PUBLIC ENVIRONMENTAL REVIEW

SELECTED SOUTH-WEST CORRIDOR LAND-USE CHANGES

Prepared by
Bowman Bishaw Gorham
Environmental Management Consultants
&
Department of Planning
& Urban Development

MARCH 1994

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As reflected in
South-West Corridor
Major Amendments to
the Metropolitan Region Scheme

Prepared by
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MARCH 1994

AN INVITATION TO COMMENT ON THIS PER

The Environmental Protection Authority (EPA) invites people to make a submission on this Public Environmental Review (PER).

The Department of Planning and Urban Development (DPUD) proposes to change land uses affecting System 6 areas and lakes protected under the *Environmental Protection (Swan Coastal Plain Lakes) Policy, 1992*.

These changes are to rezone or reserve land in the Kwinana, Rockingham and Mandurah Local Authority areas for a Rapid Transport Route, Public Purposes, Parks and Recreation Reserves, Urban and Industrial purposes.

The proposals are consistent with the South West Corridor Structure Plan prepared by DPUD in November, 1993.

The PER is available for public review for 8 weeks from 9 March, 1994.

Comments from Government Agencies and from the public will assist the EPA to prepare an Assessment Report in which it will make recommendations to Government.

Why Write a Submission?

A submission is a way to provide information, express your opinion and put forward your suggested course of action, including any alternative approach. It is useful if you indicate any suggestions you have to improve the proposal.

All submissions received by the EPA will be acknowledged. Submissions will be treated confidentially unless it is stated that they can be used publicly, then they may be quoted either in full or part in each report.

Why not Join a Group?

If you prefer not to write your own comments, it may be worthwhile joining with a group or other groups interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a Submission

You may agree or disagree with, or comment on, the general issues discussed in the PER or the specific proposals. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal environmentally more acceptable.

When making comments on specific proposals in the PER:

- clearly state your point of view;
- indicate the source of your information or argument, if this is applicable; and
- suggest recommendations, safeguards or alternatives.

Points to Keep in Mind

By keeping the following points in mind, you will make it easier for your submission to be analysed:

- attempt to list points so that the issues raised are clear - a summary of your submission is helpful;
- refer each point to the appropriate section, chapter or recommendation in the PER;
- if you discuss different sections of the PER, keep them distinct and separate, so there is no confusion as to which section you are considering; and
- attach any factual information you wish to provide and give details of the source (make sure your information is accurate).

Remember to include:

- your name;
- address; and
- date.

The closing date for submissions is 4 May, 1994.

Submissions should be addressed to:

The Chairman
Department of Environmental Protection
8th Floor 'Westralia Square'
141 St Georges Terrace
PERTH WA 6000

Attention: Ms J Boyer

EXECUTIVE SUMMARY

INTRODUCTION

The purpose of this report is to satisfy a requirement by the Environmental Protection Authority (EPA) to conduct a Public Environmental Review (PER) into future development proposals for the South West Corridor as reflected in the Stage B major amendment to the Metropolitan Region Scheme for the City of Rockingham.

Two major amendments are currently proposed to the Metropolitan Region Scheme for the South West Corridor.

- Stage A covers the northern half of the Structure Plan, including most of the City of Cockburn and the Town of Kwinana; and

- Stage B covers the City of Rockingham.

The EPA has determined that the Stage A major amendment for the Metropolitan Region Scheme does not require formal assessment except that the impact of the proposed Rapid Transport Route should be assessed as part of the Stage B Amendment PER.

The southern part of the Structure Plan in the City of Mandurah is currently subject to a separate review of the City of Mandurah's Town Planning Scheme. No level of environmental assessment has yet been set for the part of the Structure Plan falling within the City of Mandurah.

From a strategic perspective, it is important to note that the character of the South West Corridor will change dramatically over the next 25-30 years. Whereas it is now predominantly a rural corridor, mostly undeveloped, it will change character over the next planning period to become a major part of the Perth Metropolitan Region, very different in character from what it is now. Unless conservation and urban objectives are reconciled both will be prejudiced.

The Structure Plan for the South West Corridor has been through an exhaustive planning and consultation process. Alternatives to what has been proposed in the Structure Plan are not apparent. It is therefore necessary, in the process of environmental review, to base the evaluation of acceptability on achieving the best balance between urban and environmental objectives accepting that in some cases they may be mutually incompatible.

This assessment is regional in context to enable decisions to be made on regional implications of the proposed changes to the Metropolitan Region Scheme. It is acknowledged that other, more detailed, study may be required for specific development proposals at a later date, particularly in regard to derivation of appropriate management strategies for environmental protection.

FORMAT OF THE REPORT

This PER is in two parts:

The first part, written by the Department of Planning and Urban Development (DPUD), examines the regional strategic issues for environmental conservation. It examines existing provisions for conservation and proposes modifications to current arrangements which will better fit into the patterns of future development in the South West Corridor, as well as achieving an overall increase in the conservation estate.

The second part of the report, undertaken by an environmental consultant to DPUD, examines in more detail issues raised by the Environmental Protection Authority in the Stage B Amendment, as well as issues in the Leda area, on wetlands in general and some conservation areas in Stage A.

PART I - REGIONAL OVERVIEW

This assessment seeks to demonstrate the manner in which the South West Corridor Structure Plan will achieve optimum objectives for conservation within the context of a future urban corridor.

The following principles and rationales are the key to fulfilling the function of the PER:

- examine the current configuration of System 6 areas in the South West Corridor, their objectives and rationales for potential boundary changes;

- compare the proposed Parks and Recreation Reserves to current System 6 areas to assess the degree to which the System 6 recommendations would be implemented and to highlight the inconsistencies with System 6;

- analyse the extent to which existing System 6 areas and proposed Parks and Recreation Reserves (i.e. "proposed System 6") relate to the distribution of wetlands and remnant vegetation and therefore conduct a strategic comparison of conservation objectives.

It is proposed that the current arrangement of System 6 areas should be reviewed to reconcile them with the conservation and development objectives for the corridor and, in so doing, enhance their prospect as sustainable conservation reserves into the future.

Modifications to System 6 and Comparative Analysis of Land Areas

There are no reductions in area of any System 6 'reserve' in the South West Corridor due to the proposals. Overall, the proposed reconfiguration of System 6 adds an additional 3,883 hectares or 29% to the current combined area of System 6 'reserves' in the study area.

Analysis of Wetland Conservation in Proposed System 6

Of the total area of 6,613 hectares of wetlands identified on the Structure Plan (which includes EPP wetlands), 3,974 hectares or 60% would be contained within the proposed reconfiguration of System 6 reserves, compared to 3,223 hectares or 49% in existing System 6. This represents a 23% improvement of the proposed reconfiguration over the existing. Overall, the proposed changes to System 6 achieve an enhancement of wetland protection. The improvement is not so substantial for EPP wetlands but nevertheless represents a 1% improvement.

Analysis of Remnant Vegetation Conservation in Proposed System 6

The proposed reconfiguration accommodates significantly more remnant vegetation in all categories than existing System 6, except the coastal category. The reduction in the coastal category is to be expected because of the relocation of reserve M107 away from the coastal area to the Paganoni wetland area; also, the south west corner of M103, west of Ennis Avenue, which is proposed to be used for urban and light industrial purposes, measuring approximately 140 hectares, was formerly part of the coastal vegetation in the current System 6 configuration.

Benefits of Reconfiguration of System 6 Areas

In summary, the proposals for the reconfiguration of the System 6 areas in the South West Corridor and the proposals for the protection of wetlands and remnant vegetation embodied in the PER achieve the following benefits;

- They satisfy the criterion that any modifications or impingement on System 6 reserves does not reduce their overall area.

- They achieve a net increase in representation of 'good condition' remnant vegetation for most of the natural vegetation complexes in the corridor (for other complexes there is no change), which at this strategic level of review may be extrapolated to assume a net increase in ecosystem representation.

- They have better prospects for long term sustainability because they accord with, and can be accommodated with, the urban structure proposed for the South West Corridor.

- They afford more comprehensive and better protection to the wetlands in the South West Corridor.

- They better protect the remnant vegetation as mapped by the Department of Agriculture within the South West Corridor.

- They offer better prospects for rehabilitation to create a more comprehensive representation of the natural vegetation systems than were originally in the South West Corridor, thereby providing the opportunity to restore and maintain a wider range of ecological habitats than currently exist or would exist under future urban conditions.

- The proposals incorporated in this PER, although strategic in nature, should achieve greater community acceptance and "ownership" of System 6 objectives for the South West Corridor by being more logical, comprehensive, relevant and innovative.

PART II - SPECIFIC IMPACTS

Part II of the Public Environmental Review examines environmental effects and, where appropriate, management for particular aspects of the proposed MRS Amendments:

- effects of the MRS Amendments on System 6 Area M103, including the rapid transport route, rezonings in Hillman and East Warnbro, and the widening of Safety Bay Road;

- effects on EPP and Structure Plan wetlands;

- overall effect of the Amendments on regional conservation values;

- effects of the rapid transport route on The Spectacles wetland reserve;

- effects of a widening of the Beeliar Drive road reserve on System 6 area M92 and an associated EPP wetland;

- effects of the proposed upgrading of Russell Road on System 6 area M93; and

- effects of the rapid transport route on System 6 area M104 and the wider Leda open space (focussing on wetlands).

ENVIRONMENTAL MANAGEMENT PRINCIPLES

The principles for management of the major environmental issues arising from the MRS Amendment are summarised below.

- **Effects on System 6 Areas**

  A number of elements of the MRS Amendments bear on existing System 6 areas. The approach taken in the MRS Amendments has been to treat the System 6 boundaries as flexible and able to be modified to better reflect a balance of conservation priorities and urban development imperatives. The result has been a substantial increase in the area of the South West Corridor set aside as Parks and Recreation Reserve, at the expense of a small number of specific areas with conservation value.

- **Effects on EPP Lakes and Other Wetlands**

  The degree of reservation of wetlands in the Corridor is markedly increased under the amended MRS. Where individual wetlands are affected by road reserves and the rapid transport route, Environmental Management Plans should be prepared to minimise the impacts of construction. To mitigate adverse effects on EPP wetlands, replacement wetlands of equivalent size and function will be created or restored.

- **Effects on Regional Conservation Values**

  A loss of overall conservation value is inevitable and unavoidable when a sparsely settled rural area changes to a densely populated urban one. Within this framework, the MRS amendments seek to achieve the maximum retention and beneficial incorporation of the conservation values of the South West Corridor into the MRS. This is achieved with a substantial improvement in the size, linkage and protection status of most of the features identified by various studies as being the most important conservation attributes of the South West Corridor.

COMMITMENTS BY THE PROPONENT

Subject to the understanding that DPUD is not a statutory decision making body (except in a minor way by delegation) and that DPUD has only an advisory role to the Minister for Planning, the State Planning Commission and the Metropolitan Planning Council, and subject to the understanding that many decisions made on the advice of DPUD can be overturned on appeal, and subject to the understanding that DPUD does not have responsibility for the actual construction of major roads and other items of transport infrastructure, DPUD, as proponent of this PER makes the following commitments.

1. The additional areas proposed for rezoning to Parks and Recreation in the 1993 Structure Plan for the South West Corridor will be zoned for this purpose. That is, subsequent to implementation of the current Stage A and B Amendments, DPUD will recommend that additional amendments are initiated to achieve all of the Parks and Recreation allocations as proposed in the Structure Plan.

2. In the event that minor modifications to proposed Parks and Recreation Reserves are considered desirable prior to formal zoning, then DPUD will recommend that adjustments be made to ensure that there will not be a reduction in the overall allocation of open space for conservation purposes in the South West Corridor.

3. During future implementation of infrastructure proposals within transport reserves established by the Stage A and B Amendments, DPUD will recommend that a detailed Environmental Management Program (EMP) is required prior to construction (to be prepared to the satisfaction of the EPA). In particular, the following elements will be addressed by future EMP's:

    - the rapid transport route and its effects on important areas of natural environment, including but not limited to System 6 area M103 (Rockingham Lakes), The Spectacles, Stakehill Swamp and Anstey Swamp;
    - the Eighty Road extension and its impingement on the Tamworth Hill EPP wetland;
    - the proposed Beeliar Drive and its crossing of M92 and an EPP wetland;

- the widening of Russell Road through the Beeliar Regional Park (M93), and
- the proposed upgrading of Safety Bay Road through System 6 area M103.

4. As urbanisation of the South West Corridor progresses, DPUD will endeavour to ensure that the environmental protection requirements implicit to this PER are implemented, where appropriate, in Town Planning Schemes, District and Local Structure Plans and Subdivision Plans. In general, the aim will be to achieve adequate protection of Structure Plan wetlands (including EPP wetlands) and the following specific environmental features;

- the EPP wetland in the proposed regional sporting centre for the City of Cockburn (part of a proposed Parks and Recreation Reserve north of Beeliar Drive and east of the new Forest Road alignment) will be protected from recreational development;
- the two small wetlands in an area of proposed Urban Deferred (west of Hammond Road and north of Russell Road) will be incorporated within open space;
- the extreme north-eastern side of Tamworth Hill Swamp extends into a proposed urban area and, whilst completely degraded, it will be protected from adverse drainage and water quality changes which may affect Tamworth Hill Swamp;
- the small areas of System 6 area M92 which are not included as Parks and Recreation Reserve will be incorporated into local open space; and
- the southern 'spur' of System 6 area M93, which includes two wetlands, will be protected in local open space.

5. Where the rapid transport reserve crosses public land, such as the Leda open space and northern sector of M103, flexibility in the alignment will be accommodated via minor amendments to the MRS in the event that detailed environmental assessment (during preparation of the EMP) identifies an alternative, acceptable alignment with reduced environmental impact.

6. A detailed re-assessment of the configuration of the Garden Island Highway and rapid transport reserve will be conducted for the interchange area in the vicinity of Dixon Road (east) and the Mundijong railway, to determine whether or not the EPP wetland can be avoided and the rapid transport route deviated further to the north from Lake Cooloongup.

7. DPUD will prevail upon the City of Rockingham to negotiate with Special Rural landholders adjacent to the Nairn Road reserve to attempt to avoid the EPP wetland which will currently be affected by future road construction. The option of wetland replacement will be discussed with the City of Rockingham.

8. DPUD will conduct further assessment of the alternatives for the rapid transport reserve in the vicinity of The Spectacles, with a view to minimising potential adverse effects on this important area.

9. DPUD will recommend that the proposed Hillman Public Purposes Reserve be deleted from the Stage B Major Amendment to the Metropolitan Region Scheme on the basis of findings of this PER.

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PART I: REGIONAL OVERVIEW

Amendment Proposals, Effects on Existing Conservation Estate and Proposals for Enhanced Conservation

1.0 INTRODUCTION

1.1 Purpose of the Report

The purpose of this report is to satisfy a requirement by the Environmental Protection Authority (EPA) to conduct a Public Environmental Review (PER) into future development proposals for the South West Corridor as reflected in the Stage B major amendment to the Metropolitan Region Scheme for the City of Rockingham (refer to Appendix A, PER Guidelines).

At present, there are two major amendments proposed to the Metropolitan Region Scheme for the South West Corridor which are intended to give statutory effect to many of the proposals contained in the South West Corridor Structure Plan:

- Stage A covers the northern half of the Structure Plan, including most of the City of Cockburn and the Town of Kwinana; and

- Stage B covers the City of Rockingham.

The southern part of the Structure Plan in the City of Mandurah is currently subject to a separate review of the City of Mandurah's Town Planning Scheme. No level of environmental assessment has yet been set for the part of the Structure Plan falling within the City of Mandurah.

The EPA has determined that the Stage A major amendment for the Metropolitan Region Scheme does not require formal assessment except that the impact of the proposed Rapid Transport Route should be assessed as part of the Stage B Amendment PER. While this PER is mostly limited to consideration of the specific environmental issues raised by the EPA in the City of Rockingham and the southern part of Leda in the Town of Kwinana, it will also address strategic conservation issues which are a feature of the South West Corridor Structure Plan and which are the subject of the current Stage A and B major amendments to the Metropolitan Region Scheme. Other environmental issues identified by the proponent in the Stage A area are also addressed where considered appropriate. The study areas for Stage A and Stage B are shown on Figure 1.

