
Control priority 3 - Minor weed, control as resources become available

Species Name:	***Lupinus angustifolia***	*Control Priority*	*Location*		*Habit*		*Form*	
Common Name:	Lupin	2	*Dryland*	☑	*Bulb/Corm*	☐	*Tree*	☐
Seed Form:	Heavy seed		*Riparian*	☐	*Perennial*	☐	*Shrub*	☐
Seeding Time:	Oct - Dec		*Aquatic*	☐	*Annual*	☑	*Herb*	☑
Method of Spread:	Seed						*Rush/Sedge*	☐
Best Time of Control:	Aug - Oct						*Grass*	☐
Method of Control:	Handweed small populations. Alternatively, spray the plants selectively with Glyphosate 2% solution.						*Climber*	☐

Species Name:	***Medicago spp***	*Control Priority*	*Location*		*Habit*		*Form*	
Common Name:	Medics	3	*Dryland*	☑	*Bulb/Corm*	☐	*Tree*	☐
Seed Form:	Light seed		*Riparian*	☐	*Perennial*	☐	*Shrub*	☐
Seeding Time:			*Aquatic*	☐	*Annual*	☑	*Herb*	☑
Method of Spread:	Spreads mostly from seed						*Rush/Sedge*	☐
Best Time of Control:	June - Sept						*Grass*	☐
Method of Control:	This plant may be controlled effectively with Glyphosate. Kings Park Board recommends a rate of 75-100ml in 15l of water.						*Climber*	☐

Species Name:	***Oxalis pes-caprae***	*Control Priority*	*Location*		*Habit*		*Form*	
Common Name:	Soursob	2	*Dryland*	☑	*Bulb/Corm*	☑	*Tree*	☐
Seed Form:	Light seed		*Riparian*	☑	*Perennial*	☐	*Shrub*	☐
Seeding Time:	Sept		*Aquatic*	☐	*Annual*	☑	*Herb*	☐
Method of Spread:	Spreads by bulb or corm growth						*Rush/Sedge*	☐
Best Time of Control:	June - Sept						*Grass*	☑
Method of Control:	Hand weeding can be effective provided that care is taken to trace all runners from the parent plant and that no stem and root is left behind. Apply Glyphosate 75ml in 10l in winter						*Climber*	☐

Species Name:	***Pelargonium capitatum***	*Control Priority*	*Location*		*Habit*		*Form*	
Common Name:	Rose pelargonium	1	*Dryland*	☑	*Bulb/Corm*	☐	*Tree*	☐
Seed Form:	Light, easily spread by wind		*Riparian*	☐	*Perennial*	☑	*Shrub*	☐
Seeding Time:	Jan - April		*Aquatic*	☐	*Annual*	☐	*Herb*	☑
Method of Spread:	Spreads from both seed and vegetative growth						*Rush/Sedge*	☐
Best Time of Control:	Spring						*Grass*	☐
Method of Control:	Hand weed in autumn / winter, trying very hard not leave any stem or root behind as the plants will reshoot. Kings Park suggests the two herbicide treatments listed. Spot Spray with Ally/Brush 5g per ha or spray with Glyphosate 1 in 100 with wetting agent in early September. This plant is an effective coloniser and it may smother any small native plants present.						*Climber*	☐

Control priority 1 - Major environmental weed, urgent control required
Control priority 2 - Nuisance weed, control as soon as possible
Control priority 3 - Minor weed, control as resources become available

Species Name:	***Pennisetum clandestinum***	***Control Priority***	***Location***		***Habit***		***Form***	
Common Name:	Kikuyu	1	*Dryland*	☑	*Bulb/Corm*	☐	*Tree*	☐
			Riparian	☑	*Perennial*	☑	*Shrub*	☐
Seed Form:	Sterile or non seed producing		*Aquatic*	☐	*Annual*	☐	*Herb*	☐
							Rush/Sedge	☐
Seeding Time:							*Grass*	☑
Method of Spread:	Spreads readily from rhizome growth						*Climber*	☐
Best Time of Control:	Sept - Dec							
Method of Control:	The most effective technique recognised is the application of Fusillade at a rate of 4l per ha while the plant is actively growing. Fusillade should not be applied over open water. Native rushes and sedges are not at risk when using this chemical.							

Species Name:	***Plantago lanceolata***	***Control Priority***	***Location***		***Habit***		***Form***	
Common Name:	Ribwort plantain	3	*Dryland*	☑	*Bulb/Corm*	☐	*Tree*	☐
			Riparian	☐	*Perennial*	☑	*Shrub*	☐
Seed Form:	Coarse seed		*Aquatic*	☐	*Annual*	☐	*Herb*	☑
							Rush/Sedge	☐
Seeding Time:							*Grass*	☐
Method of Spread:	Spreads mostly from seed						*Climber*	☐
Best Time of Control:	Nov - Dec							
Method of Control:	Pull Ribwort by hand ensuring that tap root is properly removed. Generally populations of this weed are limited and can be be managed effectively using manual weed control methods. Kings Park Board recommends wiping with Glyphosate 100ml in 15l water.							

Species Name:	***Raphanus raphanistrum***	***Control Priority***	***Location***		***Habit***		***Form***	
Common Name:	Wild radish	3	*Dryland*	☑	*Bulb/Corm*	☐	*Tree*	☐
			Riparian	☑	*Perennial*	☑	*Shrub*	☐
Seed Form:	Light seed		*Aquatic*	☐	*Annual*	☐	*Herb*	☑
							Rush/Sedge	☐
Seeding Time:	Dec						*Grass*	☐
Method of Spread:	Spreads mostly from seed						*Climber*	☐
Best Time of Control:	Sept - Nov							
Method of Control:	Removing these species by hand is easy and can be done very quickly. Removal should occur prior to the plants flowering and seeding to reduce the rate of spread. Bagging and cutting the seeding stems, from any plants, should be undertaken prior to removal. The alternative is to paint with Glyphosate 1 in 10.								

Species Name:	***Rumex spp***	***Control Priority***	***Location***		***Habit***		***Form***	
Common Name:	Dock	2	*Dryland*	☑	*Bulb/Corm*	☐	*Tree*	☐
			Riparian	☐	*Perennial*	☑	*Shrub*	☐
Seed Form:	Light and easily spread by wind		*Aquatic*	☐	*Annual*	☐	*Herb*	☑
							Rush/Sedge	☐
Seeding Time:	March - June						*Grass*	☐
Method of Spread:	Spreads mostly from seed						*Climber*	☐
Best Time of Control:	Nov - Mar							
Method of Control:	These plants are readily eradicated through hand weeding. Remove flowering heads prior to seed ripening if complete plant removal is not possible. Always bag plants with seeds and dispose of carefully.								

Control priority 1 - Major environmental weed, urgent control required
Control priority 2 - Nuisance weed, control as soon as possible
Control priority 3 - Minor weed, control as resources become available

		Control Priority	Location		Habit		Form	
Species Name:	***Schinus terebinthifolia***							
Common Name:	Japanese pepper	1	*Dryland*	☑	*Bulb/Corm*	☐	*Tree*	☑
Seed Form:	Coarse seed		*Riparian*	☐	*Perennial*	☑	*Shrub*	☐
Seeding Time:	Sept		*Aquatic*	☐	*Annual*	☐	*Herb*	☐
							Rush/Sedge	☐
							Grass	☐
Method of Spread:	Spreads from suckers and seed						*Climber*	☐
Best Time of Control:	All year, but in wetlands treat in summer							
Method of Control:	Hand weed small seedlings. It is important to monitor for any new germinants to enable rapid removal from the site. Treating the large plants can be undertaken either by cutting the trunk and immediately painting the stump, or alternatively injecting systemic herbicide at 10 - 15 cm intervals around the trunk. Kings Park recommends either Glyphosate, Velpar or Garlon. The seed is spread predominantly by introduced birds and there is some anecdotal evidence that many native birds are poisoned by the seeds.							