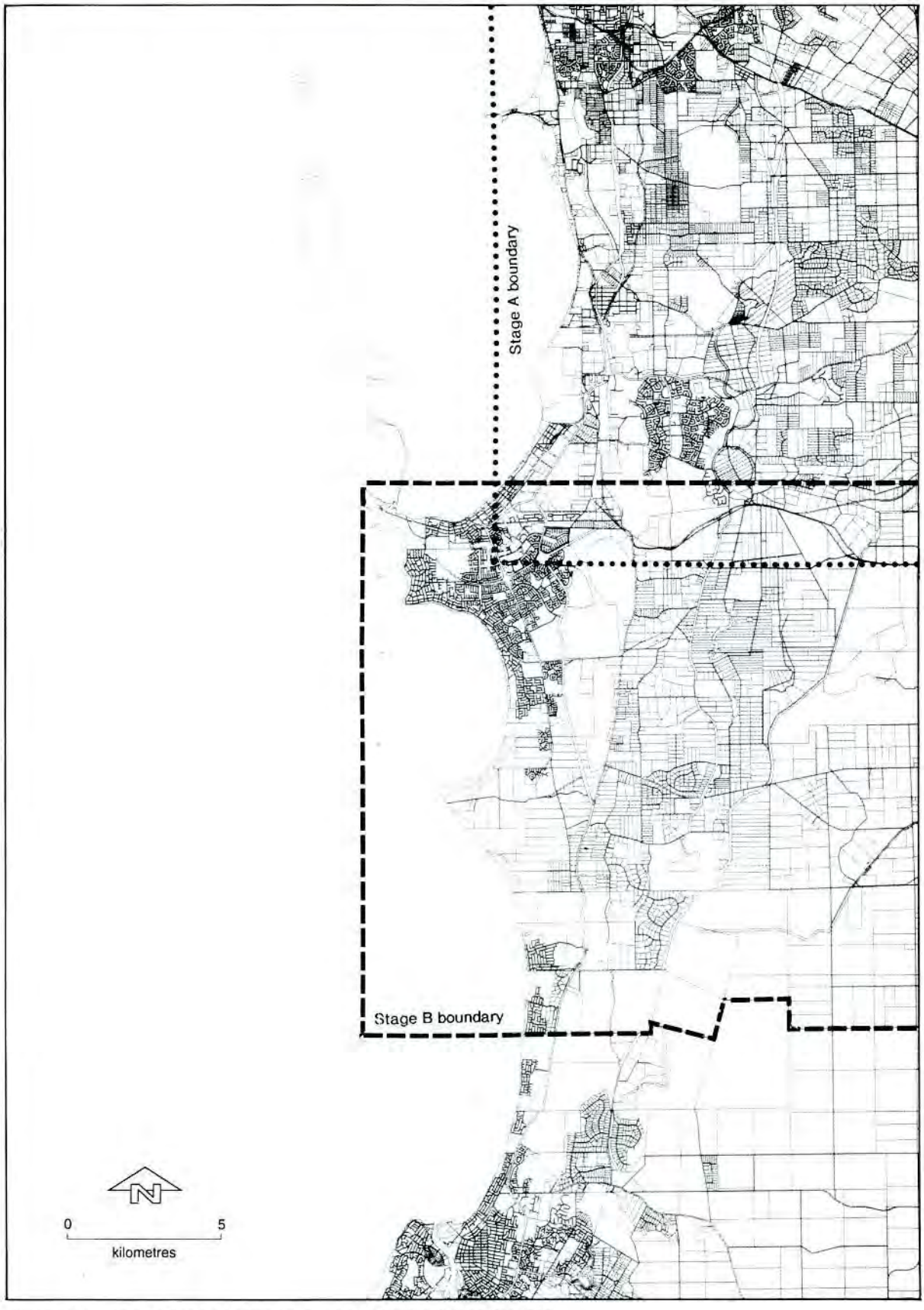

Figure 1 Study Area for Stage A and B Major Amendments

1.2 Principal Function of the PER

The Environmental Protection Authority has advised that the principal function of the PER is:

> "... to place the proposal in the context of the regional environment and progressive developments, including the cumulative impact of these proposed land use changes. It seeks to explain why this proposal is being put forward in this way at this place and at this time. It should also set out the environmental impacts the proposal will have, and what management steps the proponent intends to use to avoid, ameliorate or mitigate any negative environmental impacts."

Accordingly, this assessment is regional in context to enable decisions to be made on regional implications of the proposed changes to the Metropolitan Region Scheme. It is acknowledged that other, more detailed, study may be required for specific development proposals at a later date, particularly in regard to derivation of appropriate management strategies for environmental protection.

It should be recognised that the Department of Planning and Urban Development will not be the proponent for the future land uses for which the land the subject of these amendments will be rezoned. Rezoning, by itself, has no direct or immediate environmental impact. However, the reason for conducting an environmental assessment of the proposed amendments at this time is to ensure that the potential environmental impacts are considered in a strategic regional context.

In this context, the overall Structure Plan for the South West Corridor incorporates proposals to increase the area of land zoned as Parks and Reserves for the purposes of conservation and recreation, of which some of these proposals will be achieved by the current Stage A and Stage B amendments. The reader is asked to consider these overall benefits when reviewing the potential impacts of individual rezoning proposals. Parts of the amendments involve changes to existing System 6 areas which will generally be considered to be negative, and may be viewed as unacceptable by some when considered in isolation. Therefore, this PER endeavours to place more emphasis on the strategic conservation/recreation proposals for the whole South West Corridor, in order to place the negative environmental impacts into a framework in which the benefits can be judged and a decision made on the overall balance of advantages and disadvantages.

1.3 Report Format (Part I and Part II)

This PER is in two parts:-

Part I:

The first part, written by the Department of Planning and Urban Development (DPUD), examines the regional strategic issues for environmental conservation. It examines existing provisions for conservation and proposes modifications to current arrangements which will better fit into the patterns of future development in the South West Corridor, as well as achieving an overall increase in the conservation estate. This part of the report covers the entire area covered by the Stage A and Stage B Amendments and the City of Mandurah (i.e. the whole Structure Plan).

The structure of Part I is as follows:

- Section 2 describes the proposals included in the Stage A and Stage B major amendments to the Metropolitan Region Scheme in the context of the Structure Plan for the South West Corridor. The main features of the Structure Plan are also described in the context of future growth of the Perth metropolitan region and the need for a comprehensive approach to conservation.

- Section 3 identifies aspects of the major amendments and the Structure Plan which have specific environmental impacts on current System 6 areas, EPP[1], wetlands and other important wetlands.

- Section 4 examines strategic proposals for the reconciliation of land use and conservation objectives in the South West Corridor from the regional perspective.

- Section 5 provides key conclusions in respect of the overall conservation/recreation proposals for the South West Corridor.

Part II:

The second part of the report, undertaken by an environmental consultant to DPUD, examines in more detail issues raised by the Environmental Protection Authority in the Stage B Amendment, as well as issues in the Leda area, on wetlands in general and some conservation areas in Stage A.

Footnote 1. EPP = *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992.*

The work undertaken by the environmental consultant assesses the ecological implications of specific proposals described in Part I in greater detail, although still from a regional perspective. The specific tasks and structure of Part II are outlined in the next section.

1.4 Specific Tasks Addressed in Part II

A copy of the Environmental Protection Authority Guidelines for the PER are contained in Appendix A. These guidelines, along with other considerations, have been interpreted into the specific tasks outlined below.

Assess in broad terms the impact of the Stage B Amendment proposals on System 6 reserves in terms of:

- The nature of impact or disturbance likely from the proposed land use.
- The compatibility with System 6 intent and objectives.
- The compatibility with future planning, values, integrity and management of System 6 areas.
- The compatibility with the ecological objectives of System 6.
- The compatibility with landscape attributes of each area.

Investigate and report in broad terms the impact of the amendments and land use proposals on the conservation of flora, fauna and ecosystems, i.e.:

- The significance of the native flora and fauna within the System 6 areas, including their regional significance and their representation in other reserves.
- The extent of impact on rare or endangered species.
- The alternative management strategies required to minimise or avoid the impacts on flora, fauna and ecosystems.

Assess the impact of the amendment proposals on lakes and wetlands in terms of:

- The impact on lakes protected by the *Environmental Protection (Swan Coastal Plain Lakes) Policy* (EPP wetlands).
- The impact on other wetlands identified in the South West Corridor Structure Plan.
- The ecological impacts on EPP and other wetlands with proposed measures to overcome or minimise any identified problems.

The structure of Part II is as follows:

- Section 6 gives an introduction to the consultant study, incorporating a list of specific impacts addressed in the Scope of Work.
- Section 7 provides a brief overview of the characteristics of the existing environments.
- Section 8 assesses the potential environmental impacts of specific proposals.
- Section 9 identifies environmental management strategies which may be implemented to minimise the adverse effects of the proposals.

2.0 DESCRIPTION OF THE PROPOSALS

The two proposed major amendments to the Metropolitan Region Scheme for the South West Corridor are referred to as Stage A, the northern part covering the City of Cockburn and the Town of Kwinana, and Stage B, covering the City of Rockingham. The specific proposals contained in these two major amendments are reflected on Figure 2.

These two major amendments, when taken in conjunction with the other amendments which are currently being processed, are intended to give effect to the majority of proposals contained in the South West Corridor Structure Plan (see Figure 3). The Structure Plan is part of the metropolitan development strategy for the year 2021.

2.1 The South West Corridor Structure Plan and Rapid Transport Reserve

The South West Corridor Structure Plan, including the recently proposed Rapid Transport Reserve, is the source of the current proposed major amendments to the Metropolitan Region Scheme, both for the Stage A and Stage B Amendments. The main characteristics of the Structure Plan and the Rapid Transport Reserve are described below.

2.1.1 Population Expansion and its Implications for the Environment

The face of urban development in the South West Corridor will change radically over the next 30 years and beyond. Table 1 indicates that the current state of development in the corridor represents only 26% of the ultimate potential population within the corridor.

Table 1 indicates that the 1991 population of the area covered by the Structure Plan was approximately 115,000. Ultimately, it could reach 440,000. Quite clearly, the impact of such population growth will place pressure on currently undeveloped areas, including those which have been identified for conservation purposes. It is important, in the assessment of the issues and recommendations canvassed in this report, that the context of this population growth in the corridor is kept in mind. Unless there is a reconciliation between the conservation and development objectives for the corridor in

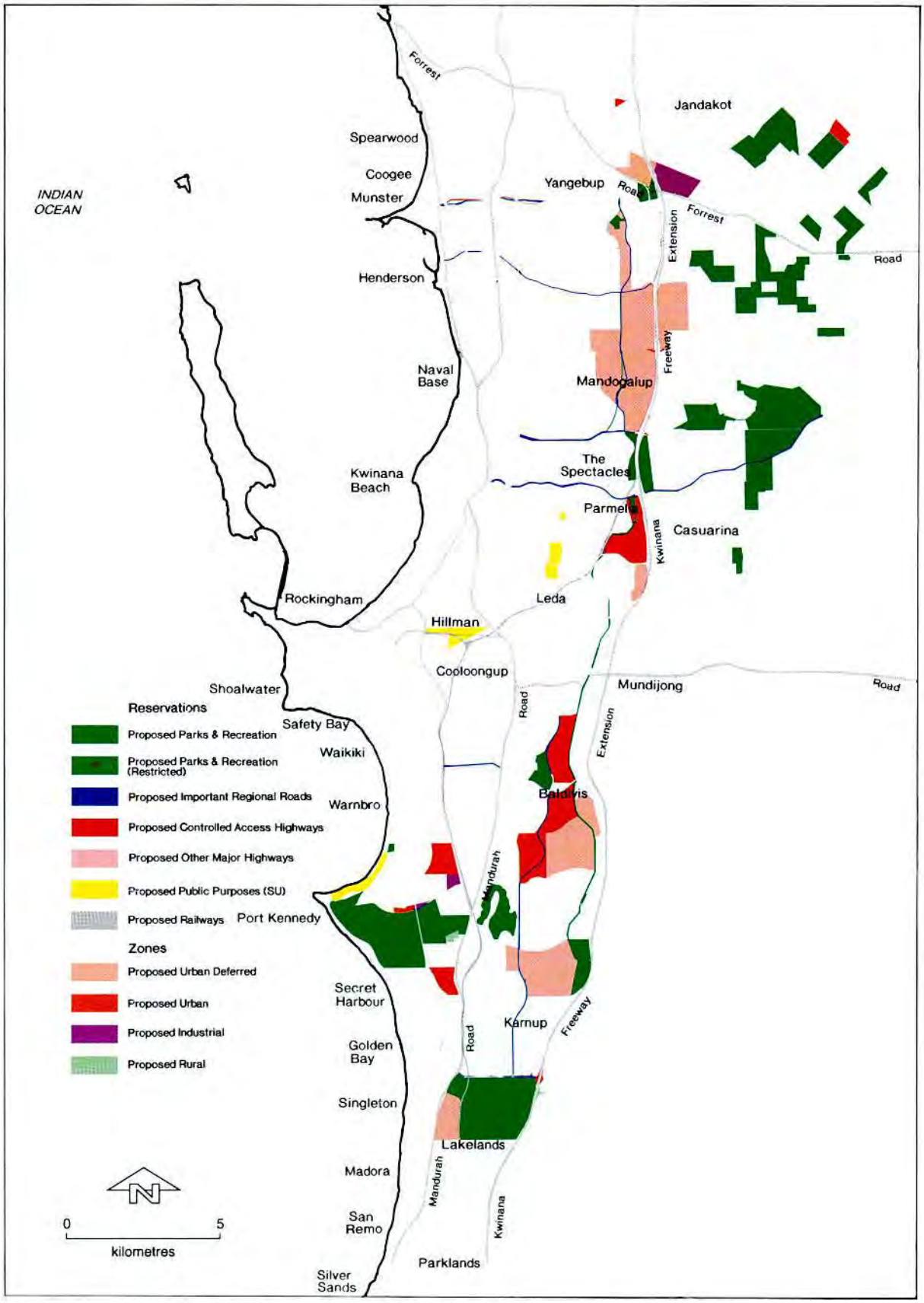

Figure 2 Stage A and B Major Amendments Proposals

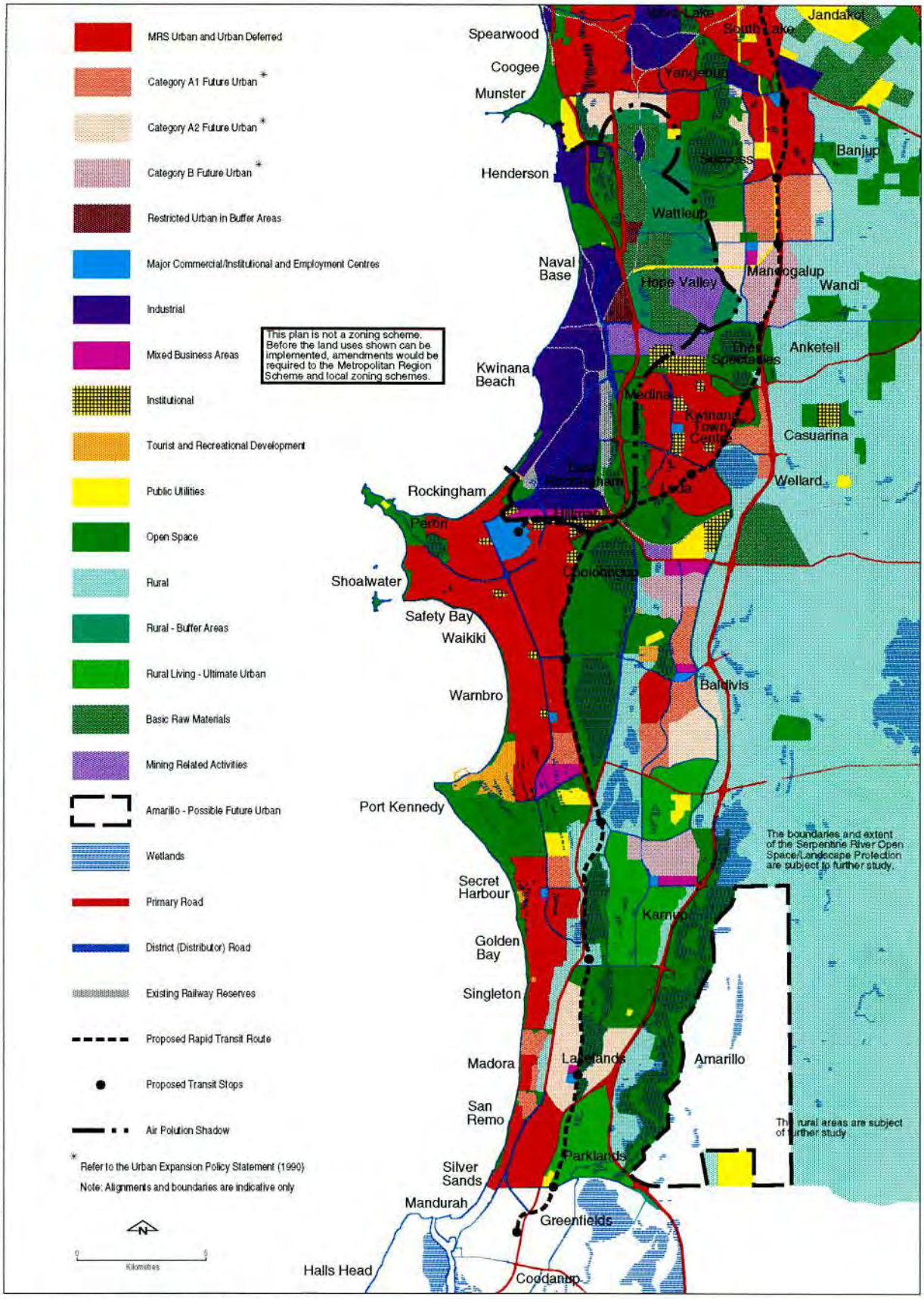

Figure 3 South-West Corridor Structure Plan

Table 1

Population Estimates for the South West Corridor: Current and Ultimate

	1991	Ultimate	Projected Growth
Cockburn	52,200	105,000	201%
Kwinana	17,900	60,000	335%
Rockingham	43,700	215,000	492%
North Mandurah	800	60,000	7,500%
Totals	**114,600**	**440,000**	**384%**

such a manner that both can be sustained in the long term, then the benefits which could accrue through sensible environmental conservation, in balance with development, could be severely compromised.

2.1.2 Extent and Locality of Urban Areas

The extent and locality of much of the urban area reflected in the South West Corridor Structure Plan has been determined over a long period of time, from preliminary structure plans produced in 1974 and the adoption of the first structure plan for the South West Corridor in 1980. The work carried out for the current (1993) Structure Plan was primarily to review those earlier plans in the light of environmental and other constraints which have recently assumed far greater importance in urban planning, with a view to determining the extent and locality of the final boundaries now being included into the Metropolitan Region Scheme by way of former or the proposed amendments to the Metropolitan Region Scheme. The extent of the urban areas, existing and proposed, reflected on the Structure Plan are summarised in Table 2.

Table 2 shows that the urban part of the South West Corridor will expand to about 3.7 times its current size. Cockburn and Kwinana will expand to roughly four times their current size and Rockingham to about three and a half times its current size. The character of these towns will be dramatically changed.

Table 2

Existing and Proposed Urban Areas in the South West Corridor

	1991 Urban Area (ha)	Ultimate Future Area (ha)	% Increase
Cockburn	896	3,565	398%
Kwinana	547	2,346	429%
Rockingham	1,785	6,099	342%
Totals	**3,228**	**12,010**	**372%**

The effect of the environmental constraints such as the Kwinana Air Pollution Buffer Zone[2] and regional drainage and conservation issues show that there is only a relatively low proportion of land within the overall South West Corridor which is unconstrained for urban development. This means that there will be a premium on land which is available and suitable for urban development. Many of the urban areas which have been identified were subject to their own environmental assessments (refer to Section 2.3).

2.1.3 Non-Urban Areas in the South West Corridor

In this context, industrial and commercial developments are counted as urban. Aside from these forms of development, the two major categories of non-urban land in the South West Corridor are regional open space and rural land. Much of the rural land in the South West Corridor has landscape attributes or other constraints which make it unsuitable for urban development. While remaining in private ownership and being entitled to the land use rights allowed within the town planning schemes which embrace the South West Corridor, the rural areas are nonetheless complementary to the regional open space in that they may provide ecological extensions to the regional open space, depending on the extent of native vegetation alteration, and provide buffers between the urban areas.

2.1.4 Rapid Transport Reserve

The proposed rapid public transport reserve, if developed as a railway, would connect the Perth central area with Rockingham and Mandurah via Kenwick, Jandakot and Kwinana.

Footnote 2. As defined in the Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1992.

A Jandakot - Fremantle link is also possible. A more direct Jandakot - Perth link within or alongside the Kwinana Freeway for bus or rail, whilst difficult and relatively expensive, remain long term options. In the long term, the system will provide an opportunity for a further link in the public transport system to service the needs of the rapidly growing hinterland near Mandurah (especially the Mandurah - Pinjarra locality).

The majority of the proposed route either uses existing transport reserves or passes through areas which are largely in public ownership. The areas of private land crossed by the route have not yet been intensively developed. From Forest Road to south of Fremantle, the proposed route is contained within the existing Kwinana Freeway reservation and other reserved areas including parkland. Where the reserve falls outside the Freeway, Ennis Avenue or Mandurah Road reserves, a width of reserve has been allowed to accommodate earthworks, alternative access roads where required, building and landscaping.

For much of the length of the reserve there is little or no flexibility for alternatives in the alignment of the proposed reserve. There are two locations where there is the flexibility for alternative options which have about equal merit; in the Parmelia locality and in the Stakehill locality.

2.2 Complementary Reports and Studies

It is not possible, within the context of the PER, to canvass the full background to the metropolitan development strategy which gives rise to the Structure Plan and the current major amendments to the Metropolitan Region Scheme. For a wider background understanding of the current proposals, the reader is referred to:

- *Metroplan (1990).* The Metropolitan Development Strategy to the Year 2021. This strategy provides the framework for the location and extent of new urban areas, regional open space, conservation, major items of transportation and regional servicing infrastructure and major employment areas. Metroplan was adopted by the State Planning Commission and endorsed by the Government in 1990.

- *Urban Expansion Policy Statement (1990).* This policy gave greater definition to the urban areas identified in Metroplan and provided some preliminary indication of the likely staging of the development areas which were identified.

- *South West Corridor Structure Plan (November, 1993).* A Draft Structure Plan was released with 9 working papers and, together with the Final Structure Plan, provides the rationale for the boundaries on which the proposals in the major Metropolitan Region Scheme Amendment are based. It also provides the basis for the proposals to reconcile conservation and urban development objectives in the South West Corridor.

- *South Jandakot/Mandogalup District Structure Plan (1993).* This Structure Plan covers parts of the City of Cockburn and the Town of Kwinana, and provides the rationale for the major amendments for new urban areas and roads in the Stage A major amendment. It also addresses conservation issues.

- *System 6 Reports Parts 1 and 2 (October, 1983).* Part 1 of the report outlines the general principles and recommendations for the protection of conservation areas identified in Part 2. Part 2 provides conservation recommendations for specific localities, including some which are the subject of this PER. For convenience, the recommendations for those specific localities covered by the South West Corridor Structure Plan and the major amendments to the Metropolitan Region Scheme are included in Appendix B.

- *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992.* This policy identifies particular lakes and wetlands within the South West Corridor and provides for their specific protection.

- *The Draft Peel Region Plan (1990).* The draft Peel Region Plan was released for public comment in October 1990. The plan covers the City of Mandurah and the Shires of Boddington, Murray and Waroona. The plan includes the southern part of the South West Corridor Structure Plan area to the north of Mandurah. The Region Plan proposals are consistent with the Structure Plan.

- *Environmental Protection (Peel-Harvey Estuarine System) Policy (1992).* This policy aims to manage or prevent specified land uses in order to minimise pollution of surface water or groundwater in the Peel-Harvey Catchment, particularly with regard to nutrient pollution. The State Planning Commission has adopted Statement of Planning Policy No. 2, The Peel-Harvey Coastal Plain Catchment (1992), to ensure that land use changes likely to cause environmental damage to the estuary are brought under planning control and prevented.

In addition to the above background material, there have been a number of environmental reviews to differing levels of detail and public participation for specific areas within the South West Corridor. These are available for reference from the Department of Environmental Protection. The areas covered by previous environmental reviews are shown on Figure 4.

2.3 Complementary Amendments to the Metropolitan Region Scheme

In addition to the current proposals reflected on the Stage A and Stage B proposed major amendments, there are a number of other major or minor amendments already being processed and awaiting finalisation. These include:

- Beeliar Regional Park;
- Leda Regional Open Space; and
- Anstey Swamp Parks and Recreation Reserve.

The proposed Stage A and Stage B Amendments to the Metropolitan Region Scheme are considered a rounding-off for the implementation of the South West Corridor Structure Plan. These amendments will essentially complete the picture for much of the future development and conservation within the corridor.

2.4 Public Consultation

The public consultation process for the Stage B major amendment has included the following:

- Establishment of a consultative committee in formulation of the Stage B Structure Plan including considerable environmental representation.
- A Draft Structure Plan and full complement of working papers including environmental analyses were published for public comment between February 1 and May 31 1993. Public workshops and seminars were held.
- From time to time other formal environmental assessments have been undertaken and advertised via the EPA process for various areas in the South West Corridor (See Figure 4).

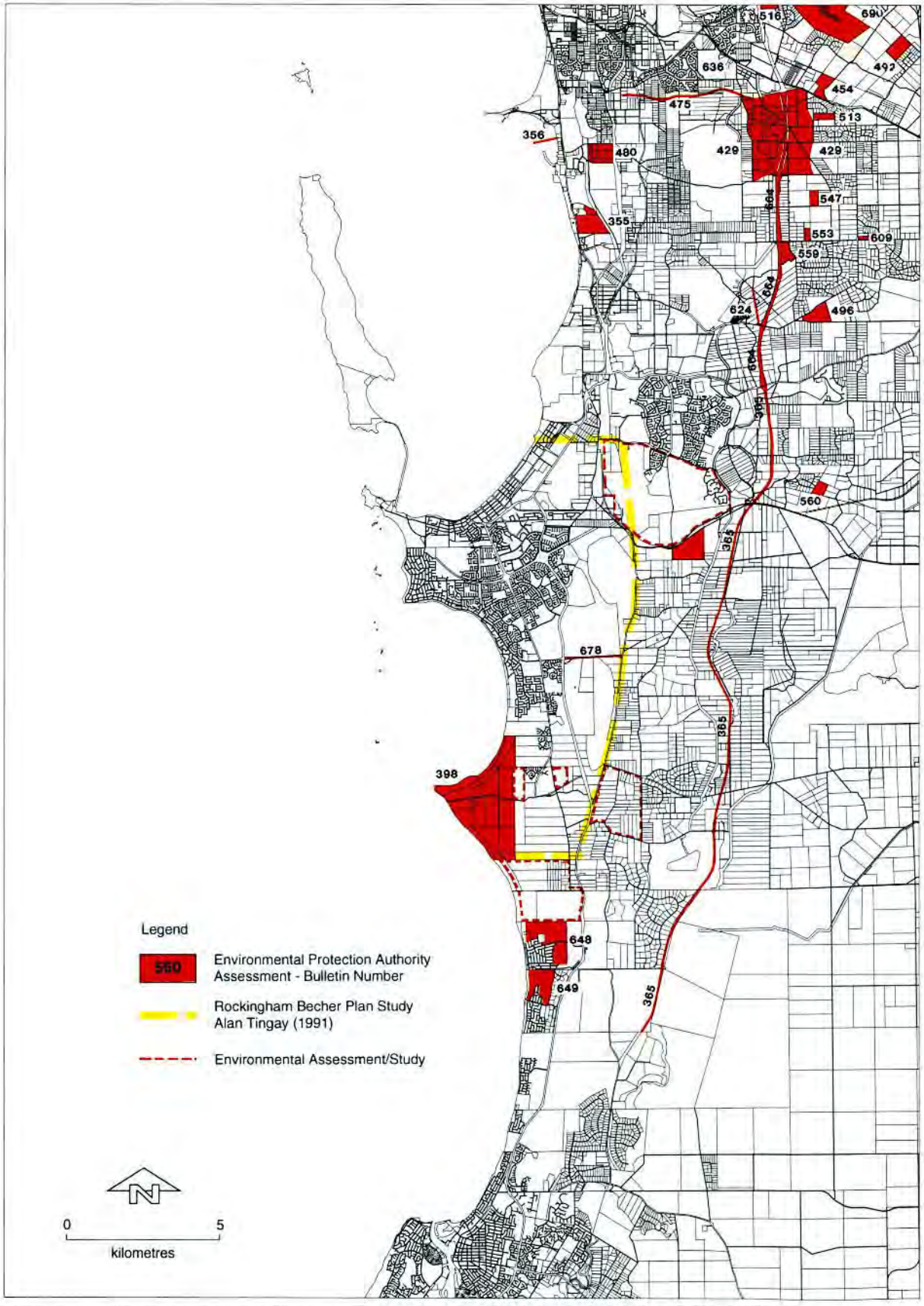

Figure 4 Areas covered by Previous Environmental Revisions in the South-West Corridor

- As part of the major amendment process, supporting reports and structure plans were released. Public meetings were held at Kwinana and Rockingham.
- The whole public consultation process has been open to and widely covered by the local news media.

A summary of public consultation undertaken in 1992-93 specifically for the preparation of the 1993 South West Corridor Structure Plan is presented in Appendix C.

3.0 SPECIFIC ENVIRONMENTAL EFFECTS ON CURRENT SYSTEM 6 AREAS, EPP WETLANDS AND OTHER IMPORTANT WETLANDS

In this chapter, the specific effects that the proposals in the Stage A and Stage B Amendments will have on current System 6 areas, EPP wetlands and other important wetlands are identified. In the context of environmental protection, the word 'effect' is used because there are both positive and negative changes as a result of the proposals. For example, some of the proposals in the major amendments actually enhance the protection of the System 6 and other areas by incorporating them into Parks and Recreation reserves.

In those instances where a negative effect is identified, these proposals are subject to more detailed assessment in Part II.

3.1 Specific Effects on Existing System 6 Areas - Stage A

In the area covered by the Stage A Amendment, the following specific effects have been identified on existing System 6 areas:

- **M92** - The proposed alignment of Beeliar Drive crosses a narrow (60 metre wide) section of M92 in the vicinity of Mayor Road. It also crosses an EPP wetland which is mostly contained within this narrow part of M92. The road reserve through this area has provision for what will initially be a 2 lane road but which could ultimately be a 4 lane road. The reserve width designated on the Metropolitan Region Scheme Amendment is approximately 56 metres wide. This proposal is considered further in Part II.

  In the Structure Plan for the South West Corridor, most of M92 has been designated as open space. The proposal has not been included in the current major Metropolitan Region Scheme Stage A Amendment because the area includes mostly private property and any reservation of such property must be preceded by specific detailed studies. It is intended that this area be incorporated into the Metropolitan Region Scheme by way of another amendment for the metropolitan region which will be initiated later in 1994.

- **M93** - This System 6 area includes the northern part of the Beeliar Regional Park. It is traversed by Russell Road, which is an existing single carriageway road within a 20 metre wide road reserve. In the future, this road will need to be upgraded, still as a single carriageway road, to incorporate improved road drainage and provision for a dual use cyclist/pedestrian path. This will necessitate the road reserve being widened from 20 to 25 metres. Further environmental assessment is conducted in Part II.

- **M99** - benefits from the proposed amendment. The whole of this System 6 area, which is currently zoned Rural, is to be reserved for Parks and Recreation in the Stage A amendment to better reflect its conservation objectives.

- **M100** - benefits from the proposed amendment. This area is currently zoned Rural in the Metropolitan Region Scheme and will be reserved for Parks and Recreation in the Stage A Amendment to better protect the conservation objectives of the reserves.

- **M104** - Leda has been the subject of a separate environmental assessment. The M104 System 6 area has been significantly altered as a result of urban planning in the Leda area under the Leda Structure Plan and a previous Metropolitan Region Scheme Amendment. In the current Metropolitan Region Scheme Amendment for this area, the proposed rapid transport route only passes through the north-west corner of the original configuration of System 6 area M104. However, the rapid transport route also has negative effects within the wider Leda region open space and is assessed in more detail in Part II.

  Overall, with the addition of the Wellard wetlands chain, the Leda region open space may be considered to represent a substantial enlargement of the original area nominated as System 6 M104.

3.2 Specific Effects on Existing System 6 Areas - Stage B

The focus of this PER is on the Stage B proposed major amendment to the Metropolitan Region Scheme because the effects are generally greater than in Stage A. All of the negative effects on current System 6 areas which are identified below are discussed in more detail in Part II.

- **M103** - Rockingham Lakes. There are a number of proposed amendments to the boundaries of System 6 Area M103.

  To the north of the proposed Garden Island Freeway in Hillman, south of Dixon Road, approximately 80ha is intended to be transferred from Parks and Recreation Reserve to Public Purposes Reserve. The uses intended for the Public Purposes Reserve are most likely a combination of tertiary educational and regional sporting facilities, although there are alternative sites under consideration for the tertiary institution in the Kwinana - Rockingham - Mandurah region. It will also be traversed by the proposed rapid transport route. The rationale behind this proposal is discussed in Section 4.

  In the south-west of M103, west of Ennis Avenue, 115ha currently reserved for Parks and Recreation in the Metropolitan Region Scheme is proposed to be rezoned to Urban. The rationale behind this proposal is also discussed in Section 4.

  Immediately to the south of this proposed urban land, the balance of System 6 area M103, west of Ennis Avenue, is proposed to be rezoned from Parks and Recreation Reserve to Industry. This area of 24.4ha is proposed to be added to an existing area of 42.6ha within the initial System 6 Area M103 which was zoned for Industry in 1982, prior to the publication of the System 6 Report. The rationale for this additional rezoning to Industry is also discussed in Section 4.

  The rapid transport route will pass inside the boundary of M103 along much of its alignment, particularly in the northern sector of M103. In the central and southern sectors of M103, the proposed transport reserve will utilise the existing Ennis Avenue road reserve to the greatest practicable extent. Therefore, whilst the rapid transport route will encroach within M103 for all of its length, in many instances the additional width of reserve is minimal.

  It is not possible for the rapid transport reserve to be located on the western side of Ennis Avenue (i.e. outside of M103) because of the existing and proposed urban residential subdivisions in this area.

  The route will occupy up to 52ha within M103. Not all 52ha will be required for railway purposes because it includes small remnant pieces which are trapped

between the rapid transport reserve and Urban zones in Cooloongup or trapped between the rapid transport reserve and the Ennis Avenue road reserve. These areas could be retained as parkland. It is intended that the natural vegetation in these areas will be retained, although they would no longer be contiguous with the remainder of M103. The implications of the rapid transport route are discussed further in Part II.

Safety Bay Road, between Ennis Avenue and Mandurah Road, is an existing road which will need to be upgraded to meet future traffic demand from the Baldivis and Karnup areas. It is proposed that the road improvements be incorporated within the existing road reserve but it will mean a comprehensive redesign and reconstruction of the existing roadworks within the reserve. The implications of this proposal are canvassed further in Part II. The part of Safety Bay Road between Mandurah Road and the future Kwinana Freeway Extension has been subject to a separate Consultative Environmental Review (CER).

There are no other System 6 areas within the South West Corridor that are directly affected by the current proposals for the Stage A and Stage B major amendments to the Metropolitan Region Scheme.

3.3 Specific Effects on Defined Environmental Protection (Swan Coastal Plain Lakes) Policy Wetlands - Stage A

In the Stage A major amendment the following Environmental Protection (Swan Coastal Plain Lakes) Policy wetlands are affected (the EPP wetlands in the South West Corridor are reflected on Figure 5):

(i) Positive Effects

- North of Beeliar Drive, east of the new Forest Road alignment, a small EPP wetland will now be included in a proposed Parks and Recreation Reserve. This area is intended as a regional sporting centre for the City of Cockburn and the development of facilities will need to take account of the protection of this small wetland. Any development in this area will probably be subject to separate environmental assessment.

- East of Beenyup Road, north of Gibbs Road and south of Bartram Road, five small EPP wetlands will benefit by being either totally or partially included in proposed Parks and Recreation Reserves.