		Control Priority	Location		Habit		Form	
Species Name:	***Stenotaphrum secundatum***							
Common Name:	Buffalo grass	1	*Dryland*	☑	*Bulb/Corm*	☐	*Tree*	☐
Seed Form:	Sterile or non seed producing		*Riparian*	☑	*Perennial*	☑	*Shrub*	☐
Seeding Time:			*Aquatic*	☐	*Annual*	☐	*Herb*	☐
							Rush/Sedge	☐
							Grass	☑
Method of Spread:	Spreads readily from rhizome growth						*Climber*	☐
Best Time of Control:	Aug - Sept							
Method of Control:	Hand weeding is very difficult, labour intensive and rarely successful. The most effective method is to implement a minimum of two spot/blanket treatments in Aug-Oct and April-May using Fusillade or Targa at 4l per ha. Brushcutting often improves ease of removal and spraying. This process typically requires more than two treatments. Can implement spraying amongst native rushes and sedges which have been demonstrated to tolerate flauzifop-butyl.							

		Control Priority	Location		Habit		Form	
Species Name:	***Taraxacum officinale***							
Common Name:	Dandelion	2	*Dryland*	☑	*Bulb/Corm*	☐	*Tree*	☐
Seed Form:	Light, easily spread by wind		*Riparian*	☐	*Perennial*	☑	*Shrub*	☐
Seeding Time:	All year round		*Aquatic*	☐	*Annual*	☐	*Herb*	☑
							Rush/Sedge	☐
							Grass	☐
Method of Spread:	Spreads mostly from seed						*Climber*	☐
Best Time of Control:	Sept - Nov							
Method of Control:	Hand weeding is the most effective means of control ensuring that if seed heads are present , they are carefully bagged prior to removal of the plant. Wiping with Glyphosate is also effective.							

Control priority 1 - Major environmental weed, urgent control required
Control priority 2 - Nuisance weed, control as soon as possible
Control priority 3 - Minor weed, control as resources become available

Species Name:	***Trifolium spp.***	*Control Priority*	*Location*		*Habit*		*Form*		
Common Name:	Clovers	3	*Dryland*	☑	*Bulb/Corm*	☐	*Tree*	☐	
Seed Form:	Heavy seed		*Riparian*	☑	*Perennial*	☐	*Shrub*	☐	
Seeding Time:			*Aquatic*	☐	*Annual*	☑	*Herb*	☑	
Method of Spread:	Spreads mostly from seed						*Rush/Sedge*	☐	
Best Time of Control:							*Grass*	☐	
Method of Control:	Hand weed small populations. Spraying populations with Glyphosate at 75 - 100 ml in 15l of water is recommended by Kings Park Board. Repeated rotary hoeing with follow up spraying can be effective in pasture situations.						*Climber*	☐	

Species Name:	***Tropaeolum majus***	*Control Priority*	*Location*		*Habit*		*Form*		
Common Name:	Nasturtium	3	*Dryland*	☑	*Bulb/Corm*	☐	*Tree*	☐	
Seed Form:	Heavy seed		*Riparian*	☑	*Perennial*	☐	*Shrub*	☐	
Seeding Time:	Nov - Jan		*Aquatic*	☐	*Annual*	☑	*Herb*	☐	
Method of Spread:	Spreads mostly from seed						*Rush/Sedge*	☐	
Best Time of Control:	Aug / Sept						*Grass*	☐	
Method of Control:	Removing this species by hand is effective. Selectively applying Glyphosate 1 in 100 can be effective. Awareness campaigns about the implications of dumping garden waste in reserves need to be upgraded and implemented intensively to discourage such activities.						*Climber*	☑	

Species Name:	***Typha orientalis***	*Control Priority*	*Location*		*Habit*		*Form*		
Common Name:	Bulrush	1	*Dryland*	☐	*Bulb/Corm*	☐	*Tree*	☐	
Seed Form:	Light, easily spread by wind		*Riparian*	☑	*Perennial*	☑	*Shrub*	☐	
Seeding Time:			*Aquatic*	☐	*Annual*	☐	*Herb*	☐	
Method of Spread:	Spreads readily from rhizome growth and seed						*Rush/Sedge*	☑	
Best Time of Control:	Winter						*Grass*	☐	
Method of Control:	Remove seed heads prior to ripening in September - December. Cut stems below water level in May, if sufficient water is present, monitor regrowth and continue to cut until September to drown the plants. For populations occurring in waterlogged areas only use Glyphosate BioActive 1 to 10 in spring, after slashing plants first and wipe new growth when plants are 1m tall. Take care when using herbicide over water. The native cumbungi, Typha domingensis, looks similar to Bulrush and it is important to ensure that the population being controlled is in fact the weed species.						*Climber*	☐	

Control priority 1 - Major environmental weed, urgent control required
Control priority 2 - Nuisance weed, control as soon as possible
Control priority 3 - Minor weed, control as resources become available

		Control Priority	Location		Habit		Form	
Species Name:	***Watsonia bulbillifera***		*Dryland*	☑	*Bulb/Corm*	☑	*Tree*	☐
Common Name:	Watsonia	1	*Riparian*	☑	*Perennial*	☐	*Shrub*	☐
Seed Form:	Light and easily spread by wind and wat		*Aquatic*	☐	*Annual*	☑	*Herb*	☑
Seeding Time:	March - May						*Rush/Sedge*	☐
							Grass	☐
Method of Spread:	Spreads by bulb/corm growth						*Climber*	☐

Best Time of Control:

Method of Control:

Remove corms by carefully digging a large area around each plant, putting the sand onto flywire, sieving and collecting all the corms. Flowers should also be harvested to prevent the production of seed and subsequent spread. The collected corms should be disposed of carefully.

Broadscale removal of dense stands may threaten bank stability. Remove in nodes along the waterway.
Selectively spray a combination of herbicides between July to August using Glean and Ally/Brushoff and subsequently painting leaf with Glyphosate in September to November can be effective. Remove the bulk of dead biomass leaving the rhizome mats in tact.

Control priority 1 - Major environmental weed, urgent control required
Control priority 2 - Nuisance weed, control as soon as possible
Control priority 3 - Minor weed, control as resources become available

APPENDIX 4

APPENDIX 4: THE FISH OF THE MOORE RIVER ESTUARY

Numerical ranking and their percentage contributions to the total catch of the fish species caught in the mouth and lower, middle and upper regions in the Moore River Estuary between February 1994-February 1995 (Modified from Young *et al* 1997)

NO or <0.01% species caught	0.01 1%	1-10%	10-40%	More then 40%

Scientific name	Common name	Life cycle	Total catch (%)	Percentage contribution of the number of each species in each region to the total number of that species in the whole estuary			
				Mouth	Lower	Middle	Upper
Leptatherina wallacei		Estuarine	74.8				
Pseudogobius olorum		Estuarine	8.8				
Acanthopagrus butcheri	Black Bream	Estuarine	5.4				
Aldrichetta forsteri	Yelloweye Mullet	Marine estuarine opportunist	2.3				
Amniataba caudavittata	Yellowtail Trumpeter	Estuarine	2.3				
Favonigobius lateralis	Long-finned Goby	Estuarine	2.1				
Mugil cephalus	Sea Mullet	Marine estuarine opportunist	1.4				
Afurcagobius suppositus		Estuarine	1.4				
Sillago schomburgkii	Yellow-finned Whiting	Marine estuarine opportunist	0.8				

Scientific name	Common name	Life cycle	Total catch (%)	Percentage contribution of the number of each species in each region to the total number of that species in the whole estuary			
Sillago (maculata) burrus	Trumpeter Whiting	Marine estuarine opportunist	0.3				
Sillago vittata	Western School Whiting	Marine straggler	0.3				
Pelates sexlineatus	Striped Trumpeter	Marine estuarine opportunist	<0.1				
Spratelloides robustus	Blue Sprat	Marine estuarine opportunist	<0.1				
Gambusia affnis	Mosquito Fish	Freshwater	<0.1				
Gerres subfasciatus	Roach	Marine estuarine opportunist	<0.1				
Hyperlophus vittatus	Sandy Sprat	Marine estuarine opportunist	<0.1				
Nematoalosa vlaminghi	Perth Herring	Semi-anadromous	<0.1				
Carrassius auratus		Freshwater	<0.1				
Rhabdosargus sarba	Tarwhine	Marine estuarine opportunist	<0.1				
Amoya bifrenatus		Estuarine	<0.1				
Pomatomus saltatrix	Tailor	Marine estuarine opportunist	<0.1				

Scientific name	Common name	Life cycle	Total catch (%)	Percentage contribution of the number of each species in each region to the total number of that species in the whole estuary			
Atherinomorus ogilbyi	Ogilby's Hardyhead	Marine estuarine opportunist	<0.1				
Sillaginodes punctatus	King George Whiting	Marine estuarine opportunist	<0.1				
Pseudorhombus jenynsii	Small-toothed Flounder	Marine estuarine opportunist	<0.1				
Leptatherina presbyteroides		Estuarine	<0.1				
Engraulis australis	Southern Anchovy	Estuarine	<0.1				
Contusus brevicaudus	Prickly Pufferfish	Marine straggler	<0.1				

FRESHWATER FISH LIST

Scientific name	Common name	Life cycle	Recorded in the area	Likely to occur	Recorded form Lower Moore River	Confluence with Gingin Brook
Tandanus bostocki	Freshwater Catfish	Endemic Freshwater				
Gambusia affnis	Mosquito Fish	Introduced Freshwater				
Carrassius auratus		Freshwater				
Galaxias occidentalis	Western Minnow	Endemic Freshwater				

Scientific name	Common name	Life cycle	Total catch (%)	Percentage contribution of the number of each species in each region to the total number of that species in the whole estuary		
Galaxiella nigrostriata	Black-stripe Minnow	Endemic Freshwater		?		
Galaxiella munda	Mud Minnow	Endemic Freshwater		?		
Bostockia porosa	Nightfish	Endemic Freshwater				
Edelia vitatta	Western Pygmy Perch	Endemic Freshwater				
Lepidogalaxias salamnandroides	Salamanderfish	Freshwater				
Nannatherina balstoni	Balston's Pygmy Perch	Freshwater		?		
Carassius auratus		Freshwater Introduced				
Gambusia hobrooki		Freshwater Introduced				
Geotria australis	Pouched Lamprey	Migrate into river at spawing				

(Based on: The Fish and Frog Fauna of the Gingin Region & Faunal Studies of the Northern Swan Coastal Plain (1978))

APPENDIX 5

APPENDIX 5: THE AMPHIBIANS AND REPTILES OF THE NORTHERN SWAN COASTAL PLAIN

The area investigated is bounded in the north by the Moore River, in the south by the Swan and Helena Rivers, in the east by the Darling Scarp, in the west by the Indian Ocean. It is based on the collections of the Western Australian Museum, the literature and observations.
The coastal plain can be divided into three longitudinal zones: the eastern, central and western.
The eastern consists largely of the valleys and floodplains of the Helena, Swan and Moore Rivers, Ellen and Gingin Brooks, Red Gully Creek, and several small streams flowing out of the Darling Range. As the soils consist mainly of fertile loams and clays, much of the zone has been cleared for pastoral and horticultural purposes. However, the Flooded Gum (*Eucalyptus rudis*) and paperbarks (*Melaleuca* sp.) that fringed the watercourses, swamps and lakes of the zone have to a large extent survived development.
The central zone comprises the deep white sands of the Bassendean System. They were originally covered with heath vegetation with tall shrubs (especially *Banksia* sp.) and low trees. Much of the zone has been cleared for Perth and its suburbs, pine plantations, and small farms (especially around the numerous freshwater lakes and seasonal swamps).
The western zone in underlain by aeolian limestone, which outcrops here and there in cliffs along the coast and lower Swan River and on ridges in the Wanneroo – Yanchep districts. The inland, sheltered parts of this zone support an open forest of Tuart (Eucalyptus gomphocephala). Towards the sea the vegetation becomes heath-like. Most of the coast is backed by sand dunes

Group	Scientific name	Common name	Seen in the area	Likely to occur in the area	Distribution	Relative abundance	Habitat
LEPTODACTYLIDAE Ground Frogs	*Crinia georgiana*	Quacking Frog			Eastern zone, south of Gingin		Coastal plain & forest where there is ample of shallow water in winter
	Heleioporus barycragus	Western Marsh Frog			Eastern zone, north of Bullsbrook		
	Heleioporus eyrei	Moaning Frog			Eastern zone	Common	In or near sandy winter swamps
	Heleioporus psammophilus	Sand Frog			Confined to eastern zone		
	Limnodynastes dorsalis	Bullfrog or Banjo Frog			All zones	Common	In or near freshwater swamps & lakes
	Myobatrachus gouldii	Turtle Frog			Sandy parts of central & western zones	Common	Usually found below ground in termite-infested wood
	Neobatrachus pelobatoides	Humming Frog			Confined to eastern zone	Common	
	Pseudophryne guentheri	Gunther's Toadlet			Eastern & central zone	Common	Beneath ground cover such as rock, timber & dead leaves

Group	Scientific name	Common name	Seen in the area	Likely to occur in the area	Distribution	Relative abundance	Habitat
LEPTODACTYLIDAE Ground Frogs	*Ranidella insignifera*	Squelching Froglet			Eastern & central zones	Common to moderately common	Temporary swamps
	Ranidella pseudinsignifera	Beating Froglet			Confined to foot of Darling Scarp		
HYLIDAE Tree Frogs	*Litoria adelaidensis*	Slender Tree Frog			All zones		Vicinity of permanent fresh water in dense vegetation
	Litoria moorei	Bell Frog, Motorbike Frog			All zones	Very common	Vicinity of permanent fresh water
CHELUIDAE Side-necked Turtles	*Chelodina oblonga*	Oblong Turtle	Guilderton (1)			common	In permanent fresh water, also seasonal swamps
	Pseudemydura umbrina	Western Swamp Turtle			Confined to Ellen Brook	rare	Confined to seasonal swamps along Ellen Brook
GEKKONIDAE Geckos	*Crenadactylus ocellatus*	Clawless Gecko			Confined to Tuart belt of western & eastern zone	Scarce	Shelter in large clumps of Triodia
	Diplodactylus alboguttatus				Eastern zone	Scarce	
	Diplodactylus polyophthalmus				Confined to Tuart belt of western zone	Scarce	Under debris, logs & rocks
	Diplodactylus spinigerus	Western Spiny-Tailed Gecko	5km E of Guilderton (1)		Western zone	common	Coastal dune & limestone country, in heath & open woodland
	Phyllodactylus marmoratus	No data (current?)			Western & central zones	common	
	Phyllurus milii	Current?			Western zone	Scarce	Confined to limestone caves, cliffs & outcrops