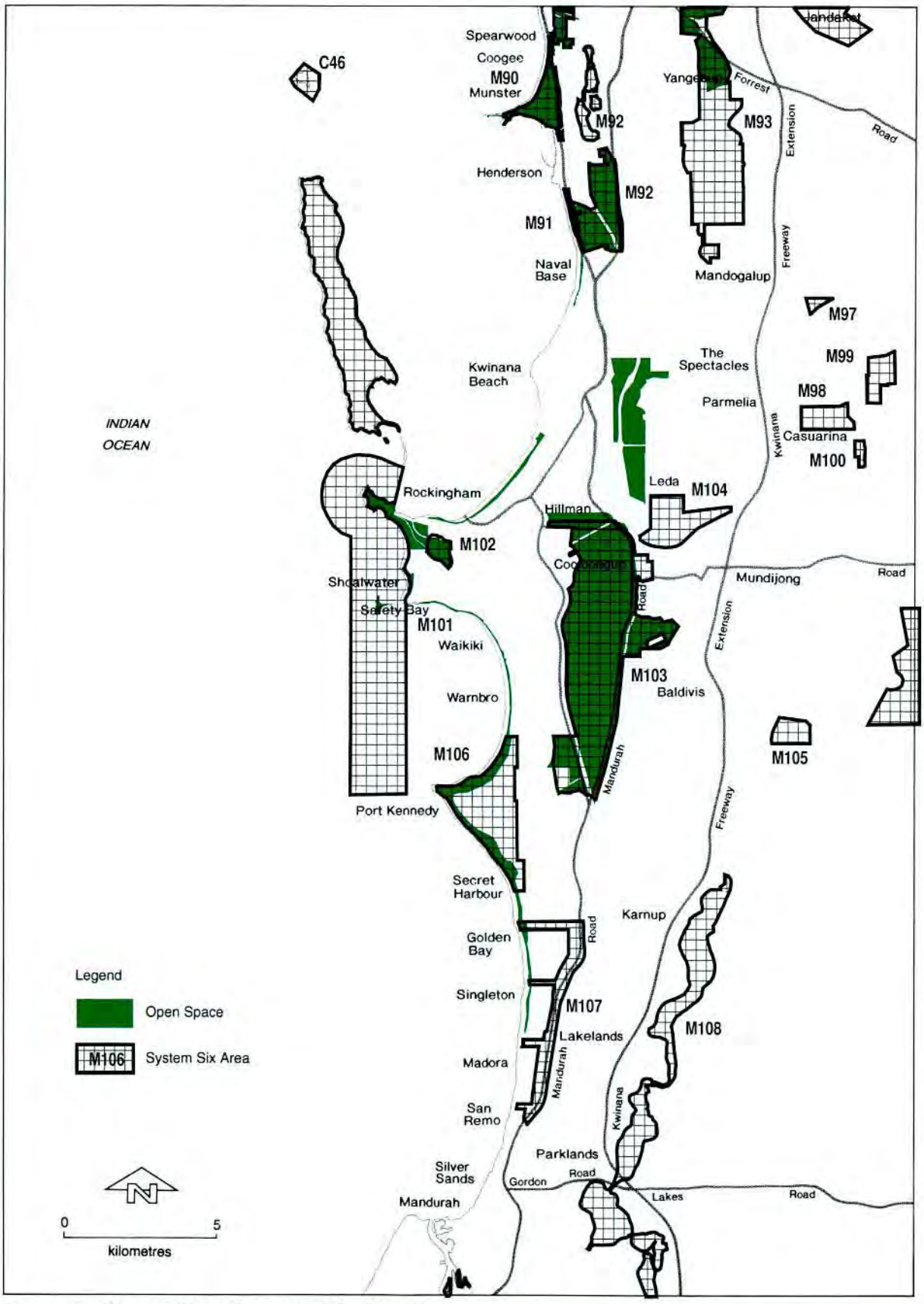

Figure 5 Current Open Space and System Six

- South of Hope Valley Road, north of Anketell Road, an EPP wetland will benefit by inclusion in a proposed Parks and Recreation Reserve.

- North of Thomas Road, east of the Kwinana Freeway, an EPP wetland will benefit by being included in a proposed Parks and Recreation Reserve.

(ii) Negative Effects

- East of Dixon Road, just east of the Mundijong/Kwinana railway line, the proposed rapid transport route will traverse an un-named EPP wetland. This is examined further in Part II.

  Detailed consideration of planning and technical factors in respect of the potential alignments for the rapid transport route has not been able to avoid the negative effect on the EPP wetland described above. The transport reserve must cross the Leda open space and Hillman area to provide the connection between the Kwinana Freeway section of the reserve and the population centre at Rockingham. It can not be moved further north as the public transport route would be required to traverse the Kwinana Industrial Area, which is ruled out on safety grounds due to greater exposure to industrial risk. It can not be moved further south because of Lake Cooloongup.

3.4 Specific Effects on Defined Environmental Protection (Swan Coastal Plain Lakes Policy) Wetlands - Stage B

In the Stage B major amendment proposals to the Metropolitan Region Scheme, the following EPP wetlands are affected:

(i) Positive Effects

- The entire Stakehill Swamp EPP wetland will benefit by being included within a proposed Parks and Recreation Reserve.

- The entire Paganoni Swamp area, north of the metropolitan boundary, including several EPP wetlands, will benefit by inclusion in a proposed Parks and Recreation Reserve.

- In the present explosives reserve just west of the proposed Kwinana Freeway, a small EPP wetland will benefit by being included in a proposed Parks and Recreation Reserve.

(ii) Negative Effects

- Approximately 2km north of Paganoni Road, the proposed Nairn Road arterial route crosses the eastern edge of a small EPP wetland. This road reserve has been set aside on the basis of previous approved Special Rural subdivisions in the locality, hence there is no alternative to the future impact of road construction other than negotiation with adjoining landholders to re-locate the road reserve, with potential compensation implications. DPUD intends to liaise with the City of Rockingham to initiate this negotiation process in an attempt to avoid this impact.

- North of Safety Bay Road, the proposed Eighty Road extension crosses the north-east edge of the Tamworth Hill EPP wetland. The balance of the Tamworth Hill EPP wetland is included in a proposed Parks and Recreation Reserve, which is a positive effect for the future security of this wetland. The Eighty Road extension will only impact a small portion of the wetland; a detailed environmental management plan will need to be prepared to minimise adverse effects on the wetland.

- On the western side of Anstey Swamp, the proposed rapid transport reserve intersects the southern edge of the Anstey Swamp EPP wetland, adjacent to Mandurah Road. Planning considerations related to existing residential developments and future urbanisation proposals preclude the alternative alignment on the western side of Mandurah Road. This is examined further in Part II.

In broad terms, these negative effects can be considered to be balanced or compensated by the proposed addition of substantial areas of wetland to Parks and Recreation Reserve elsewhere in the South West Corridor. For example, the Wellard wetlands in the Leda open space and the "Paganoni Reserve" wetlands represent significant contributions to the conservation estate. The concept of 'compensation' for adverse impacts on specific wetlands, by creating new wetlands or buying existing wetlands on private property and transferring to the State, is now accepted as an environmental management/protection mechanism by EPA (eg. Kwinana Freeway extension to Thomas Road).

There are no EPP wetlands in any of the proposed Urban or Urban Deferred areas in either Stage A or Stage B.

3.5 Effects on Identified "Structure Plan" Wetlands

The Structure Plan features many more wetlands than were identified in the Environmental Protection (Swan Coastal Plain Lakes) Policy (see Figure 6). These additional wetlands were identified from the Environmental Audit for the South West Corridor (Semeniuk, 1991), from aerial photography, through local knowledge supplied by the South West Corridor Advisory Planning Committee and through field inspections. They are considered to represent a comprehensive description of all the important wetlands in the South West Corridor. While in some cases wetlands identified in the Structure Plan more or less correspond to wetlands defined in the EPP, the boundaries are not the same. In most cases, the Structure Plan has identified a broader area than the EPP mapping as being the true representation of the extent of the wetland.

Therefore, in addition to the effects on EPP wetlands as identified in Sections 3.3 and 3.4 above, the proposals in the Stage A and B major amendments include effects on Structure Plan wetlands as outlined below.

In Stage A the following Structure Plan wetlands are affected:

- West of Hammond Road and north of Russell Road two small wetlands are included in an area of proposed Urban Deferred. These wetlands will be accommodated as open space in the local structure planning, which will take into account the Department of Environmental Protection guidelines on buffer zone establishment for wetlands in urban areas, i.e. a 50 metre separation from fringing wetland vegetation or 1 metre AHD in height, whichever provides the greater buffer.

In Stage B the following wetlands are affected:

- The extreme south west of Stakehill Swamp as defined on the Structure Plan (rather than the EPP definition) is marginally affected by the proposed rapid transport reserve. The transport route, as defined on the plan, is relatively close to the fringing vegetation but it is 2 metres AHD higher than Stakehill Swamp because the land on this side of the swamp rises sharply from the edge of the fringing vegetation. A detailed environmental mangement plan will need to be prepared to ensure that development of the rapid transport system would not have any direct impact on the vegetation fringing Stakehill Swamp and its habitat values.

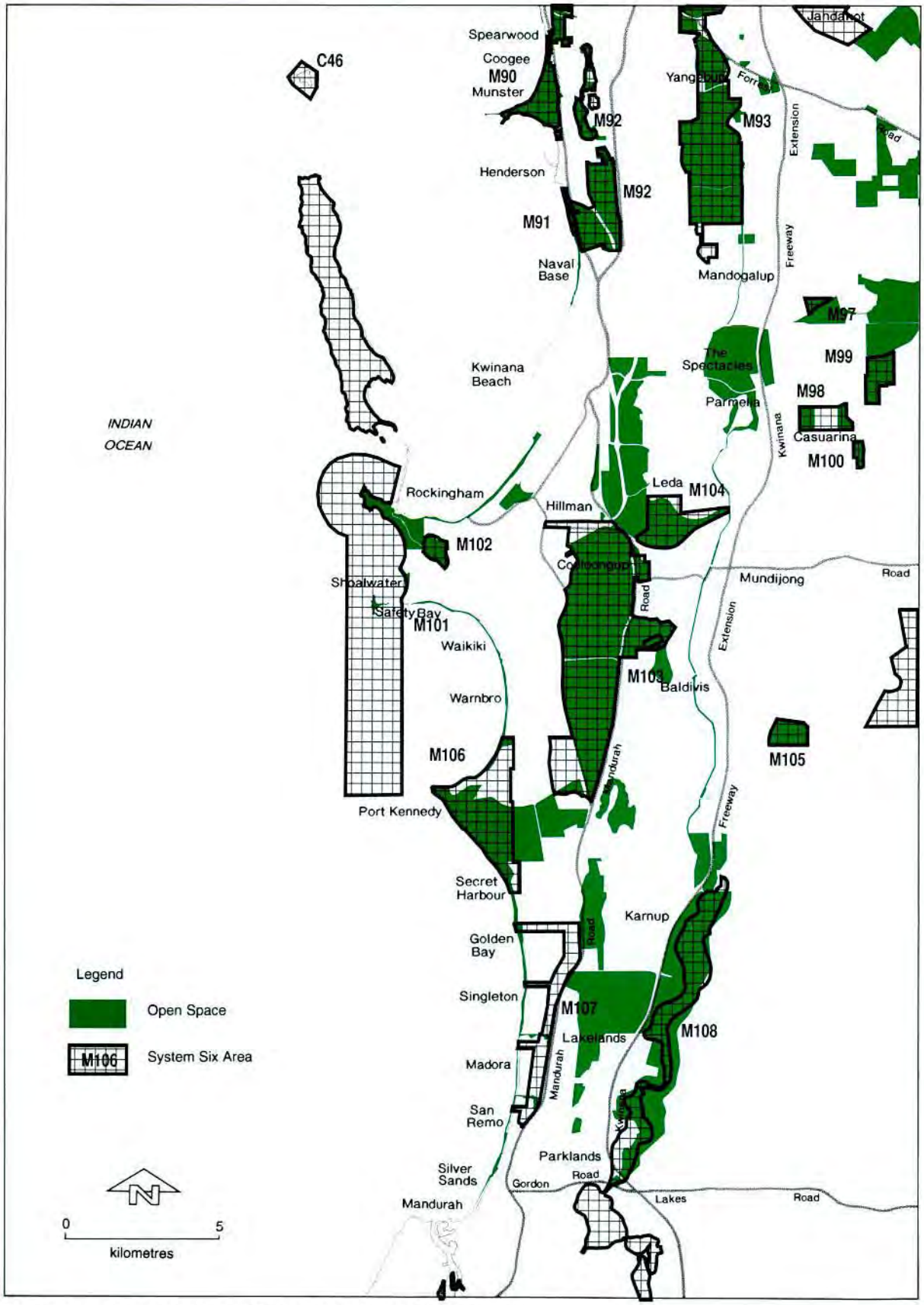

Figure 6 Proposed Open Space and Current System Six

- On the western side of Anstey Swamp the rapid transport reserve, although pushed up against the existing Mandurah Road reserve, cuts through the western side of Anstey Swamp as defined on the Structure Plan wetland mapping. There is no way of avoiding Anstey Swamp because the rapid transport route, which is on the eastern side of Mandurah Road, cannot be pushed any further west than the current alignment of Mandurah Road. Mandurah Road itself also cuts through Anstey Swamp. At the time of construction of the rapid transport route a detailed environmental management plan will be required to ensure that the construction is done in such a way as to minimise the impact on the swamp.

- On the north eastern side of Tamworth Hill Swamp, the Structure Plan wetland mapping shows a small part of the swamp extending into the proposed urban area. This part of the wetland has been completely cleared for grazing and is hardly recognisable as part of the wetland other than that it becomes waterlogged during winter. The proposed urbanisation in this locality will need to take account of this low lying area, which will most likely be included in local open space, and drainage and water quality considerations.

4.0 PROPOSALS FOR THE RECONCILIATION OF LAND DEVELOPMENT AND CONSERVATION OBJECTIVES IN THE SOUTH WEST CORRIDOR

This section reviews the strategic conservation/recreation proposals for the whole South West Corridor and therefore presents the regional framework for assessment of the environmental acceptability of the Stage A and B amendment proposals. The principles and rationales presented below are the key to fulfilling the function of the PER, as previously discussed in Section 1.2.

The following sections of the PER:

- examine the current configuration of System 6 areas in the South West Corridor, including their objectives and rationales, to allow consideration of potential boundary changes;

- compare the proposed Parks and Recreation Reserves to current System 6 areas to assess the degree to which the System 6 recommendations would be implemented and to highlight the inconsistencies with System 6;

- analyse the extent to which existing System 6 areas and proposed Parks and Recreation Reserves (i.e. "proposed System 6") relate to the distribution of wetlands and remnant vegetation and therefore conduct a strategic comparison of conservation objectives.

This assessment seeks to demonstrate the manner in which these amendments and subsequent proposed amendments (i.e. to complete the South West Corridor Structure Plan) will achieve optimum objectives for conservation within the context of a future urban corridor.

4.1 Comparison of Current System 6 Areas and Gazetted MRS Parks and Recreation Reserves

Within the area covered by the Structure Plan for the South West Corridor there are 18 System 6 areas or parts of System 6 areas represented (note that the Structure Plan is wider than the area covered by the Stage A and Stage B amendments).

Where the border of the Structure Plan cuts through a System 6 area, only that part of the System 6 area which falls within the border has been considered for the purposes of the following discussion.

For convenience, the full text and recommendations for each of the 18 System 6 areas have been extracted from the System 6 Report and are included as Appendix B. Also, the general recommendations from Part I of the System 6 Report, which are applicable to the 18 System 6 areas, have been extracted and are included in Appendix B.

The primary objective of the System 6 areas in the South West corridor is conservation. However, it is fair to say that determination of the location and extent of the System 6 area at the time they were selected was not based solely on the environmental attributes of the region. The boundaries of the System 6 areas often follow cadastral, rather than ecological, boundaries and/or match existing Government owned land. For the most part, the System 6 are Government owned land or reserves.

There are notable exceptions, however, in which System 6 areas were designated over private land and where the boundaries do correspond more closely to the environmental elements which were sought to be conserved, such as M105 (the Lowlands property) and M108 (Goegrup Lakes), in the lower reaches of the Serpentine River.

The one significant departure from the conservation philosophy of the System 6 areas was M107 through Peelhurst, Singleton and Madora. The rationale behind this area, which is almost entirely over private property, is primarily directed towards *landscape protection*, with a view to protecting the rural landscape along Mandurah Road. It is noted that the boundaries of parts of M107 have recently been modified in accordance with EPA determinations of development proposals in the Singleton and Peelhurst areas.

To date, of the 18 System 6 areas (or part areas) represented in the South West Corridor Structure Plan, only M90, M102 and M103 and parts of M91, M92 and M93 have been incorporated into the Metropolitan Region Scheme as Parks and Recreation Reserves. The situation is about to be improved with the imminent gazettal of a Parks and Recreation Reserve over the balance of area M93, the northern part of the Beeliar Regional Park.

From a strategic perspective, unless the System 6 areas are ultimately incorporated into Parks and Recreation Reserves in the Metropolitan Region Scheme, their long term conservation and protection will not be assured. Reservation is the first step in the

planning process for implementation of the System 6 recommendations for each identified area. Following reservation, the land needs to be purchased by the State (if in private ownership) or vested in the relevant managing authority (if Crown land). Preparation of a management plan and its implementation is the final step.

Bearing in mind that the South West Corridor will undergo transformation from a largely rural area to a largely urban one, the following conclusions can be drawn regarding the current status and configuration of System 6 areas in the Corridor:

- While the System 6 areas generally encompass valid conservation resources, there are a number of important conservation areas and attributes in the South West Corridor that are not reflected in the System 6 areas.

- The boundaries and location of the System 6 areas often follow cadastral boundaries rather than the boundaries of the physiographic, hydrological or natural vegetation systems within the corridor. Their shape, size and distribution appear to be strongly influenced by the fact that they are mostly Government owned land or reserves.

- While conservation is important, so too is good urban form. In some instances the location, shape and size of System 6 areas are both inconsistent with ecological boundaries and incompatible with future development requirements for the South West Corridor as an urban corridor. Where the boundaries of the System 6 areas do not correspond to ecological boundaries or areas of particular conservation values they are unlikely to be sustainable as conservation reserves and should be reviewed. In the same way, important conservation areas not currently recognised by System 6 recommendations need to be brought into the reserves system.

With the hindsight of improved inventory and understanding of conservation resources and values, it is easy to criticise the original System 6 Study and highlight faults. However, that is not the intention of this discussion. Neither does this critique aim to justify alterations to System 6 areas simply to achieve development objectives. The purpose is to point out that the System 6 boundaries are not always ecological and therefore not absolute, and that proposals to change boundaries should be considered on

their merits. There is no reason why the boundaries of the System 6 areas in the South West Corridor should not be altered, provided the amended System 6 areas still reflect the intent of the System 6 objectives.

Therefore, it is proposed that the current arrangement of System 6 areas should be reviewed to reconcile them with the conservation and development objectives for the corridor and, in so doing, enhance their prospect as sustainable conservation reserves into the future.

This review will be guided by four overriding objectives or criteria:

(1) There should be no net loss in the area of System 6 "reserves" in the South West Corridor (refer to Table 3).

(2) The boundaries and location of the System 6 reserves should be related as far as is practicable, to the environmental features which they are seeking to protect.

(3) The System 6 reserves should focus on regionally significant conservation resources and should contain representative examples of the range of vegetation complexes and communities, native flora, fauna and fauna habitats which are present in the region.

(4) There must be mutual recognition between the conservation and urban objectives, and all the infrastructure that this entails, in defining appropriate boundaries for areas that will be sustainable as conservation reserves into the long term future, and which can be protected by way of Parks and Recreation or Open Space reserves in the Metropolitan Region Scheme and Local Town Planning Schemes.