Group	Scientific name	Common name	Seen in the area	Likely to occur in the area	Distribution	Relative abundance	Habitat
PYGOPODIDAE Legless Lizards	*Aclys concinna*				Western zone		Coastal heat & woodland, on a sandy substrate
	Aprasia pulchella			?	Eastern & central zone	Scarce	Under granitic & lateritic stones
	Aprasia repens				All zones	Common	Sandy country
	Delma fraseri					Scarce	Usually found under rocks, logs or ground debris
	Delma grayii			?	Western & eastern zones,	Scarce	
	Lialis burtonis	Burton's Snake-Lizard			All zones	Very common	Variety of habitats
	Pletholax gracilis			?	Uncommon in coastal dunes of western zone, scare elsewhere		
	Pygopus lepidopodus	Common Scaly-Foot				scarce	Apparently favouring vicinity of water
AGAMIDAE	*Tympanocryptis (Amphibolurus) adelaidensis*					common	Sandy country with low vegetation, coastal heath, Banksia scrub
	Pogona Amphibolurus minor	Dwarf Bearded Dragon			Western zone	Moderately common	Semi-arboreal species
SCINCIDAE Skinks	*Cryptoblepharus plagiocephalus*		Guilderton (1)		All zones	common	Open forests & woodlands, usually feeding on vertical surfaces
	Ctenotus fallens					Moderately common	Avoids deep white sands, coastal dunes & heaths, low shrublands

Group	Scientific name	Common name	Seen in the area	Likely to occur in the area	Distribution	Relative abundance	Habitat
SCINCIDAE Skinks	*Ctenotus gemmula*			?	Confined to southern quarter o central zone	Uncommon	White sandplains with low vegetation
	Ctenotus impar			?		Scarce	Coastal heathlands, Mallee & Low Eucalyptus Woodland
	Ctenotus lesueurii			?		Moderately commons	Deep white sand (coastal dunes & inland sandplains
	Egernia kingii	King's Skink				Uncommon	Favouring coastal cliffs & vicinity of swamps & watercourses
	Egernia luctuosa			?		Apparently absent from country north of Perth	Swamp vegetation
	Egernia napoleonis					Uncommon	Found in stumps or under bark of trees and shrubs, including blackboys (Xanthorrhoea)
	Hemiergis quadrilineatum					Very common	Coastal dunes & inland sandplains (seldom found in summer)
	Pseudemoia (Leiolopisma) trilineata		Gingin Brook East			Moderately common	Damp places
	Lerista elegans				Western & central zones	Moderately common	Heath, low shrubland
	Lerista lineopunctulata		Guilderton		Western zone	Common	Coastal dunes & inland sandplains
	Lerista praepedita		Guilderton		Western & central zones	Very common	Sandy country

Group	Scientific name	Common name	Seen in the area	Likely to occur in the area	Distribution	Relative abundance	Habitat
SCINCIDAE Skinks	*Menetia greyii*				Tuart belt of western zone	Rare near the coast	
	Morethia lineoocellata				Western & central zones	Uncommon	
	Morethia obscura				Western & central zone	Uncommon	Favouring damper situations
	Cyclodomorphus branchialis				Confined to western zone	Uncommon	Coastal limestone & dunes
	Tiliqua occipitalis	Western Blue-Tongued Lizard				Uncommon	
	Trachydosaurus (Tiliqua) rugosus	Shingle-Back				Common	Cleared country
VARANIDAE Goannas	*Varanus gouldii*	Gould's Goanna or Sand Monitor				Scarce	
	Varanus rosenbergi			?	Know only from Mussel Pool		
	Varanus tristis			&	Western & eastern zone	Scarce	Rocky hills & outcrops
TYPHLOPIDAE Blind Snakes	*Ramphotyphlops (Typhlina) australis*		10km S of Guilderton turn off Lancelin Rd		All zones		
	Ramphotyphlops (Typhlina) bituberculata			?	Confined to eastern zone		
BOIDAE Pythons	*Liasis childreni*	Children's Python		?	Confined to eastern zone	Scarce	Tuart belt
	Morelia (Python) spilota subsp. *variegata*	Carpet Python	Guilderton		Easter and limestone belt of western zone	Scarce	

Group	Scientific name	Common name	Seen in the area	Likely to occur in the area	Distribution	Relative abundance	Habitat
ELAPIDAE Front-fanged Snakes	*Echiopsis (Brachyaspis) curta*	Bardick	Guilderton		Western zone including coastal dunes	Moderately common	
	Demansia psammophis subsp. *reticulata*	Yellow-Faced Whip Snake			Western zone (especially the Tuart belt)	Moderately common (disappearing from built-up areas	
	Drysdalia (Denisonia) coronata	Crowned Snake				Scarce to the north of Perth	
	Suta (Denisonia) gouldii	Black-headed Snake				Generally common	Likes blackboy (*Xanthorrhoea* sp.) country
	Notechis ater subsp. *occidentalis*	Black Tiger Snake	13km E of Guilderton		Central & eastern zones and low lying eastern parts of western zones	Common	In swamps, around lakes
	Pseudechis australis	Mulga or King Brown Snake		?	Status unknown, accidentally introduced		
	Pseudonaja affinis	Dugite	Guilderton		Western & central zone (very common), moderately common in eastern zone	Low densities in undisturbed bush remote from settlement, increasing densities as settlement approaches	Abundance related to availability of prey (mainly the House Mouse (Mus musculus)

Group	Scientific name	Common name	Seen in the area	Likely to occur in the area	Distribution	Relative abundance	Habitat
ELAPIDAE Front-fanged Snakes	*Pseudonaja nuchalis*	Western Brown Snake or Gwardar			Confined to eastern zone (accidentally introduced)		
	Simoselaps (Vermicella) bertholdi	Desert Banded Snake			Western & central zone (common), uncommon in eastern zone		Sandy country
	Simoselaps (Vermicella) bimaculata	Western Black-naped Snake			Western & central zones	Moderately common (rare in eastern zone)	Deep sand s
	Simoselaps (Vermicella) calonotus	Western Black-striped Snake	Gulderton		Central & western zone	Common to moderately common (rare in eastern zone)	Deep white sand
	Simoselaps (Vermicella) fasciolatus subsp. *fasciolatus*	Narrow-banded Snake			Western zone	Uncommon (rare in other zones)	
	Simoselaps (Vermicella) semifasciatus subsp. *semicasciata*	Half-girdled Snake			All zones	Moderately common	Often in buried or half-buried rotten wood

APPENDIX 6

APPENDIX 6: BIRDS OF THE LOWER MOORE RIVER

The information is based on number of sources:

1) Sightings:
   - by Chris & Bill Ros (between December 1994 to December 1999)
   - Nicole Siemon (November-December 1999 surveys)
2) Literature:
   - Bird of the Gingin Shire (list prepared by the member of the Western Australian Group of Birds Australia and the Museum of WA)
   - Faunal Studies of the Northern Swan Coastal Plain

Family/Group	Common name	*Scientific name*	Local (seen)	Likely to occur	Relative abundance	Ecological Status	Habitat	Breeding season
Casauriidae	Emu	*Dromaius novaehollandiae*	■		Uncommon	Breeding resident	Banksia & Tuart Woodland	
MOUNDBUILDERS, QUAILS								
	Stubble Quail	*Coturnix pectoralis*	■			Migrant (Nov-Apr)		
	Brown Quail	*Coturnix ypsilophora*		■		Uncertain		
WATERFOWLS								
	Blue-billed Duck	*Oxyura australis*		■		?	Fresh & brackish lakes	Oct-Dec,
	Musk Duck	*Biziura lobata*	■		Moderately common	Resident	Fresh & brackish lakes, winter swamps	Jul-Oct
	Freckled Duck	*Stictonetta naevosa*		■	Uncertain	Rare visitor		
	Black Swan	*Cygnus atratus*	■		Common	Breeding resident	Rivers, swamps, lakes	Jun-Sep
	Australian (Mountain) Shelduck	*Tadorna tadornoides*	■		Common	Resident (common visitor, all year, but mainly Nov-Jul)	Brackish lakes, saltmarshes, foreshores	Jun-Jul,
	Australian Wood Duck	*Chenonetta jubata*	■		Moderately common	Resident	Mainly short grass in vicinity of water	

	Mallard	*Anas platyrhynchos*				Resident (Introduced)	Lakes	
	Pacific Black Duck	*Anas superciliosa*			Very Common	Breeding resident	Freshwater lakes, pools, swamps & saltmarshes	Jun-Oct
	Australasian Shoveler	*Anas rhynchotis*			Common	Resident	Fresh or brackish lakes & swamps (especially wooded with *Melaleuca teretifolia* & other melaleucas)	Oct
	Grey Teal	*Anas gracilis*			Very common	Breeding resident	Salt & brackish & fresh, waters, Moore R estuary	Jul-Sep
	Chestnut Teal	*Anas castanea*			Rare	Visitor (small number	Swamps	
	Pink-eared Duck	*Malacorhynchus membranaceus*				Uncertain Visitor	Saltlakes	
	Hardhead	*Aythya australis*				Uncertain	Fresh & brackish water	
GREBES								
	Australasian Grebe	*Tachybaptus novaehollandiae*			Common	Resident	Generally fresh waters, fringed with *Typha, Juncus*	Jul-Mar
	Hoary-headed Grebe	*Poliocephalus poliocephalus*				Nomad	Fresh or brackish water	Spring
	Great Crested Grebe	*Podiceps cristatus*			Scarce	Uncertain Visitor	Large fresh or brackish waters	
OCEAN BIRDS								
	Southern Giant-Petrel	*Macronectes giganteus*			Uncertain	Visitor (May-Sep) beach-washed		
	Kerguelen Petrel	*Lugensa brevirostris*				Visitor (winter)		
	Cape Petrel	*Daption capense*				Visitor (May-Oct)		
	Great-winged Petrel	*Pterodroma macroptera*			Rare	Visitor, beach-washed		

	Soft-plumaged Petrel	*Pterodroma mollis*				Visitor, beach-washed		
	Blue Petrel	*Halobaena caerulea*				Visitor, beach-washed, winter		
	Antarctic Prion	*Pachyptila desolata*				Visitor, beach-washed, winter		
	Slender-billed Prion	*Pachyptila belcheri*				Visitor, beach-washed, winter		
	Fairy Prion	*Pachyptila turtur*						
	Wedge-tailed Shearwater	*Puffinus pacificus*				Breeding vagrant		Lancelin, Edward Is
	Flesh-footed Shearwater	*Puffinus carneipes*				Migrant (winter passage)		
	Sooty Shearwater	*Puffinus griseus*			Rare	Visitor (winter)		
	Short-tailed Shearwater	*Puffinus tenuirostris*			Rare	Visitor		
	Hutton's Shearwater					Visitor		
	Little Shearwater	*Puffinus assimilis*				Visitor (beach-washed)		
	Wandering Albatross	*Diomedea exulans*			Rare	Visitor (Jan-Nov)		
	Black-browed Albatross	*Diomedea melanophris*			Rare	Visitor (Apr-Nov)		
	Shy Albatross	*Diomedea cauta*			Rare	Visitor (May-Oct)		
	Grey-headed Albatross	*Diomedea chrysostoma*			Rare	Visitor (May-Sep)		
	Yellow-nosed Albatross	*Diomedea chlororhynchos*				Visitor (May-Sep)		
	Wilson's Storm Petrel	*Oceanites oceanicus*				Migrant		
	White-faced Storm-Petrel	*Pelagodroma marina*				Breeding Vagrant		Lancelin Is
PELICANS, CORMORANT,								

ALLIES								
	Australasian Gannet	*Morus serrator*				Visitor (winter)		
	Darter	*Anhinga melanogaster*				Resident	Major watercourses, lakes, swamps	Aug-Dec, nesting in trees over water
	Little Pied Cormorant	*Phalacrocorax melanoleucos*			Common	Breeding resident	Mostly aquatic, nesting in trees over water	Jul-Mar, clutch 3-6
	Little Black Cormorant	*Phalacrocorax sulcirostris*			Common	Breeding resident	Mostly aquatic, nesting in trees over water	May-Jan (mostly late May-mid Nov), clutch 3-5
	Pied Cormorant	*Phalacrocorax varius*				Visitor		
	Great Cormorant	*Phalacrocorax carbo*				Resident	Fresh or brackish water	
	Australian Pelican	*Pelecanus conspicillatus*				Resident	Fresh or salt water	
HERON, IBIS								
	White-faced Heron	*Egretta (Ardea) novaehollandiae*			Common	Breeding resident	Near wetlands, nesting solitary in tree tops	Jun-Nov & Jan-Apr (winter & spring in south west, clutch2-5
	Little Egret	*Egretta (Ardea) garzetta*			Uncommon	Resident	Shallow wetlands	
	Eastern Reef Egret	*Egretta (Ardea) sacra*				Resident	Intertidal zone	Not breeding
	White-necked (Pacific) Heron	*Ardea pacifica*				Visitor (Aug-May)	Freshwater swamps	Not breeding
	Great Egret	*Ardea alba*				Resident	Shallows of wetlands, intertidal	Sep-Feb, clutch 3-4

							mud flats, rivers, nesting in trees	
	Cattle Egret	*Ardea ibis*			Rare	Visitor	Dry swamps & pastures	
	Nankeen Night (Rufous) Heron	*Nycticorax caledonicus*				Resident	By day: in waterside trees (*Eucalyptus rudis, Melaleuca rhaphiophylla*)	Sep
	Little Bittern	*Ixobrychus minutus*				Resident	Swamps, lakes & river margins heavily vegetated	Aug-May
	Australasian Bittern	*Botaurus poiciloptilus*			Rare	Resident	Lakes & swamps heavily vegetated with *Typha, Juncus*	
	Glossy Ibis	*Plegadis falcinellus*			Uncommon	Resident (visitor?)		
	Sacred Ibis (now Australian White Ibis	*Threskiornis molucca*				Resident	Wetland, pastures, tidal flats, nesting in trees or bushes over water	Late Aug-early Oct, clutch 2-4 (mostly 3)
	Straw-necked Ibis	*Threskiornis spinicollis*			Common	Resident	Swamps, damp or inundated grasslands	
	Royal Spoonbill	*Platalea regia*			Rare	Visitor		
	Yellow-billed Spoonbill	*Platalea flavipes*				Visitor	Fresh, brackish or saline waters	
HAWKS, EAGLES, FALCONS								
	Osprey	*Pandion haliaetus*				Resident		Breeding on Lancelin Is
	Black-shouldered Kite	*Elanus scriptus*				Resident		
	Square-tailed Kite	*Lophoictinia isura*			Rare	Uncertain		
	Whistling Kite	*Haliastur (Milvus) sphenurus*				Resident	Vicinity of lakes, swamps &	Aug-Oct

							watercourses	
	White-bellied Sea-Eagle	*Haliaeetus leucogaster*				Visitor (winter)		
	Spotted Harrier	*Circus assimilis*			Rare	Visitor		
	Swamp Harrier	*Circus approximans*				Resident (visitor Mar-Sep)	Swamps, lakes, watercourses, especially were ducks are breeding	
	Brown Goshawk	*Accipiter fasciatus*				Resident		
	Collared Sparrowhawk	*Accipiter cirrhocephalus*				Resident		
	Wedge-tailed Eagle	*Aquila audax*				Resident		
	Little Eagle	*Hieraaetus morphnoides*				Resident	In rabbit-infested localities	
	Brown Falcon	*Falco berigora*			rare	Resident		
	Australian Hobby	*Falco longipennis*				Visitor (Fen-Jan)		
	Peregrine Falcon	*Falco peregrinus*			Uncommon	Visitor		
	Nankeen Kestrel	*Falco cenchroides*			Moderately common	Resident Passage migrant		
RAILS, CRAKES, BUSTARD								
	Buff-banded Rail	*Gallirallus philippensis*				Resident		Breeding on Lancelin Is
	Baillon's Crake	*Porzana pusilla*				Nomad		
	Australian Spotted Crake	*Porzana fluminea*				Uncertain		
	Spotless Crake	*Porzana tabuensis*					Beds of sedges (esp. *Cladium articulatum*) around lakes & in swamps	
	Purple Swamphen	*Porphyrio porphyrio*				Resident	Dense vegetation (*Typha, Cladium, Juncus*)	Sep-Oct