4.2 Comparison of Current System 6 Areas and Proposed Parks and Recreation Reserves

By reference to Figure 7, it can be seen that the proposals for open space in the South West Corridor Structure Plan which are being implemented, in part, by the current Stage A & B amendments will achieve a substantial increase in the formal reservation of System 6 areas, where these have been considered appropriate. (Additional amendments will be initiated on a staged basis in the future to implement the balance of Structure Plan proposals for open space/conservation.) The anomalies are discussed below.

Table 3

South West Corridor Calculation of System 6 Areas (Part or Complete)[1].

Existing System 6	Area (ha)[2].	Proportion Measured in Study Area
M90	242.1	Part
M91	29.4	All
M92	688.3	Part
M93	1395	Part
M94	244.9	Part
M96	1209	All
M97	30.6	All
M98	172.4	All
M99	155.5	All
M100	32.8	All
M101	2937	All
M102	81.5	All
M103	2570	All
M104	371.7	All
M105	570.7	Part
M106	859.2	All
M107	492.5	All
M108	1394	Part
Total Area	**13476**	

Notes:

1. The reference to Part or Complete (All) relates to the boundary of the Structure Plan or "Study Area", in which some of the 18 System 6 areas continue outside of the Structure Plan.

2. In subsequent tables which present areas of System 6 recommendations, the areas include only those parts which fall within the Structure Plan border.

In M92, the small areas not included in the Parks and Recreation Reserve will be incorporated into local open space during the development process.

In M93 (Beeliar Regional Park), the boundaries for the Parks and Recreation Reserve have now been determined through the Beeliar Regional Park Study and are the final agreed boundaries. On the northern side of M93, it is unlikely that the parts of the System 6 area outside the Parks and Recreation reserve (coloured green) will be included. On the southern side of M93, the spur of System 6 land, incorporating two wetlands, which is outside the Parks and Recreation Reserve will be protected in local open space.

The central portion of System 6 area M98, Casuarina Prison, will remain a Public Purposes reserve, but the areas either side will become Parks and Recreation reserve.

Area M104 has already been the subject of an environmental assessment as part of the Leda Structure Plan. The boundary of the Parks and Recreation Reserve does not coincide with the northern boundary of M104, which is to be incorporated into the Leda urban area.

In area M103, the northern extremity shown outside the proposed Parks and Recreation Reserve boundary will be cut off from the body of M103 by the future Garden Island Highway. This northern section is proposed for educational or recreational development which may involve the comprehensive modification or removal of existing vegetation on the site. The south-west corner of M103 is proposed to be removed from the current Parks and Recreation Reserve and rezoned for urban and light industrial purposes. However, as discussed in Section 4.3 below, other areas will be added to M103 (in Lark Hill and around the Tamworth Hill Swamp) and, whilst there are recognisable differences in values between the proposed excisions and additions, M103 will remain an area of open space with regional significance.

M106 (Port Kennedy) is mostly proposed as a Parks and Recreation Reserve in the Stage B Amendment. It was formerly a Public Purposes Reserve in the Metropolitan Region Scheme. The northern part of this reserve now falls under the Port Kennedy Act (1992) and is to be developed as a Tourist Resort. Consequently, the area which has been designated under the Act for a Tourist Resort has been excluded from the proposed Parks and Recreation Reserve. A small portion of M106 in the southern sector has been included in the Secret Harbour Urban Development area as a result of the environmental assessment for Secret Harbour. The foreshore reserve has been widened at Secret Harbour during the development process, and for the purposes of this analysis, is included as the southern portion of M106.

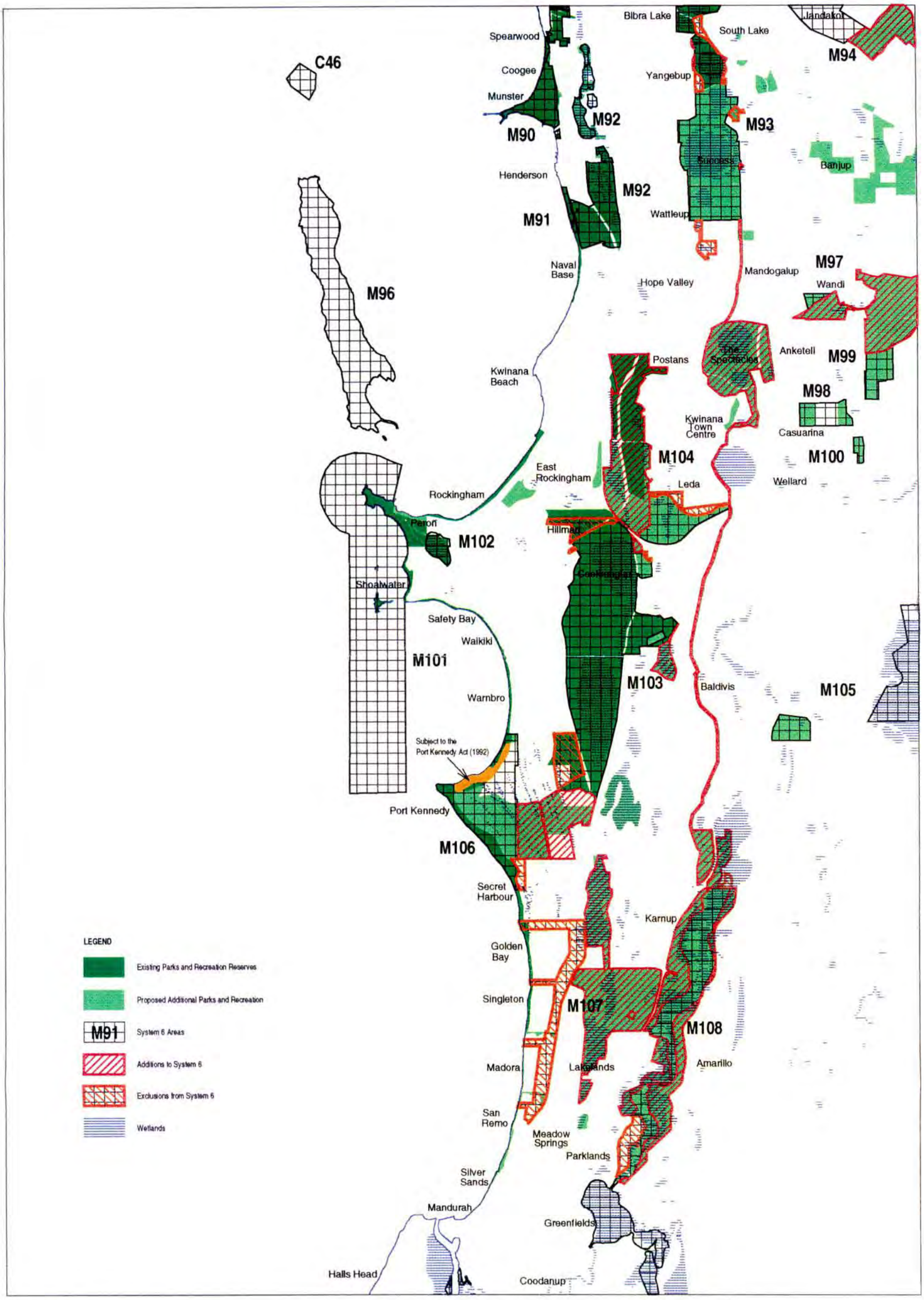

Figure 7 Existing & Proposed System 6 & Parks & Recreation Reserves

Virtually none of System 6 area M107 is included in Parks and Recreation Reserve, aside from the coastal foreshore reserve and fairly narrow open space lateral wedges as is now proposed in the local structure plan for the Madora area. All of M107 is in private ownership, and most of it has been subdivided and sold either as special rural zones or is to be developed for urban purposes.

A new System 6 area is proposed to include the newly created Paganoni Swamps Parks and Recreation Reserve. This area is proposed to replace M107 and provides a substantial area of wetland habitat in excellent condition which will help to compensate for any loss of portions of other EPP wetlands or System 6 areas due to proposed land use changes in the Structure Plan.

In the south-western sector of M108, a relatively small proportion of this Sytem 6 area has been excluded from the proposed Peel Regional Park open space because it has been subdivided and alienated as a special rural zone.

4.3 Reconciling System 6 with Strategic Planning and Conservation Objectives in the South West Corridor

There would appear to be obvious advantages in reconciling the location and boundaries of some of the original System 6 areas in the South West Corridor with the strategic planning and conservation objectives embodied in the Structure Plan for the South West Corridor.

The proposed reconfiguration of System 6 is compared with existing System 6 areas on Figure 7. Note that not all of the System 6 areas are affected by the proposed reconfiguration. A broad analysis of the proposed reconfiguration is conducted in the sections which follow.

4.3.1 Modifications to System 6 and Comparative Analysis of Land Areas (hectares)

The modified System 6 areas are identified and briefly described below, followed by a comparison of original versus proposed areas of land in terms of overall hectares.

M93 has been expanded to include the Spectacles and the so-called Baldivis Tramway Park Strip which connects the Beeliar Regional Park through the Spectacles and Leda Regional Open Space to the Serpentine Regional Park, Peel Regional Park and beyond. The principle of linking these regional parks is considered a most important open space/recreation objective in the planning of the South West Corridor.

Areas M97 and M99 have been expanded to incorporate major elements of the Jandakot Botanic Park.

M104 has been reconfigured to include all of the regional open space on the southern and eastern side of Leda and the Town of Kwinana.

M103 (Rockingham Lakes) has been reconfigured to include the Tamworth Hill Swamp and parts of Lark Hill. It is proposed to include the Water Authority Treatment Site and an area to be retained as a public purpose reserve on the southern side of Lark Hill. Both of these latter areas, while reserved for Public Purposes, will retain most of their natural vegetation and will form an integral part of the conservation belt linking the Rockingham Lakes Regional Park to the Port Kennedy regional open space.

M106 (Port Kennedy) has been expanded eastwards to meet the expanded area M103 at the future alignment of Warnbro Sound Avenue. M106 also includes all of the coastal foreshore reserve which will extend in a continuous strip from the northern side of Port Kennedy down the coast into the City of Mandurah, as far as the study area boundary at Silver Sands.

M107 (Madora, Singleton) has been substantially modified to allow for future urban development. It will essentially comprise two east-west strips, retained in accordance with the local structure plan for the Madora area, and the foreshore reserve. The Paganoni Reserve, on the eastern side of Mandurah Road, is nominated as a new System 6 area and for the sake of continuity, is labelled as M107. This comprises a large area of remnant vegetation in good condition (Lots 1 and 2 Paganoni Road) and also includes Paganoni Swamp and its southerly extensions into Mandurah. It also extends northwards to include Anstey Swamp.

M108 has been adjusted to reflect the boundaries of the regional open space in the Structure Plan. This proposed regional open space does not form part of the current major amendment to the Metropolitan Region Scheme because structure planning for the area is not yet complete and implementation is complicated by the fact that M108 'straddles' the MRS boundary. The original boundaries to M108 were nominal only and the boundaries shown on Figure 7 reflect a substantial enlargement. The boundaries may be subject to minor modification with the planning of the Amarillo area and the final determination of the boundaries for the Peel Regional Park.

A comparative analysis of the relative areas of the current System 6 areas and the proposed System 6 'reserves' is provided in Table 4.

Table 4 demonstrates that the proposed re-configuration of the System 6 areas in the South West Corridor meets criterion (1) proposed in Section 4.1 and generally required by the Department of Environmental Protection that any re-configuration or impingement should not reduce their overall area. There are no reductions in area of any System 6 'reserve' in the south West Corridor due to the above proposals. Overall, the proposed re-configuration of System 6 adds an additional 3,883 hectares or 29% to the current combined area of the System 6 'reserves' in the South West Corridor Structure Plan.

4.3.2 Analysis of Wetland Conservation in Proposed System 6

A most important conservation objective for the South West Corridor is the conservation of the wetlands in the region. As part of the structure planning process, care was taken to identify all the important wetlands in the South West Corridor, which included those identified in the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* and others identified in the Environmental Audit for the South West Corridor (Semenuik, 1991), which included work undertaken by the same consultant who mapped all of the wetlands of the Swan Coastal Plain. It is considered that the wetlands identified on the Structure Plan are a comprehensive inventory of the wetlands worthy of conservation in the South West Corridor. Table 5 below compares the extent to which these wetlands are contained within the existing and proposed System 6 areas.

Table 5 shows that, of the total area of 6,613ha of wetlands identified on the Structure Plans (which includes EPP wetlands), 3,974ha or 60% would be contained within the proposed re-configuration of System 6 Reserves, compared to 3,223 or 49% in existing System 6. This represents a 23% improvement of the proposed re-configuration over the existing. Overall, the proposed changes to System 6 achieve an enhancement of wetland protection. The improvement is not so substantial for EPP wetlands but nevertheless represents a 1% improvement.

Table 5 also indicates that, while the proposed re--configuration of System 6 reserves embraces considerably more of the wetlands in the South West Corridor than the current System 6 areas, and while other wetlands will be conserved in proposed Parks and Recreation Reserves outside System 6, there will still be a considerable number of important wetlands which fall outside the protection of these reserves. It is an objective of

Table 4

Comparative Analysis of Areas: Existing System 6 and Proposed Modified System 6 Areas

Existing System 6 Configuration	Area (ha) from Table 3	Proposed System 6 Configuration	Area (ha)	% Difference
M90	242.1	M90	242.1	0%
M91	29.4	M91	29.4	0%
M92	688.3	M92	688.3	0%
M93	1395	M93	2182	+56%
M94	244.9	M94	523.5	+114%
M96	1209	M96	1209	0%
M97	30.6	M97	158	+416%
M98	172.4	M98	172.4	0%
M99	155.5	M99	674	+333%
M100	32.8	M100	34.1	+4%
M101	2937	M101	2937	0%
M102	81.5	M102	81.5	0%
M103	2570	M103	2697	+5%
M104	371.7	M104	1239	+233%
M105	570.7	M105	570.7	0%
M106	859.2	M106	1159	+35%
M107	492.5	M107	0	-100%
M108	1394	M108	1649	+18%
Paganoni	0	Paganoni	1114	+100%
Total Area	**13476**	**Total Area**	**17359**	**+29%**

Table 5

Area of Wetlands Contained in Existing System 6 Compared to the Proposed Re-configured System 6 Reserves

	Total Wetland Area in Study Area (ha)	Total in P & R (Existing and Proposed) (ha)	In Existing System 6 (ha)	In Proposed System 6 (ha)
EPP Wetland	3168	2011	1880	1915
Structure Plan Wetlands	6613	3762	3223	3974

the Structure Plan (to be carried through to more detailed district and local structure planning) that all wetlands shown on the Structure Plan will be protected in accordance with standards acceptable to the Department of Environmental Protection. Guidelines have been prepared for wetland protection via the provision of appropriate buffer zones, as discussed previously, and water balance and nutrient pollution issues will also need to be addressed.

4.3.3 Analysis of Remnant Vegetation Conservation in Proposed System 6

Another important conservation objective for the South West Corridor is the protection of remnant vegetation. The following analysis is based on preliminary data being collected for the Perth Environmental Plan and has been collated and analysed through the departmental geographic information system (GIS).

The remnant vegetation in the South West Corridor, as mapped and classified by the Department of Agriculture, is illustrated on Figure 8. An assessment of the representation of remnant vegetation in existing and proposed System 6 areas is provided in Table 6.

Care must be taken in interpreting the results in Table 6 because of a complete lack of data for the north-western and northern parts of the study area covering System 6 areas M90, M91, M92, the northern part of M93 and the northern part of the proposed

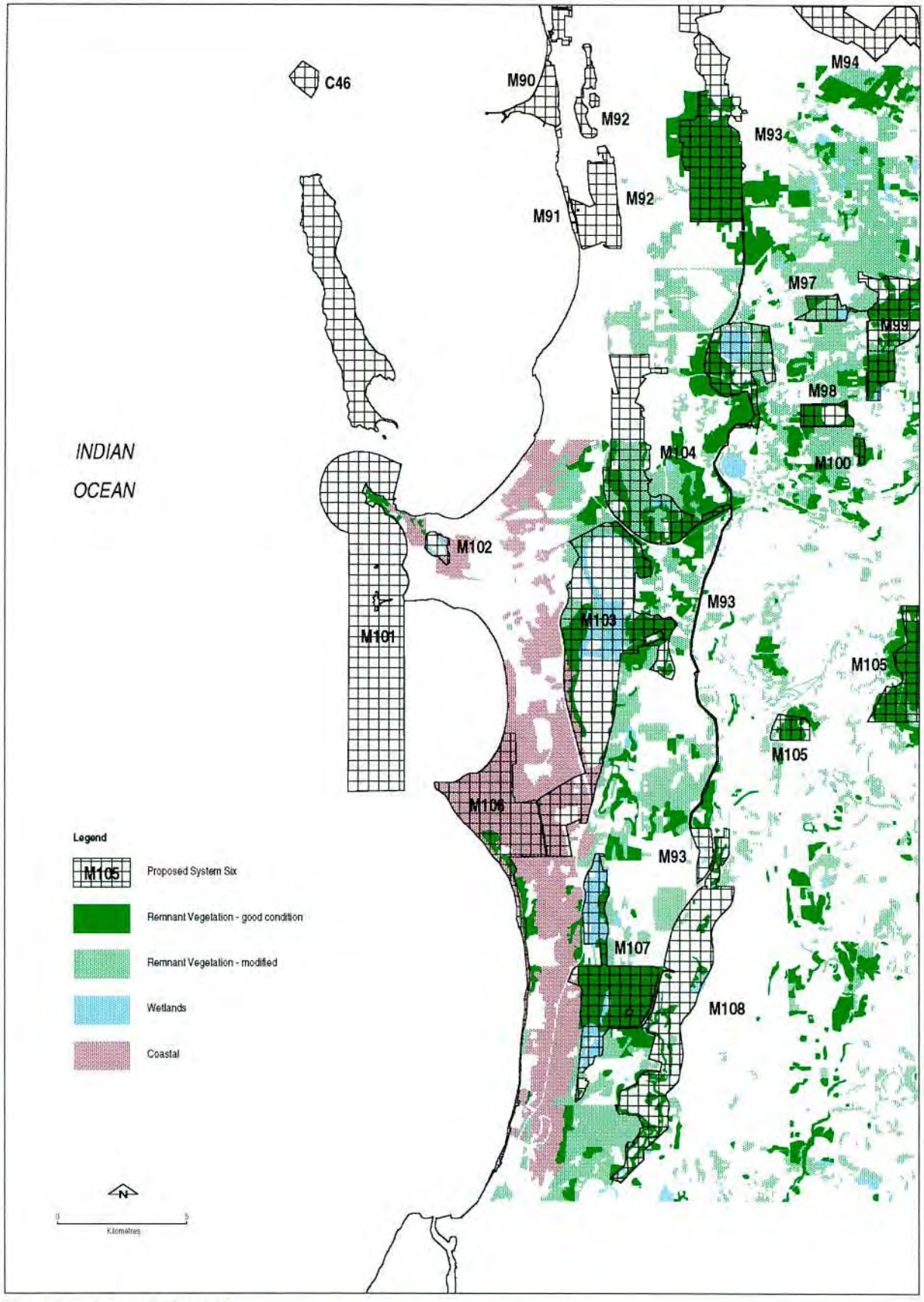

Figure 8 Remnant Vegetation

Table 6

Condition of Areas of Remnant Vegetation in Current System 6 Reserves Compared to Areas in Proposed Re-configured System 6 Reserves

EXISTING SYSTEM 6	Total Area (ha)	Good Area (ha)	Modified Area (ha)	Wetland Area (ha)	Coastal Area (Ha)	Un-classified Area (ha)	PROPOSED SYSTEM 6	Total Area (ha)	Good Area (ha)	Modified Area (ha)	Wetland Area (ha)	Coastal Area (ha)	Unclassified Area (ha)
M90	242					242	M90	242					242
M91	29					29	M91	29					29
M92	688					688	M92	688					688
M93	1395	921				474	M93	2182	1168	205	125		684
M94	245					245	M94	524					524
M96	1209					1209	M96	1209					1209
M97	31	29				2	M97	156					158
M98	172	113	1			58	M98	172	113	1			58
M99	156	139	2	14		1	M99	674	405	179	29		61
M100	33	32	1				M100	34	33	1			
M101	2937					2937	M101	2937					2937
M102	82			26	21	35	M102	82			26	21	35
M103	2570	498	298	349	348	1077	M103	2697	502	214	346	44	1590
M104	372	206	127	16		24	M104	1239	315	425	16		484
M105	571	445	39			87	M105	571	445	39			86
M106	859	70			752	37	M106	1159	65			1028	66
M107	493	66	8		386	33	Paganoni	1114	677	31	325	10	70
M108	1394	137	115	31		1111	M108	1649	279	63	28		1280
Total Area	**13476**	**2654**	**591**	**436**	**1507**	**8289**	**Total Area**	**17359**	**4002**	**1158**	**894**	**1103**	**10202**

Source: Dept Agriculture, 1993.