	Dusky Moorhen	*Gallinula tenebrosa*				Resident	Freshwater lakes, swamps & stream	Aug-Dec
	Black-tailed Native-hen	*Gallinula ventralis*				Nomad (breeding)		Apr-May, Aug-Sep
	Eurasian Coot	*Fulica atra*			Common	Resident	Fresh & brackish water	Jul-Oct
	Australian Bustard	*Ardeotis australis*			Rare	Nomad	Coastal heat	
BUTTON-QUAIL								
	Painted Button-quail	*Turnix varia*				Resident		
WADERS								
	Bar-tailed Godwit	*Limosa limosa*				Migrant (Sep-Apr)		
	Whimbrel	*Numenius phaeopus*				Migrant		
	Eastern Curlew	*Numenius madagascariensis*			Rare	Migrant (Sep-Mar)		
	Marsh Sandpiper	*Tringa stagnatilis*			Uncertain	Migrant		
	Common Greenshank	*Tringa nebularia*				Migrant	Muddy or sandy margins & shallows of brackish & freshwater lakes & swamps	
	Wood Sandpiper	*Tringa glareola*				Migrant (Aug-May)		
	Terek Sandpiper	*Xenus cinereus*			Uncertain	Migrant (Sep-Feb)	Moore River estuary	
	Common Sandpiper	*Actitis hypoleucos*			Uncommon	Migrant	Rocks, cliffs & stone embankments, mouth of Moore River	
	Grey-tailed Tattler	*Heteroscelis (Tringa) brevipes*			Uncommon	Migrant (Sep-Mar)		
	Ruddy	*Arenaria interpres*				Migrant (Sep-Apr)	About rocks on coast	

	Turnstone							
	Great Knot	*Calidris tenuirostris*				Migrant (Oct-Jul)		
	Red Knot	*Calidris canutus*				Migrant (Sep-May)		
	Sanderling	*Calidris alpina*				Migrant (Oct-Apr)	Sandy beaches	
	Red-necked Stint	*Calidris ruficollis*			common	Migrant	Sandy shores of broadwaters, fresh & brackish lakes & swamps	
	Long-toed Stint	*Calidris subminuta*			Uncommon	Migrant		
	Pectoral Sandpiper	*Calidris melanotos*			Uncommon	Migrant		
	Curlew Sandpiper	*Calidris ferruginea*				Migrant (Aug-Jul)	Sandy shores of broadwaters, mudflats, brackish lakes	
	Ruff	*Philomachus pugnax*			Rare	Migrant		
	Painted Snipe	*Rostratula benghalensis*			Rare	Migrant		
	Bush Stone-curlew	*Burhinus grallarius*			Rare	Extinct in shire?		
	Pied Oystercatcher	*Haematopus longirostris*				Resident		Lancelin Is
	Sooty Oystercatcher	*Haematopus fuliginosus*			Uncommon	Migrant (from south May-Sep)		
	Black-winged Stilt	*Himantopus himantopus*				Visitor	Fresh, brackish & saline waters	
	Banded Stilt	*Cladorhynchus leucocephalus*				Visitor	Salt, brackish & freshwater lakes, Swan River estuary	

	Red-necked Avocet	*Recurvirostra novaehollandiae*				Visitor		
	Grey Plover	*Pluvialis squatarola*				Migrant (Sep-Apr)		
	Red-capped Plover	*Charadrius ruficapillus*				Resident	Coastal beaches & dunes, edge of saltlakes	Aug-Oct
	Greater Sand Plover	*Charadrius leschenaultii*				Migrant (Oct-Feb)		
	Inland Dotterel	*Charadrius (Peltohyas) australis*			Rare	Vagrant		
	Black-fronted Dotterel	*Elseyornis (Charadrius) melanops*				Resident		
	Hooded Plover	*Thinornis (Charadrius) rubricollis*				Migrant (Dec-Apr)		
	Red-kneed Dotterel	*Erythrogonys cinctus*				Visitor (Sep-Jan)		
	Banded Lapwing	*Vanellus tricolor*				Resident		
	Australian Pratincole	*Stiltia isabella*			Rare	Vagrant		
SKUAS, GULLS, TERNS								
	Pacific gull	*Larus pacificus*			Rare	Uncertain		
	Silver Gull	*Larus novaehollandiae*				Resident		Lancelin Is, Jan-Nov
	Caspian Tern	*Sterna caspia*				Resident		Lancelin Is
	Crested Tern	*Sterna bergii*				Resident		Lancelin Is, Jul-Nov
	Gull-billed Tern	*Sterna nilotica*			Uncommon	Visitor (Oct-Jan)	Lakes	
	Roseate Tern	*Sterna dougallii*				Resident/Migrant		Lancelin Is, Nov-Dec
	Fairy Tern	*Sterna nereis*				Visitor		

	Bridled Tern	*Sterna anaethetus*				Visitor		Lancelin Is, Sep-Feb
	Sooty Tern	*Stern fuscata*			Rare	Visitor (winter gales)		
	Whiskered Tern	*Chlidonias hybrida*				Visitor (irregular)		
	White-winged Black Tern	*Chlidonias leucoptera*			Uncommon	Visitor (Nov-May, irregular)		
	Common Noddy	*Anous stolidus*				Resident		Lancelin Is since '91
	Lesser Noddy	*Anous tenuirostris*			Rare	Visitor		
PIGEONS & DOVES								
	Rock Dove	*Columba livia**				Resident		
	Laughing Turtle-Dove	*Streptopelia senegalensis**				Resident		Aug-Feb
	Spotted Turtle Dove	*Streptopelia chinensis*				resident		
	Common Bronzewing	*Phaps chalcoptera*				Resident	Acacia thickets, Banksia & Eucalyptus woodlands	
	Brush Bronzewing	*Phaps elegans*						
	Crested Pigeon	*Ocyphaps (Geophaps) lophotes*				Resident		
COCKATOOS, PARROTS								
	Red-tailed Black-Cockatoo	*Calyptorhynchus banksii*				Resident		
	Short-billed Black-Cockatoo	*Calyptorhynchus latirostris*				Migrant/Resident		Breeding
	Suphur crested Cockatoo	*Cacatua galerita*				Resident		

	Galah	*Eolophus (Cacatua) roseicapilla*				Resident		
	Little Corella	*Cacatua sanguinea*				Resident		
	Cockatiel	*Nymphicus hollandicus*			Rare	Visitor		Wann Is, Oct-Feb
	Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*				Visitor (mainly Mar-Jun & Oct-Dec)	Flowering *Eucalyptus rudis & Corymbia calophylla*	
	Regent Parrot	*Polytelis anthopeplus*				Migrant (May-Nov)		
	Western Rosella	*Platycercus icterotis*				Resident	Eucalyptus Open Forest & *Melaleuca teretifolia* Thickets along Moore River & Gingin Brook	