Notes:
1. In the above table "Unclassified Area" means that there was no data available on the condition of remnant vegetation, or the area was cleared or was under water or did not fall into one of the categories below.
2. "Good" includes vegetation assessed as being in good or slightly modified condition and includes dense coastal shrubland.
3. "Modified" includes remnant vegetation which has been parkland cleared or has degraded understorey or is modified vegetation in Special Rural Zones.
4. "Wetland" includes wetland association vegetation in good condition.
5. "Coastal" includes sparse coastal shrubland and coastal health.

re-configuration of M104. M96 (Garden Island) and M101 (Cape Peron, Shoalwater Bay and Warnbro Sound Marine Park) were also not classified. Nevertheless, in areas for which data are available, the comparison between the current configuration of System 6 and the proposed re-configuration of System 6 reserves shows that the proposed System 6 captures more remnant vegetation in all classes than the existing configuration of System 6 areas, other than for coastal vegetation. The comparative data in Table 6 are summarised in Table 7 for each of the vegetation categories (as defined in Table 6).

Table 7 shows that the proposed re-configuration of the System 6 reserves for the South West Corridor generally achieves improved conservation of remnant vegetation. It shows that the proposed re-configuration accommodates significantly more remnant vegetation in all categories except the coastal category. The reduction in the coastal category is to be expected because of the excision of M107, which accounts for most of the reduction, and the adjustments in the south-east corner of M103 (west of Ennis Avenue). Note that there is a substantial addition to the coastal category in M106.

4.3.4 Analysis of Representation of Natural Vegetation Complexes in Proposed System 6

In addition to conservation of remnant vegetation, another important objective is to ensure that some proportional representation of the natural vegetation systems in the South West Corridor is protected in the conservation reserves (see Figure 9). Determination of the proportion of each natural vegetation system which should be preserved is beyond the scope of this PER, but will be one of the subjects covered in the forthcoming Perth Environmental Plan. At present there is no Government policy on the proportion of natural vegetation complexes which should be conserved. Nevertheless, it is interesting to observe how the current configuration of System 6 areas compares to the proposed re-configuration of System 6 reserves regarding the protection of different natural vegetation systems. Natural vegetation complexes are mapped on Figure 9 and summarised relative to the existing and proposed configuration of System 6 in Table 8.

Table 8 indicates that the proposed re-configuration of System 6 reserves will achieve a better coverage of natural vegetation complexes than do the current System 6 areas. However, the data in Table 8 provide no indication of the extent of remnant vegetation in each of the natural vegetation complexes. Further analysis has been conducted to ascertain the areas of 'good condiiton' remnant vegetation and wetland associations in each complex identified in Table 8. These data are provided in Table 9 and generally show a marked improvement in representation of good condition vegetation and wetland associations.

The above analyses are based on preliminary data and are therefore subject to refinement. Nevertheless, the data are sufficient for the purposes of this PER to indicate the relative merits of the proposed re-configuration of System 6 as put forward in the South West Corridor Structure Plan. While it is true that some natural vegetation groups would appear to be under-represented in the open space or System 6 reservations as currently exist or are now proposed, the current Stage A & B Amendments do at least reflect an improvement in the situation and lay the basis for further initiatives in the Metropolitan Region as part of the proposed Perth Environmental Plan.

Table 7

Summary of Vegetation Condition

Represented in Current System 6 Compared to Proposed Re-configured System 6 Reserves

Remnant Vegetation Categories	Current * System 6 (ha)	Proposed * System 6 (ha)	Difference (ha)	%
Good	2654	4002	+1348	+51%
Modified	591	1158	+567	+96%
Wetland	436	894	+458	+105%
Coastal	1507	1103	-404	-27%

* Note: These figures exclude areas from Table 6 for which there were no data.

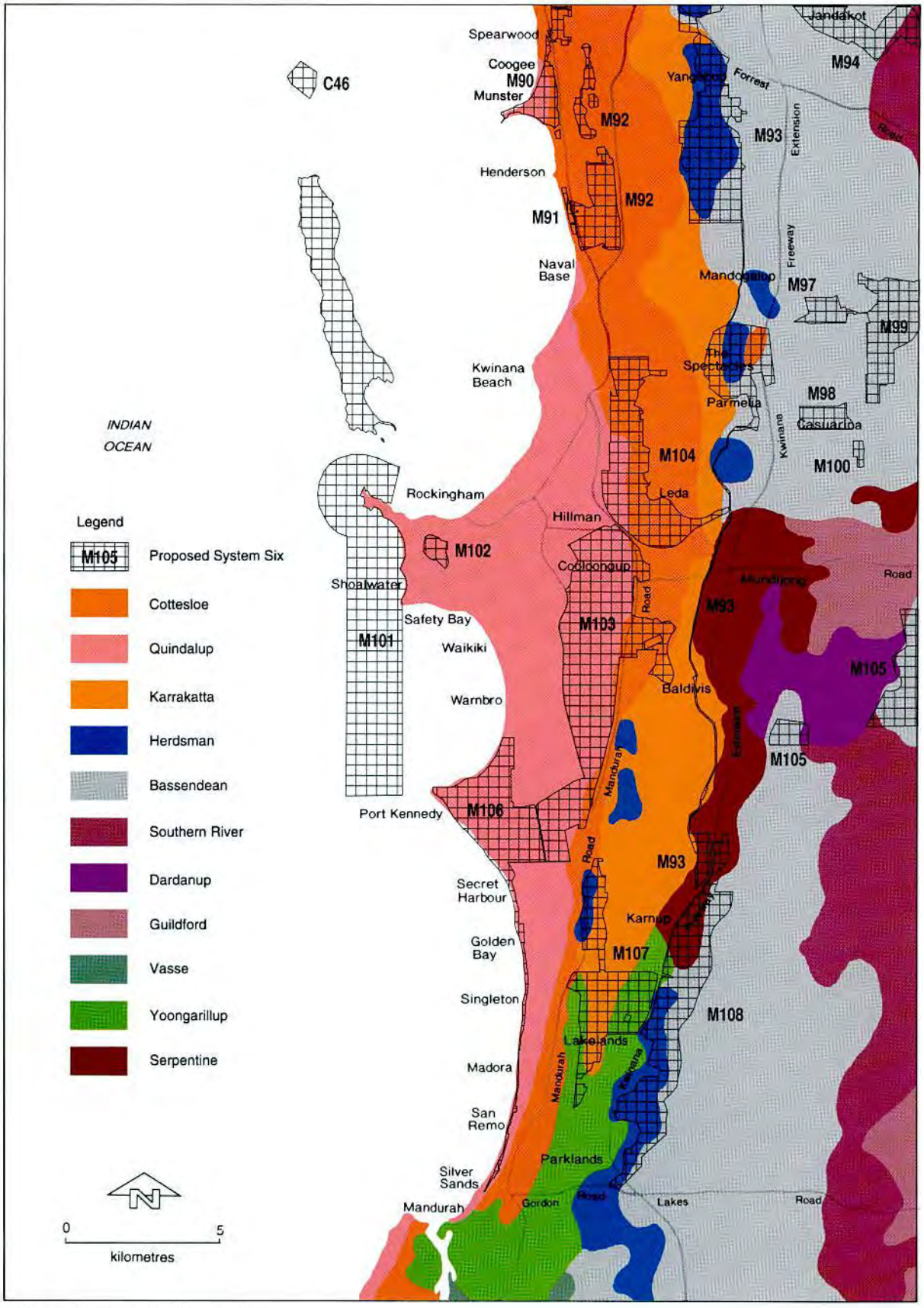

Figure 9 Natural Vegetation

Table 8

Proportions of Natural Vegetation Complexes in Current System 6 Reserves Compared to the Proposed Reconfiguration of System 6 Reserves

Complex Name	Existing System 6 (ha)	% of Total	Proposed System 6 (ha)	% of Total	Total Area On Plan (ha)	% Difference Existing v Proposed
Guildford	15	1%	15	1%	2544	0%
Dardanup	42	2%	42	2%	1992	0%
Serpentine	167	4%	485	12%	4032	+190%
Southern River	20	0%	123	2%	7110	+515%
Bassendean	1850	7%	3197	12%	26845	+73%
Karrakatta	147	2%	910	13%	6988	+519%
Cottesloe	1949	18%	2292	21%	10986	+18%
Herdsman	1778	48%	1778	48%	3729	0%
Quindalup[1]	3644	30%	4045	33%	12270	+11%
Yoongarillup	23	1%	483	12%	3927	+2000%
Vasse	118	100%	118	100%	118	0%

1. The result for the Quindalup Complex (+11%) apparently conflicts with the result for coastal vegetation (-27%) in Table 7. However, this is due to the differences in the categories between the two data sets. For example, the remnant vegetation mapping for M103 shows very little coastal vegetation (mostly wetland and other categories as per Table 7) but in terms of natural vegetation complexes, M107 is mapped almost entirely as Quindalup Complex, an exclusively coastal vegetation complex.

Table 9

Comparative Representation of Good Condition Remnant Vegetation and Wetland Associations For Each of the Natural Vegetation Complexes (Current System 6 vs Modified System 6)

Complex Name	Existing System 6 Rem Veg **(GOOD)** (ha)	Proposed System 6 Rem Veg **(GOOD)** (ha)	% change	Existing System 6 Rem Veg **WETLANDS** (ha)	Proposed System 6 Rem Veg **WETLANDS** (ha)	% change
Guildford	9	9	0	0	0	0
Dardanup	26	26	0	0	0	0
Serpentine	8	45	+462%	0	4	+++%
Southern River	13	13	0	0	0	0
Bassendean	1027	1367	+33%	35	48	+37%
Karrakatta	85	522	+514%	0	215	+++%
Cottesloe	192	432	+125%	35	54	+54%
Herdsman	699	793	+13%	10	195	+1950%
Quindalup	358	416	+16%	355	353	-0.6%
Yoongarillup	0	374	+++%	0	23	+++%
Vasse	0	0	0	0	0	0

5.0 CONCLUSIONS TO PART I

From a strategic perspective, it is important to note that the character of the South West Corridor will change dramatically over the next 25-30 years. Whereas it is now predominantly a rural corridor, mostly undeveloped, it will change character over the next planning period to become a major part of the Perth Metropolitan Region, very different in character from what it is now. Unless conservation and urban objectives are reconciled, both will be prejudiced.

The analysis in Part 1 of this PER has demonstrated that a reconfiguration of System 6 reserves along the lines proposed in Figure 7 will continue to achieve the conservation objectives of the South West Corridor Structure Plan and System 6 while being more compatible with future development proposals. The current Stage A and B amendments to the Metropolitan Region Scheme which are the subject of this PER are derived from the Structure Plans for the South West Corridor and provide a foundation for a realistic balance between conservation and urbanisation in the South West Corridor. There is now the opportunity to reconcile conservation objectives, as represented by the South West Corridor Structure Plan and the Stage A and B amendments which give it effect.

There is no denying that there will be substantial impacts over time on the existing environment of the South West Corridor. It is in the nature of human settlement patterns to profoundly alter the natural environment in order to make high density urban living efficient and sustainable. There will therefore be a need to accept essential elements of urban infrastructure impinging on environmentally sensitive areas if it can be demonstrated:

- that the item of urban infrastructure, road rail or otherwise is essential and;
- that no better alternative workable solution is available.

The Structure Plan for the South West Corridor has been through an exhaustive planning and consultation process. Alternatives to what has been proposed in the Structure Plan are not readily apparent. It is therefore necessary, in the process of environmental review, to base the evaluation of acceptability on achieving the best balance between urban and environmental objectives, accepting that in some cases they may be mutually incompatible.

In summary, the proposals for the re-configuration of the System 6 reserves in the South West Corridor and the proposals for the protection of wetlands and remnant vegetation embodied in the PER achieve the following benefits:

- They satisfy the criterion that any modifications or impingement on System 6 reserves does not reduce their overall area.

- They achieve a net increase in representation of 'good condition' remnant vegetation for most of the natural vegetation complexes in the corridor, for other complexes there is no change, which at this strategic level of review may be extrapolated to assume a net increase in ecosystem representation.

- They have better prospects for long term sustainability because they accord with, and can be accommodated with, the urban structure proposed for the South West Corridor.

- They afford more comprehensive and better protection to the wetlands in the South West Corridor.

- They better protect the remnant vegetation as mapped by the Department of Agriculture within the South West Corridor.

- They offer better long term prospects for rehabilitation to create a more comprehensive representation of the natural vegetation systems that were originally in the South West Corridor, thereby providing the opportunity to restore and maintain a wider range of ecological habitats that currently exist or would exist under future urban conditions.

- The proposals incorporated in this PER, although strategic in nature, should achieve greater community acceptance and "ownership" of System 6 objectives for the South West Corridor by being more logical, comprehensive, relevant and innovative.

PART II: SPECIFIC IMPACTS

Description of Existing Environment, Assessment of Potential Environmental Impacts of Specific Proposals and Identification of Appropriate Management Strategies

PART II: SPECIFIC IMPACTS

6.0 INTRODUCTION TO PART II

This part of the Public Environmental Review examines environmental effects and, where appropriate, management options for particular aspects of the Stage A and Stage B Amendments described in Part I. Part II deals mainly with the Stage B Amendment, with specific reference to:

- effects of the amendments on System 6 area M103, including the rapid transport route, rezonings in Hillman and East Warnbro, and the widening of Safety Bay Road;
- effects on EPP and Structure Plan wetlands; and
- overall effect of the Amendments on regional conservation values.

Some specific elements of the Stage A amendment are also examined, including:

- effects of the rapid transport route on The Spectacles wetland reserve;
- effects of a widening of the Beeliar Drive road reserve on System 6 area M92 and an associated EPP wetland;
- effects of the proposed upgrading of Russell Road on System 6 area M93; and
- effects of the rapid transport route on System 6 area M104 and the Leda open space (focussing on wetlands).

Part II is intended to provide detailed assessments of particular elements of the proposed amendments, rather than an assessment of the overall proposals (refer to Section 1.4). In some cases, development of the land uses foreshadowed in the amendments is expected to be preceded by further environmental assessment, with particular emphasis on derivation of management procedures to minimise adverse effects.

7.0 THE EXISTING ENVIRONMENT

7.1 Regional Setting

The South West Corridor extends from the City of Cockburn in the north to Mandurah in the south. The location and major features of the "study area", which is encompassed by the Stage A & B Amendments, are shown on Figures 1 and 2 (refer to Part I).

The Stage B amendment corresponds to the local government boundaries of the City of Rockingham, which has primarily been a rural area that has experienced steady urban growth in recent years. This growth is largely concentrated in coastal parts but is also spreading inland.

7.2 Geology, Geomorphology and Soils

The study area is located on the coastal belt of the Swan Coastal Plain, a broad sedimentary plain composed of sands, clays and silts of marine, aeolian and alluvial origin. The plain extends from about Dongara in the north to Dunsborough in the south, and from the coastline eastward to the Darling Scarp.

The Swan Coastal Plain has evolved through a number of cycles of marine deposition and erosion which have given rise to distinct dune sequences. Sand is deposited on the shoreline as beach ridges which are then blown inland and reworked by the prevailing winds. The lines of relict foredune ridges are clearly visible in parts of the study area, particularly in the vicinity of Port Kennedy and on the western side of Lakes Cooloongup and Walyungup.

The landforms and soils of the Swan Coastal Plain have been mapped by McArthur and Bettenay (1960) and subsequent authors as a number of divisions based on the age and origin of the sediments. The western part of the study area (west of Mandurah Road) consists of Quindalup Dunes, the youngest dune sequence on the Swan Coastal Plain. The soils are Safety Bay Sands, a unit of the Quindalup Association, with smaller areas of limestone as well as silts of lagoonal origin. The area of beach ridges south of Rockingham is particularly well-expressed as a geomorphic feature, and is commonly known as the Rockingham-Becher Plain.

East of Mandurah Road the landforms and soils change to the Spearwood Dunes, an older dune sequence, with Tamala Limestone and limestone-derived soils being dominant. There are also smaller areas of sandy clays and clayey sands of lacustrine origin.

The eastern edge of the study area is composed of Bassendean Sand, the oldest dune sequence on the Swan Coastal Plain. This zone also contains areas of alluvial silty clays and clayey silts associated with the floodplain of the Serpentine River.

7.3 Climate

The study area has a warm Mediterranean climate with mild wet winters and warm to hot dry summers. The region has a strongly seasonal rainfall regime, with approximately 90% of annual rainfall occurring between April and October. Evaporation exceeds rainfall during the months from September to April. The long-term average rainfall for Rockingham is 826mm per annum, compared with 869mm for Perth City (Bureau of Meteorology, pers. comm.).

The predominant wind direction is south-easterly in the morning (9.00am) and south-westerly in the afternoon (3.00pm) except during winter, when the wind varies from predominantly north-east in the morning to northwest-southwest in the afternoon.

7.4 Vegetation and Flora

7.4.1 General

The vegetation of the Swan Coastal Plain has been mapped by Heddle, Loneragan and Havel (1980) into a series of vegetation complexes that correspond in distribution to the major landform and soil units defined by Churchward and McArthur (1980).

The Structure Plan area contains eleven of these vegetation complexes in varying quantities. However, the principal effects addressed herein for the Stage B Amendment relate mainly to four of the vegetation complexes. These are described below and their distribution is shown on Figure 9 (refer to Part I).

- *Type 55 (Quindalup Complex)*

  This complex extends from the southern (near Dunsborough) to the northern (near Dongara) extremity of the Swan Coastal Plain and is restricted to the Quindalup coastal dunes. The complex can be divided into two alliances: the strand and foredune alliance, and the mobile and stable dune alliance. The former is dominated by pioneer species such as *Cakile maritima, Angianthus cunninghamii, Spinifex longifolius* and *Pelargonium capitatum.* The latter supports woody shrubs such as *Acacia cyclops, Olearia axillaris* and *Scaevola crassifolia.* Local areas support *Melaleuca lanceolata* (Rottnest Tea Tree) - *Callitrix preissii* (Star Flowers) low closed forest and *Acacia rostellifera* closed scrub.

  The species composition of the Quindalup complex changes from south to north with climatic and topographic factors, but is not formally subdivided, appearing rather to form a continuum of species distribution and vegetation structure that varies form south to north with changing rainfall patterns and other environmental factors.

  The Quindalup Complex makes up the coastal portion of the study area and extends inland as far as the eastern margin of Lakes Cooloongup and Walyungup.

- *Type 52 (Cottesloe Complex - Central and South)*

  This complex occurs on the Cottesloe unit of the Spearwood Dunes and varies from a heath on limestone outcrops to a mosaic of *E. gomphosephala* (tuart) woodland and *Eucalyptus marginata* (jarrah) - *E calophylla* (marri) -*Banksia* open forest on deeper sands.

  In the study area, the complex occupies a mostly narrow belt on the eastern edge of the Quindalup Complex.

- *Type 53 (Herdsman Complex)*

  This complex is restricted in the study area to major freshwater wetlands such as Anstey Swamp, Stakehill Swamp and the floodplain of the Serpentine River. The complex is dominated by sedgelands and a woodland of *E. rud*is (River gum) - *Melaleuca spp.*, with the species of *Melaleuca* depending on the local drainage and adjacent soils.

- *Type 49 (Karrakatta Complex - Central and South)*

  This complex occurs on the deep yellow-brown sands of the Karrakatta unit of the Spearwood Dune system. The vegetation consists mainly of an open forest of tuart-jarrah-marri with an understorey of *Banksia spp., Allocasuarina fraseriana* (Sheoak) and *Agonis flexuosa* (Peppermint). Common shrubs include *Acacia cyclops, Jacksonia furcellata, Casuarina humilis* and *Calothamnus quadrifidus.*

  In the study area, this complex occurs as a belt to the east of the Cottesloe Complex, reaching its maximum width inland from Port Kennedy. It tapers out north of Rockingham and south of Singleton.

Apart from the broad scale work of Heddle *et al,* (1980) and similar scale mapping by Beard (1981), there has been little published work on the vegetation of the coastal region from Perth to Bunbury. There are a number of published studies of smaller areas for environmental impact assessment and planning purposes. These were used, along with other regional overviews such as the South West Corridor Environmental Audit (Semeniuk, 1991) and specific surveys, as source material for the assessment of regional vegetation values in this PER.

A botanical survey of specific areas affected by the proposed amendments, within and peripheral to System 6 area M103, was carried out in December 1993. The report of that survey is presented in Appendix D.

7.4.2 Significant Flora

The flora of the South West Corridor is moderately well known but rather poorly collected. The Department of Conservation and Land Management (CALM) lists six

species of Declared Rare Flora (DRF) or Priority Flora species as likely to occur in or near the study area. These are listed in Table 10.

Table 10

Rare and Significant Flora which may occur in the Study Area

Species	*Conservation Code*	*Occurrence*
Aponogeton hexatepalus	DRF	Perth-Busselton
Caladenia huegelii	DRF	Perth-Yallingup, D'Entrecasteaux, Scott River
Conostylis pauciflora (subsp. pauciflora)	Priority 4	Yarloop, Dawesville, Golden Bay, Yalgorup
Diuris micrantha	DRF	Medina
Drakaea elastica	DRF	Gingin-Busselton
Drakaea micrantha	DRF	Perth-Augusta-Albany
Jacksonia sericea	Priority 3	Wanneroo, Trigg, Perth, Mandurah- Pinjarra

Source: CALM (1992)

Of these species, four *(Aponogeton hexatepalus* (aquatic herb), *Caladenia huegelii* (orchid), *Diuris micrantha* (orchid) and *Drakaea elastica)* (orchid) are known to occur in the vicinity of The Spectacles, including two populations near an option for location of the rapid transport reserve.

The number of DRF or Priority species specifically listed as occurring in the study area is rather low by comparison with other areas. It is possible that detailed surveys would reveal additional species within the area; however, the paucity of rare species is also fairly typical of coastal areas (particularly the Quindalup dunes), which tend to have a less diverse flora than inland areas of the Swan Coastal Plain (for example, the alluvial soils of the eastern coastal plain).

7.5 Fauna

7.5.1 General

Most of the first-hand information available on the fauna of the South West Corridor is of a regional nature. A number of consultant's reports for individual developments have been published but, with the exception of some trapping studies around Secret Harbour and Port Kennedy (Tingay, 1991, 1992), the treatment of fauna in these is mostly based on regional information.

The study area contains a number of fauna habitat types. These include:

- the coastal dunes, dominated by low scrub;
- inland areas dominated by Tuart tall open woodland with an understorey of *Banksia spp., Acacia rostellifera* or *Xanthorrhoea preissii* (Blackboy);
- major wetlands with large expanses of open water surrounded by sedges; and
- medium to small wetlands dominated by Tuart and Flooded Gum with a substorey of *Melaleuca spp.* and a dense understorey of shrubs and sedges.

A survey of fauna habitats in particular areas affected by the Stage B Amendment was carried out in December 1993. The report of that survey is attached in Appendix E.

A list of fauna species known or expected to occur in the study area is presented in Appendix F. The list was compiled from a number of sources including Bamford (1993), DCE (1983), EPA (1992a,b), Mitchell McCotter (1992) and Binnie & Partners (1988).

7.5.2 Significant Fauna

The Southern Brown Bandicoot or Quenda *(Isoodon obesulus)*, a gazetted rare species, was detected in The Spectacles, the proposed Hillman Public Purposes Reserve and around the wetlands north-east of Lake Cooloongup during this study. It has also been reported from many other parts of the study area on various occasions in recent years. The favoured habitat of the species is the densely vegetated margins of freshwater wetlands. Any wetland containing bandicoots or other gazetted fauna is immediately assigned a High Conservation status, in accordance with the "Guide to Wetland

Management in the Perth and near Perth Swan Coastal Plain Area" (Bulletin 686). This category requires that a detailed management plan be prepared to the satisfaction of the EPA before any development can take place which affects the wetland.

The Southern Brown Bandicoot is declining around Perth due to the progressive loss, degradation and fragmentation of its habitat. It is important for the survival of the species in the study area that adequately sized and linked areas of suitable habitat are preserved.

Several species of birds that are rarely seen near Perth are known or believed to occur in the area. These include the Splendid Fairy-wren (*Malurus splendens)*, the Common Bronzewing (*Phaps chalcoptera)*, Scarlet Robin (*Petroica multicolor)* and Weebill (*Smicrornis brevirostris)*. As with the Bandicoot, survival of these species in the area depends largely on the protection of their habitat.

7.6 Conservation Areas

7.6.1 System 6 Areas

The Structure Plan contains eighteen areas (or part areas) recommended for management in the EPA's System 6 "Red Book" (DCE, 1983). These are listed in Table 3 (refer to Part I) and are described in Appendix B in the form of extracts from the System 6 Red Book. The locations of the System 6 areas are shown on Figure 7 (Part I).

The status of implementation of the EPA's recommendations (source: K. McAlpine, EPA, January 1994) is also presented in Appendix B.

7.6.2 EPP and Structure Plan Wetlands

The *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* lists approximately 20 wetlands within the Stage B study area as requiring protection. These wetlands are shown on Figure 5. Wetlands gazetted under the EPP are not permitted to be filled, drained, cleared, polluted or otherwise damaged without the written permission of the Minister for the Environment.

Several EPP wetlands are within areas affected by the rezoning proposals of the amendments. Some of the effects are positive and will benefit the future security of the

wetlands, as discussed in Section 3 (Part I). The EPP wetlands which have the potential to be adversely affected by the proposed land uses are listed below and the potential impacts are discussed in Sections 8.3 and 8.4.

- An EPP wetland mostly contained with System 6 area M92 (affected by the proposed widening of the Beeliar Drive road reserve and the construction of the road);

- a small wetland east of Dixon Road in Leda (bisected by the proposed rapid transport route);

- the northern edge of Lake Walyungup and southern extremity of the Lake Cooloongup system (affected by widening of Safety Bay Road);

- Anstey Swamp (impinged upon by the proposed rapid transport route); and

- a small EPP wetland north of the Paganoni Swamps area, on the alignment of the Nairn Road arterial route.

In addition to those wetlands gazetted under the Lakes EPP, the South West Corridor Structure Plan (DPUD, 1993) identifies a number of other wetlands and damplands in the study area. In some cases, these constitute additional buffers and areas surrounding the open water areas identified as EPP wetlands. In other cases, the Structure Plan wetlands are entirely separate from the gazetted EPP wetlands. The Structure Plan wetlands are shown on Figure 6 (Part I).

8.0 ASSESSMENT OF POTENTIAL ENVIRONMENTAL IMPACTS

8.1 Overview

The objective of this PER is not to provide a comprehensive analysis of the impacts of each land use that may possibly occur in the areas to be rezoned. It is rather to provide an overview of the impacts of the rezonings, in the light of their proposed land use, on conservation and environmental protection objectives at a regional level. This strategic approach is applied to individual areas and land uses where appropriate.

In this context, the significant aspects of the proposed amendments that require assessment in this part of the PER are:

- impacts on System 6 Area M103 in terms of the objectives of the System 6 recommendation, retention of the ecological values of the area and the future management of M103;
- impacts on other System 6 areas and other areas of public open space;
- impacts on lakes and wetlands, particularly those identified in the Lakes EPP and the South West Corridor Structure Plan; and
- regional impacts of the proposed rezonings on the vegetation, fauna and landscape of the South West Corridor.

Table 11 provides a summary of the potential environmental impacts and proposed management strategies for each of the areas for which rezoning is proposed. As most of the individual rezonings are expected to have little or no environmental impact, the remainder of this chapter concentrates on impacts and management in terms of the major aspects noted above.

8.2 Impacts on System 6 Area M103

The potential environmental effects on System 6 area M103 are a predominant concern, as evidenced by the EPA Guidelines (Appendix A). M103 will be affected by the following elements of the proposal, which are illustrated on Figure 2 (Part I):

TABLE 11

SOUTH - WEST CORRIDOR
POTENTIAL IMPACTS AND MANAGEMENT
OF PROPOSED AMENDMENTS

Site No.	*Site Name*	*Current MRS Zoning (as at 9/9/93)*	*Proposed MRS Zoning*	*Conservation Value*	*Issues*	*Potential Impacts*	*Proposed Management*
1	**Rail Transit Route**						
	1a NE of Millar Rd	CAH Reserve/Urban	Railway Reserve	High	Impacts on EPP wetland, Structure Plan wetland and remnant bushland.	Loss of vegetation & habitat, subdivision of wetland, landscape changes, noise.	Optimise alignment of railway reserve, minimise earthworks close to wetlands.
	1b Millar Rd - Safety Bay Rd	Parks & Recreation	Railway Reserve	Med - High	Impacts on System 6 M103.	Loss of area, barrier & boundary effects, impacts on picnic ground and golf course.	Compensated for by creation of Parks and Recreation reserves elsewhere.
	1c Safety Bay Rd - Mandurah Rd	Parks & Recreation	Railway Reserve	Low	Impacts on System 6 M103.	Loss of remnant vegetation.	Minimise width, optimise alignment of railway reserve.
	1d Mandurah Rd - Paganoni Rd	Rural	Railway Reserve	Low	Impacts on rural area.	Loss of remnant vegetation and farmland.	As above.
	1e Paganoni Rd - MRS Boundary	Rural	Railway Reserve	High	Impacts on proposed Paganoni Swamp Reserve.	Loss of vegetation & habitat, isolation of portion of reserve.	As above.
2	**Hillman Public Purposes Reserve**	Parks & Recreation	Public Purposes	Med - Low	Impacts on System 6 M103.	Loss of remnant vegetation including unusual vegetation associations.	Suggest retention of least-disturbed woodland areas.
3	**Safety Bay Rd East**	Parks & Recreation	Important Regional Roads Reserve	Low - High	Impacts on L. Walyungup and System 6 M103.	Loss of vegetation, filling of swamp, disturbance of lake fringe, noise, road kills.	Route road reserve at least 80m away from Lake Walyungup.
4	**Baldivis Tramway Park**	Rural	Parks & Recreation	Low	None.	Provision of wildlife corridor. Recreation resource.	None required.
5	**Nairn Rd Arterial Route**						
	5a Eighty Rd (northern) section	Rural	Important Regional Roads Reserve				
	5b Nairn Rd (southern) section	Rural/State Forest	Important Regional Roads Reserve				
6	**Baldivis Urban Zone**						
	6a Northern section	Urban	Urban				
	6b Southern section	Rural/State Forest	Urban				

TABLE 11 (Continued)

Site No.	*Site Name*	*Current MRS Zoning (as at 9/9/93)*	*Proposed MRS Zoning*	*Conservation Value*	*Issues*	*Potential Impacts*	*Proposed Management*
7	**Tamworth Hill Parks & Recreation Reserve**	Rural	Parks & Recreation				
8	**Baldivis Urban Deferred Zone** **8a** NE section (east of Baldivis Rd) **8b** SW section (west of Baldivis Rd)	 Rural Rural	 Urban Deferred Urban Deferred				
9	**Port Kennedy North Parks & Recreation Reserve**	Public Purposes (SU)	Parks & Recreation	High	Zoning undecided.	Major addition to Parks and Recreation reserves.	Detailed management plans in preparation.
10	**Port Kennedy North Public Purposes Reserve**	Parks & Recreation	Public Purposes	High	Developed for recreation, accommodation.	Loss of vegetation and landforms.	Detailed management plans in preparation.
11	**Warnbro SE Urban Zone**	Parks & Recreation	Urban	Low - Med.	Impacts on System 6 M103.	Loss of remnant vegetation, reduction in System 6 area.	Compensated for by creation of Parks and Recreation zones to south and elsewhere.
12	**Warnbro SE Industrial Zone Extension**	Parks & Recreation	Industrial	Low - Med.	Impacts on System 6 M103.	As above.	As above.
13	**Port Kennedy South Parks & Recreation Reserve**	Public Purposes (SU)	Parks & Recreation	Low - Med.	Ultimate use & degree of preservation. Suitability for replacement of lost M103 areas. Linkage to M103.	Large addition to M103 Parks and Recreation zone.	Detailed management plans currently in preparation.
14	**Port Kennedy Drive Urban Zone**	Public Purposes (SU)	Urban	Low	Undecided, pending realignment of Pt Kennedy Drive.	Minor loss of vegetation.	None required.
15	**Port Kennedy Drive Industrial Zone**	Public Purposes (SU)	Industrial	Low	As above.	As above.	None required.
16	**Lark Hill Rural Zone**	Public Purposes (SU)	Rural	Low.	Rural vs Parks and Recreation.	Loss of remnant vegetation.	None.
17	**Stakehill Swamp Parks & Recreation Reserve**	Rural	Parks & Recreation	High	Impact of rail corridor. Management of nearby rural land.	Addition to conservation areas.	Detailed management plan to be drawn up. Manage for conservation priority.
18	**Explosives Reserve Urban Deferred Zone**	Public Purposes (SU)/Rural	Urban Deferred			Loss of bushland.	
19	**Explosives Reserve Parks & Recreation Reserve**	Public Purposes (SU)	Parks & Recreation				
20	**East Singleton Urban Deferred Zone**	Rural	Urban Deferred	Low		Loss of remnant vegetation.	