	Australian Ringneck	*Barnardius zonarius*				Resident	Suburban gardens	Spring
	Red-capped Parrot	*Purpureicephalus spurius*				Resident	Open Eucalyptus Forests & Woodlands, adjacent Banksia Woodlands	
	Mulga Parrot	*Psephotus varius*			Uncommon	Visitor (irregular, summer)		
	Budgerigar	*Melopsittacus undulatus*			Uncommon	Visitor (infrequent)		
	Elegant Parrot	*Neophema elegans*				Visitor (winter)	Clearings or road verges in vicinity of Open Eucalyptus Forests & Woodlands & Banksia Woodlands	
	Rock Parrot	*Neophema petrophila*				Resident		
CUCKOOS								
	Pallid Cuckoo	*Cuculus palliidus*				Breeding Migrant		May-Dec
	Fan-tailed Cuckoo	*Cuculus flabelliformis*				Breeding Migrant	Jarrah & Tuart Forests, Banksia Woodlands, Acacia thickets	Apr-Sep
	Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*				Breeding Migrant		Jun-Jan
	Shining Bonze-Cuckoo	*Chrysococcyx lucidus*				Breeding Migrant		Jul-Jan
OVALS, FROGMOUTH								
	Barking Owl	*Ninox connivens*			Rare	Uncertain (Wann Is, several		

						reports)		
	Southern Boobook	*Ninox novaeseelandiae*				Uncertain		
	Barn Owl	*Tyto alba*			Uncommon	Visitor (May-Oct)		
	Tawny Frogmouth	*Podargus strigoides*				Resident	Open Eucalyptus Forests & Woodlands, Banksia Woodlands & Acacia thickets	
	Spotted Nightjar	*Eurostopodus mysticalis*			Uncommon	Visitor (Feb-Jul)		
	Australian Owlet-nightjar	*Aegotheles cristatus*				Uncertain		
SWIFTS	Fork-tailed Swift	*Apus pacificus*			Uncommon	Visitor (Dec-Mar)		
KINGFISHERS, ALLIES								
	Laughing Kookaburra	*Dacelo novaeguineae*				Resident		Sep-Nov
	Red-backed Kingfisher	*Todiramphus pyrrhopygia*			Rare	Visitor		Lancelin '85
	Sacred Kingfisher	*Todiramphus sanctus*				Breeding Migrant		Sep-May
	Rainbow Bee-eater	*Merops ornatus*				Breeding Migrant		Oct-Apr

FAIRY-WRENS								
	Splendid Fairy-wren	*Malurus splendens*				Resident	Melaleuca & Regalia Thickets in swamps, lakes & watercourses, Tuart Forest, coastal dunes,	Aug-Dec
	Variegated Fairy-wren	*Malurus lamberti*				Resident	Coastal dunes, *Acacia rostellifera* & other thickets	
	Blue-breasted Fairy-wren	*Malurus pulcherrimus*			Uncommon	Resident	Coastal scrubs	
	Red-winged Fairy-wren	*Malurus elegans*				Resident	Dense vegetation along Gingin Brook & near its confluence with Moore River (1950)	
	White-winged Fairy-wren	*Malurus leucopterus*				Resident	Coastal heats, samphire swamps	Oct-Nov
	Southern Emu-wren	*Stipiturus malachurus*				Resident	Dune scrub at the mouth of the Moore River (1965)	
PARDALOTES THORNBILLS, ALLIES								
	Spotted Pardalote	*Pardalotus punctatus*				Migrant (May-Aug)		
	Red-browned Pardalote	*Pardalotus rubricatus*					Woodlands	
	Striated Pardalote	*Pardalotus striatus*				Resident		

	White-browed Scrubwren	*Sericornis frontalis*				Resident	Dune scrubs (mainly *Acacia rostellifera*) from Guilderton south	
	Rufous Fieldwren	*Calamanthus (Sericornis) campestris*				resident		
	Weebill	*Smicrornis brevirostris*				Uncertain	Open Tuart & Wandoo Forests & Woodlands	Sep-Nov
	Western Gerygone	*Gerygone fusca*				Resident		
	Inland Thornbill	*Acanthiza apicalis*				Resident		
	Chestnut-rumped Thornbill	*Acanthiza uropygialis*				Uncertain (small flocks Wann Is)		
	Western Thornbill	*Acanthiza inornata*				Resident	Open Tuart Forests & Woodlands	Nov-Dec
	Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*				Resident	Open ground near trees & shrubs	Jul-Dec
SITTELLAS								
	Varied Sittella	*Daphoenositta chrysoptera*					Woodlands	
HONEYEATERS								
	Red Wattlebird	*Anthochaera carunculata*				Resident	Mainly Eucalyptus & Banksia Woodlands, attracted to flowering *Banksia menziesii, B. ilicifolia, B. grandis, Eucalyptus gomphocephala, Anigozanthos manglesii*	Jul-Dec

	Little Wattlebird	*Anthochaera lunulata*				Resident	Banksia Woodlands	Aug-Oct
	Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*				Uncertain (small flocks)		
	Yellow-throated Miner	*Manorina flavigula*				Resident	Mainly Banksia Woodlands, also Tuart, Jarrah-Marri & Melaleuca Woodlands	Aug-Oct
	Singing Honeyeater	*Lichenostomus virescens*				Resident	Mainly Banksia Woodlands & Coastal Scrubs & Heaths	
	Yellow-plumed Honeyeater	*Lichenostomus ornatus*				Uncertain		
	Brown-headed Honeyeater	*Melithreptus brevirostris*				Visitor		
	White-naped Honeyeater	*Melithreptus lunatus*				Resident		
	Brown Honeyeater	*Lichmera indistincta*				Resident	All kinds of woodland, scrub & thicket	Sep-Oct
	New Holland Honeyeater	*Phylidonyris novaehollandiae*				Resident	Thickets of *Adenanthos, Melaleuca, Regelia* & *Pultenaea* spp. around swamps & watercourses	Aug-Oct
	White-cheeked Honeyeater	*Phylidonyris nigra*				Resident	Towards coast in thickets of *Dryandra sessilis*, *Acacia pulchella* & *Xanthorrhoea*, Low Woodlands of *Banksia prionotes* & *B. menziesii*	Aug-Nov
	White-fronted Honeyeater	*Phylidonyris albifrons*				Uncertain (small flocks NE of Gingin		

						Shire)		
	Tawny-crowned Honeyeater	*Phylidonyris melanops*				Uncertain	Coastal limestone belt	
	Western Spinebill	*Acanthorhynchus superciliosus*				Resident	Banksia Woodlands	Aug-Nov
	White-fronted Chat	*Epthianura albifrons*				Visitor	Mainly open or bare flats around lakes & swamps, sparsely vegetated coastal dunes	Breeding on Lancelin Is
AUSTRALIAN ROBINS								
	Jacky Winter	*Microeca fascinans*			Rare	Resident (Mogumber nearest)		
	Scarlet Robin	*Petroica multicolor*				Resident		Late Jul-Oct
	Red-capped Robin	*Petroica goodenovii*				Resident		
	Hooded Robin	*Melanodryas cucullata*			Uncommon	Resident	Mainly Banksia Woodlands, also *Dryandra sessilis* & *Xanthorrhoea* sp. heaths	
	Western Yellow Robin	*Eopsaltria griseogularis*			Rare	Uncertain (extinct in Gingin Shire?)		
	White-breasted Robin	*Eopsaltria georgiana*				Resident (coast N of Lancelin)	*Acacia rostellifera* thickets	
WHISTLERS FLYCATCHERS								
	Crested Bellbird	*Oreoica gutturalis*				Resident	Mainly Low Open Woodlands	

	Golden Whistler	*Pachycephala pectoralis*			Uncommon	Resident (west of Gingin Shire)		
	Rufous Whistler	*Pachycephala rufiventris*				Resident	Wooded country	Sep-Dec
	Grey Shrike – thrush	*Colluricincla harmonica*				Resident	Open Forests & Woodlands of Eucalyptus, Banksia & Melaleuca	
	Restless Flycatcher	*Myiagra inquieta*				Resident	Mainly around lakes, in swamps & along watercourses, in *Melaleuca rhaphiophylla, M. parviflora* & *Eucalyptus rudis*	
	Magpie-lark	*Grallina cyanoleuca*				Resident	Bare or sparsely vegetated flats, pastures in vicinity of water	Aug-Nov
	Grey Fantail	*Rhipidura fuliginosa*				Resident	In forests, scrubs & thickets around lakes, in swamps & along watercourses	Sep-Oct
	Willie Wagtail	*Rhipidura leucophrys*				Resident	Common around stock, residential areas.	Aug-Nov
CUCKOO-SHRIKES								
	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*				Resident	Open Tuart Forests & Woodlands	Jul-Oct
	White-winged Triller	*Lalage sueurii*				Migrant (Sep-Jan)		
WOODSWALLOWS								
	Black-faced Woodswallow	*Artamus cinereus*				Resident	Mainly coastal heaths (attracted to	Oct-Nov

							seeding *Xanthorrhoea* sp.)	
	Dusky Woodswallow	*Artamus cyanopterus*			Uncommon	Visitor (autumn-winter) recorded Beermullah L		
BUTCHERBIRDC URRAWONG								
	Grey Butcherbird	*Cracticus torquatus*				Resident	All kinds of forest, woodland, scrub or thicket	Sep-Nov
	Pied Butcherbird	*Cracticus nigrogularis*				Resident		
	Australian Magpie	*Gymnorhina tibicen*				Resident	Man-made habitats	Aug-Nov
	Grey Currawong	*Strepera versicolor*			Rare	Resident (patchy, recorded at Muchea)		
CROWS, RAVENS								
	Australian Raven	*Corvus coronoides*				Resident		Aug-Oct
	Little Crow	*Corvus bennetti*			Uncommon	Migrant in flocks (Dec-May)		
	Richard's Pipit	*Anthus novaeseelandiae*				Resident	Bare or sparsely vegetated ground near coast, around swaps & lakes	
FINCHES								
	Zebra Finch	*Taeniopygia guttata*			Uncommon	Visitor (drought refuge)		
	Mistletoebird	*Dicaeum hirundinaceum*				Nomad	Mainly Open Eucalyptus Forests & Woodlands (Flooded Gum, Tuart & Marri)	

SWALLOW MARTINS								
	White-backed Swallow	*Cheramoeca leucosternus*				Resident	Nesting in road banks between Guilderton & Yanchep	Mainly winter
	Welcome Swallow	*Hirundo neoxena*				Resident	Nest placed under bridges, river jetties, costal limestone, hollow trees & human dwellings	Aug-Oct, fledging period 25-26 days
	Tree Martin	*Hirundo nigricans*				Resident	Nesting in trees (Jarrah & River Gums)	Aug-Nov
	Fairy Martin	*Hirundo ariel*			Uncommon	Nomad	Nests placed in chalk quarries & kilns, clay-pits	Aug-Nov
OLD WORLD WARBLERS								
	Clamorous Reed-Warbler	*Acrocephalus stentoreus*				Resident	Beds of *Typha, Cladium* & *Juncus* around lakes & in swamps	Oct-Jan
	Little Grassbird	*Megalurus timoriensis*				Uncertain	Beds of *Typha, Cladium* & *Juncus* around lakes & in swamps	Aug-Oct
	Rufous Songlark	*Cincloramphus mathewsi*				Migrant (Sep-May		
	Brown Songlark	*Cincloramphus cruralis*				Migrant (Oct-Jan	Open grasslands & pastures	
SILVEREYES								
	Silvereye	*Zosterops lateralis*				Resident		

APPENDIX 7

APPENDIX 7: MAMMALS OF THE NORTHERN SWAN COASTAL PLAIN

Group	Scientific name	Common name	Seen in the area	Likely to occur in the area	Relative abundance in the area studied	Habitat
MACROPODIAE	*Macropus fuliginosus*	Western Gray Kangaroo			Common	Woodland, shrubland, heath
	Macropus irma	Brush Wallaby			Frequently sighted	Mixed *Banksia menziesii* woodland, heathland, *Eucalyptus marginata* & *E. gomphocephala* woodland
	Macropus eugenii	Tammar			Isolated patches	
	Petrogale lateralis	Bush-tailed Rock Wallaby		?		
	Onychogalea lunata	Wurrung		?		
	Bettongia penicillata	Woylie		?		
	Bettongia lesueur	Boodie				
	Setonix brachyurus	Quokka		?		Coastal thickets & swamps
	Lagostrophus fasciatus	Munning		?		
PHALANGERIDAE	*Trichosurus vulpecula*	Brush-tailed Possum				
	Pseudocheirus peregrinus	Common Ringtail		?		
BURRAMYIADE	*Cercartetus concinnus*	Mundarda		?		
TRASIPEDIDAE	*Tarsipes spencerae*	Noolbenger	Mouth of Moore River			Sandplain heath
PERAMELIDAE	*Isoodon obesulus*	Quenda				Thickly vegetated damp situations
THYLACOMYIDAE	*Macrotis lagotis*	Dalgyte		?		

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Group	Scientific name	Common name	Seen in the area	Likely to occur in the area	Relative abundance in the area studied	Habitat
DASYURIDAE	*Dasyurus geoffroii*	Chuditch			Scarce	
	Antechinus apicalis	Dibbler				
	Antechinus flavipes	Mardo		?		
	Phascogale tapoatata	Tuan		?		
	Sminthopsis crassicaudata	Tat-tailed Dunnart			Rare	
	Sminthopsis murina	Common Dunnart		?		
	Sminthopsis granulipes	White-tailed Dunnart		?		
MYRMECOBIIDAE	*Myrmecobius fasciatus*	Numbat		?		
RODENTIA	*Rattus fuscipes*	Southern Brush-Rat				
	Rattus tunneyi	Tunney's Rat		?		
	Rattus rattus	Black Rat				Associated with permanent or ephemeral fresh water
	Hydromys chrysogaster	Water Rat				Coastal areas along streams & rivers
	Pseudomys albocinereus	Ashey-grey Mouse				Coastal sandplain heath
	Mus musculus	House Mouse				
CHROPTERA	*Macroderma gigas*	Ghost Bat		?		
	Nyctophilus geoffroyi	Lesser Long-eared Bat		?		
	Eptesicus regulus	Southern Little Bat				
	Chalinolobus gouldii	Gould's Wattled Bat				
	Chalinolobus morio	Chocolate Bat		?		

Group	Scientific name	Common name	Seen in the area	Likely to occur in the area	Relative abundance in the area studied	Habitat
CHROPTERA	*Myotis adversus*	Large-footed Myotis		?		
	Tadarida australis	White-striped Mastiff Bat		?		
	Pteropus scapulatus	Red Flying Fox		? (stray animal)		
CARNIVORA	*Canis familiaris*	Dingo				
	Vulpes vulpes	Red Fox				
	Felis catus	Domestic Cat				
	Mustela putorius	Ferret		?		
LAGOMORPHA	*Oryctolagus cuniculus*	European Rabbit				
MONOTREMATA	*Tachyglossus aculeatus*	Echidna				