TABLE 11 (Continued)

Site No.	*Site Name*	*Current MRS Zoning (as at 9/9/93)*	*Proposed MRS Zoning*	*Conservation Value*	*Issues*	*Potential Impacts*	*Proposed Management*
21	**Paganoni Swamp Parks & Recreation Reserve**	Rural/Important Regional Roads	Parks & Recreation	High	Effects of rail corridor, nearby urban deferred.	Large addition to cons. reserve area.	Detailed management plan to be drawn up. Manage for conservation priority.
22	**Mandurah Rd South**	Rural	Other Major Highways Reserve	Medium	Intention: clear or retain?	Possible loss of remnant trees.	Retain remnant vegetation.
23	**Paganoni Rd realignment**						
	23a Western section	Rural	Important Regional Roads Reserve	High	Position of road - in or out of bush?	Possible loss of vegetation.	Minimise encroachment on bush.
	23b Eastern section	Rural	Important Regional Roads Reserve	High	As above.	As above.	As above.
24	**New Paganoni Rd - Kwinana Fwy Interchange**	Rural	CAH Reserve				
25	**Old Paganoni Rd - Kwinana Fwy Interchange**	CAH Reserve	Rural				
26	**Port Kennedy Drive realignment**	Public Purposes (SU)	Important Regional Roads Reserve	Low		Minor loss of vegetation.	Minimise disturbance, rehabilitate with local species.
27	**Secret Harbour East Urban Zone**	Rural	Urban	Low		Loss of remnant vegetation.	

- rezoning of the northern end of M103 (Hillman) from Parks and Recreation to Public Purposes;
- establishment of a rapid transport reserve through the northern sector and along the western side;
- widening of Safety Bay Road;
- rezoning of areas at the south-west corner from Parks & Recreation to Urban and Industrial;
- rezoning of an area near the south-west corner (outside the System 6 area) from Public Purposes to Parks & Recreation, as an effective addition to M103; and
- rezoning of Tamworth Hill Swamp and part of Tamworth Hill to Parks and Recreation, as additions to M103.

In the following sections, each of the above elements are assessed individually. Following this, the overall significance of the proposals in terms of the regional conservation objectives for M103 and the South West Corridor is discussed, and where applicable, potential management strategies are described.

8.2.1 Proposed Excisions From M103

8.2.1.1 Hillman Public Purposes Reserve

The current Stage B Amendment proposes to excise a parcel of about 80ha in Hillman from the existing Parks and Recreation Reserve and rezoned to Public Purposes. The potential land uses which initially precipitated the amendment to Public Purposes are a university campus and/or regional sporting or recreational facilities. However, it is noted that a range of alternative sites are still under investigation with respect to the university, and it is now most likely to be located elsewhere.

The vegetation of this area mainly consists of *Eucalyptus gomphocephala* (Tuart) tall open woodland over an understorey of *Acacia rostellifera* or *Xanthorrhoea preissii* (Blackboy). In some swales, *Banksia littoralis* forms a low open woodland over *Xanthorrhoea preissii* over *Gahnia trifida* (Coastal Saw Sedge) and *Lepidosperma gladiatum* open sedgeland. The condition of the vegetation ranges from parkland cleared to very good condition, with about half of the area (about 40ha in the eastern sector) being in the latter category.

The less-disturbed part of the Hillman area is believed to have regionally significant conservation value for vegetation, especially in the context of the future urbanisation in the region as proposed in the Structure Plan. The main vegetation values of the area are listed below:

- The occurrence of Tuart tall open woodland on Quindalup soils is rare. This vegetation type was probably originally common across what is now the Rockingham urban area. The fact that this vegetation is in good to very good condition is also of note since most areas of Tuart woodland have been disturbed to a moderate degree in the understorey.
- The parcel contains possibly the largest and least-disturbed stand of *Xanthorrhoea preissii* (Blackboy) on the Rockingham - Becher Plain. The stand has not been burnt for some time, judging from the presence of multiple flower spikes on many of the *Xanthorrhoea.*
- The occurrence of *Banksia littoralis* as an overstorey in swales is also very unusual on Quindalup soils, making this a rare vegetation type with significant conservation value.

The botanical conservation values of this area are described in more detail in Appendix D.

The less-disturbed parts of the area also have significant fauna habitat values because:

- The vegetation has high structural complexity, comprising many old Tuart trees with hollow branches and a dense, diverse understorey. The area is therefore probably of high value as a nesting habitat for birds and other fauna.
- The Southern Brown Bandicoot (*Isoodon obesulus*), a gazetted rare species, has been detected in the area. Several birds that are either rare or uncommon near Perth are also reported to occur in the area, including the Golden Whistler, Scarlet Robin, Weebill, Splendid Fairy-wren, Barn Owl and Masked Owl.
- The Tuart woodland constitutes a significant proportion of a restricted habitat (Tuart on Quindalup dunes). Its removal may have a significant impact on the populations of animals in the area that rely on this habitat type.

The significance of the area for fauna is described more fully in Appendix E.

In summary, the excision of the Hillman area from M103 as a Public Purposes Reserve will have an adverse ecological impact in terms of the reduction in area of a rare vegetation type and of high quality fauna habitat. In a planning context, the initial rationale for the proposed rezoning recognised that the ecological values of the area to be excised would be reduced in any case by the proposed construction of the Garden Island Highway along the southern edge of the proposed excision. The highway is already formally reserved in the Metropolitan Region Scheme and is therefore not part of this assessment. However, construction of the highway will diminish the values of the Hillman area for fauna in particular due to the effects of isolation from the habitat at the northern end of Lake Cooloongup.

During preparation of this PER, the high conservation values of the northern sector of M103, including the less-disturbed parts of the Hillman area, have been discussed in detail with DPUD. In view of the potentially adverse environmental impacts of constructing a major tertiary institution at the site, and the fact that there are a number of alternative sites still being considered for the proposed university, DPUD has resolved to recommend to the State Planning Commission that the proposed Hillman Public Purpose Reserve be deleted from the Major Amendment. The area will no longer be considered as a potential university site.

8.2.1.2 Urban and Industrial Rezonings in the South West of M103 (East Warnbro)

About 115ha of land in the south west corner of M103 currently zoned Parks and Recreation will be rezoned to Urban. An additional 25ha currently zoned Parks and Recreation will be rezoned to Industrial. The latter will complement an adjacent parcel of 108ha, 43ha of which is within M103, that is already zoned Industrial under the MRS. All of this land is located on the western side of Ennis Avenue.

This area supports low coastal shrubland dominated by *Jacksonia furcellata, Melaleuca spp., Acacia rostellifera* and *A. saligna.* The condition of the vegetation ranges from poor to very good, with most parts of the area being rated as good to very good condition. Weed invasion is variable but generally moderate, which prevents the vegetation condition from being rated very good. The fauna habitat value of the area is rated as low to moderate due to its relatively low structural and floristic diversity. The vegetation and fauna habitats of the area are described in detail in Appendices D and E, respectively.

An overall assessment of the effects of removing these areas from M103 is conducted in Section 8.2.5 subsequently.

8.2.2 Proposed Additions to M103

The proposed additions to M103 comprise land at Lark Hill (south-south-west of M103) and around the Tamworth Hill Swamp (east of M103).

The Lark Hill land is located to the south of the excisions described in Section 8.2.1.2 above. For the purposes of this PER, the additions to M103 in this locality include the Water Authority treatment site (zoned for Public Purposes) and extend in a westerly direction from Mandurah Road to the proposed alignment of Warnbro Sound Avenue. However, the new Parks and Recreation Reserve continues in a westerly direction to Port Kennedy, part of which forms an addition to System 6 area M106.

The vegetation of the Lark Hill section has been substantially disturbed, including clearing for a horse racecourse and pasture which comprises approximately 50% of the site (Lark Hill Equestrian Centre). The vegetation of the less-disturbed parts consists of dense *Acacia rostellifera* thicket and *Jacksonia furcellata/Acacia saligna* open shrubland. Small chains of degraded *Melaleuca rhaphiophylla* damplands are present in interdunal swales. This vegetation type is unusual on Quindalup sands in the study area.

While the vegetation of this area is generally more disturbed than that of the areas to be excised from M103, in parts it has greater floristic and structural diversity and is therefore probably of at least equal value to fauna. (The vegetation and fauna habitats of this area are described in detail in Appendices D and E). In the long term, unless the Equestrian Centre is managed to ensure protection of the existing remnant ecological values in this sector, the conservation functions will continue to decline.

The addition at Tamworth Hill Swamp, including part of Tamworth Hill bushland, will be rezoned to Parks and Recreation. This area is adjacent to an existing eastern extension of M103, although the two areas are separated from the main body of M103 by Old Mandurah Road. This rezoning will protect an area of bushland and an EPP wetland in good condition and represents a substantial improvement to M103 in this locality.

The eastern boundary of the new Parks and Recreation Reserve will be demarcated by the proposed Eighty Road extension. Land further to the east is to be rezoned for urban development. Eighty Road will impinge upon the north-eastern corner of the wetland and

will isolate approximately 2.8 hectares into the future urban area. This is a fringe area to the wetland and has been totally cleared and therefore is completely degraded. It will be important however, in future drainage design for the road and urbanisation, to ensure appropriate protection of water quality and water quantity in the balance of this EPP wetland.

8.2.3 Rapid Transport Reserve in M103

The proposed rapid transport route extends from the north-east, through the northern and north-western parts of M103 and then south along its western boundary. An interchange is to be located in the north-west of M103 and a spur line will extend from there through Hillman to the Rockingham town centre. The alignment is shown on Figure 2 and Figure 3 (Part I).

In view of the recent initiative to select another site for the proposed university (other than Hillman, refer Section 8.2.1.1) there may now be more flexibility in the alignment for the rapid transport reserve in the northern sector of M103. Alternatives are currently being investigated to optimise the environmental effects of the route.

The current alignment of the rapid transport route as proposed in the Stage B amendment will affect System 6 area M103 in the following ways:

Negative Effects

- alienation and direct disturbance of a corridor through and adjacent to M103;
- isolation of sections of M103; and
- increased boundary ratios and edge effects in parts of M103.

Positive Effects

- provision of an effective buffer against human, vehicular and animal access to the reserve on its western side, thereby enabling management of the reserve to be improved.

These aspects are assessed further in the sections which follow.

8.2.3.1 Alienation of Land

The land occupied by the rapid transport reserve will directly alienate up to 52ha (including small parcels of land between the transport route and the boundary of the System 6 area, near the Rockingham Hospital and golf course) from M103, out of a current total of 2570ha. This represents about 2% of the existing area of M103. The route passes through Tuart open woodland/Blackboy scrub (north of Safety Bay Road) and degraded, grazed coastal *Acacia* scrub (south of Safety Bay Road).

The Tuart open woodland in the north-eastern sector of M103 is of high quality and has regional conservation significance. In the north-western sector the Tuart becomes more sparse and the understorey has variable condition, although in very good condition in parts.

Approximately 80% of the route lies adjacent to Ennis Avenue and indeed, will be located within the road reserve to the greatest practicable extent. As a consequence, the rapid transport route will only extend the existing Ennis Avenue by clearing an additional 20-60m, depending on the degree of accommodation in the road reserve. This strip of land is commonly disturbed by vehicular tracks, small clearings and heavy weed invasion but the route will still cause some loss of remnant vegetation.

The provision of security/safety fencing for the entire route, and particularly alongside Ennis Avenue, would restrict both vehicular and pedestrian access to M103 from the west and in that sense would help to reduce dispersed impacts on the western part of M103.

8.2.3.2 Isolation and Boundary Effects

Once the rapid transport facility (road or rail) is constructed, it will cause sections of M103 to be isolated from the main body of the System 6 area. Two areas in the northern sector, measuring about 14ha (north-east) and 33ha (north-west) will be isolated between the rapid transport route and the proposed Garden Island Highway. A third area, comprising about 4ha, will be isolated as the route passes between the Rockingham golf course and Ennis Avenue. A very small area (less than 1 ha) will also be isolated in the far south of M103 next to Mandurah Road.

The botanical and fauna values of these areas are variable and, for the purposes of evaluation, are ranked in decreasing order of conservation importance as follows:

(i) North-east parcel (14ha) - High value open Tuart woodland with dense understorey in good to very good condition. Rare vegetation association (Tuart over dense sedge on Quindalup). Bandicoots present, also important as a habitat continuum with the fringing vegetation of Lake Cooloongup.

(ii) North-west parcel (33ha) - Moderate to high value scattered Tuart woodland with medium to dense Blackboy understorey in good condition, parts in very good condition. Bandicoots not confirmed but possibly present. The area provides a linkage between the high quality vegetation/habitat at Hillman and the fringing vegetation of Lake Cooloongup.

(iii) Golf course parcel (4ha) - Low to moderate value coastal shrubland. Low value habitat due to lack of structural complexity. Does not have a strong linkage to the fringing vegetation of Lake Cooloongup due to the presence of the golf course.

(iv) Southern parcel (<1ha) - Low value coastal shrubland. Acts as buffer to interior of M103, but the triangulation between Old Mandurah Road and Ennis Avenue/Mandurah Road enhances the edge effects in this locality.

Whilst the vegetation in these areas will be retained, their conservation values will be reduced by the isolation and by the resultant high boundary-to-area ratio. The reduction in values is expected to be most acute for ground-dwelling vertebrate fauna due to the isolation effects from adjoining habitat. These comments mainly apply to the two land parcels in the northern sector, which at present have high habitat values.

Overall, these areas represent about 1.9% of the total existing area of M103, which is a relatively minor proportion of the suite of vegetation associations and habitats which comprise this System 6 area. From the perspective of the Tuart woodland associations (which occur throughout M103 but are mainly confined to the Cooloongup system), the two land parcels described in items (i) and (ii) above probably comprise about 10% of the area of these associations, although this estimate would need to be confirmed by detailed inventory and mapping of M103. Whilst the habitat values in particular will be reduced in

the northern sector of the Cooloongup system, this needs to be considered in the context of the regional additions to the conservation estate in the South West Corridor (refer to Part I and Section 8.2.5 below).

The transport reserve will encroach slightly further into M103 adjacent to Ennis Avenue, which will result in a small increase in edge effects along this side of M103. This is considered to be an insignificant impact on the overall values of M103 and can be managed to minimise the extent of further encroachment.

8.2.3.3 Restriction of Access

It is expected that, for safety reasons, the rapid transport route will be fenced at the time of construction to exclude humans and animals from the bus route or rail tracks. Access across the reserve would be provided at a very limited number of points. This will inhibit the free access to M103 currently available along the northern and western sides. This is likely to inconvenience some people but, on the other hand, will actually assist the management of the System 6 area by excluding domestic or feral animals and allowing human visitor traffic to be more closely controlled.

8.2.4 Safety Bay Road Widening

Safety Bay Road crosses the centre of M103 on a 14m wide causeway between Lakes Cooloongup and Walyungup. It is proposed to widen this causeway to a nominal width of 40m to allow for the upgrading of Safety Bay Road to Important Regional Road status. In addition, the existing road reserve will be deviated to the north at the western (Ennis Avenue) end and deviated to the south at the eastern (Old Mandurah Road) end.

A Consultative Environmental Review (CER) has previously been prepared for the extension of Safety Bay Road from the eastern sector of M103 to Eighty Road (Mitchell McCotter, 1992). The CER considered 5 route options for the road extension. These options were located in a study area which included a portion of M103 (for a distance of approximately 1,300 metres to the east of Old Mandurah Road). Evaluation of the route options also considered upgrading of sections of the existing road to a 40-60 metre wide corridor. A decision was made regarding a preferred option and the authorised route for the 'CER study area' is reflected on the Structure Plan (Figure 3, Part I).

This PER evaluates the proposed widening of the balance of the road alignment and particularly the segment on the western side connecting to Ennis Avenue which is approximately 900 metres in length or 43% of the total width of M103 in this locality.

The proposed widening from 14 metres to 40 metres will mostly be confined to the existing road reserve or other disturbed land near to Ennis Avenue. This means that there will be minimal additional alienation of land from M103 and only minor increases in barrier effects due to the road widening. The widening should be conducted on the northern side of the existing road in the vicinity of Lake Walyungup to prevent further encroachment towards the lake margins. This matter can be addressed in detail during preparation of an Environmental Management Plan by the eventual proponent for construction of the road (presumably the City of Rockingham).

A completely new section of road is proposed to connect to Ennis Avenue, directly opposite the continuation of Safety Bay Road to Warnbro Sound Avenue, which will involve straightening the existing deviation of Safety Bay Road in M103. The new road will traverse approximately 350 metres of land that is predominantly cleared due to historical tracks, firebreaks and miscellaneous disturbance.

The widening of the disturbed ground to achieve the new road section will impact upon paperbark closed forest for about 150 metres. As a consequence, there will be some loss of natural vegetation in good condition, although this is not considered to be an adverse impact to the extent that a different alignment should be selected. The reasons for this conclusion are twofold:

- there are natural, linear discontinuities in the paperbark closed forest due to the presence of low dune ridges which are unsuitable as habitat for this vegetation type (the discontinuity caused by the road causeway will mimic this situation); and

- the additional disturbance can be offset by closure and rehabilitation of the existing deviation of Safety Bay Road.

8.2.5 Regional Perspective of Effects on M103 Values

The management objectives for M103, as outlined in the System 6 Red Book and endorsed by the State Government, are:

- that Lake Cooloongup be managed primarily for conservation of flora and fauna;
- that Lake Walyungup be managed to permit development for recreational use; and
- that management be coordinated to ensure that the conservation and recreation values of the area are enhanced.

Protection of the landscape attributes of the natural environment is also an important aspect of the System 6 recommendations.

A brief discussion of the effects of the proposals on recreation and landscape values is provided below, followed by an overall perspective of the effects of the rezonings and infrastructure proposals on the conservation values of M103.

8.2.5.1 Recreation and Landscape

Recreational use of System 6 areas is generally anticipated to be of a passive nature, and the picnic site and walking tracks at the northern end of Lake Cooloongup support the type of 'low-key' activity which is consistent with the intent of System 6. The future presence of both the rapid transport route and Garden Island Highway may curtail access to these facilities. However, the design of these major infrastructure facilities could readily include opportunities to maintain recreational access, although it is noted above that the objective for Lake Cooloongup is conservation of flora and fauna, not recreational use.

Elsewhere in M103, recreational use would appear to be ad hoc and uncontrolled, other than the provision of signage advising the conservation function of the area. In this regard, management of ad hoc recreational access would be greatly assisted by the provision of a fenced boundary along the northern and western sides of M103 when the rapid transport reserve is implemented. Recreational nodes could be established at the same time to focus this activity on managed facilities; a shift away from the northern end of Lake Cooloongup to the Lake Walyungup area would also be consistent with the management objectives for M103.

The major landscape attributes of M103 are views of the bushland and lakes from Ennis Avenue, Old Mandurah Road and Dixon Road. The most outstanding views occur along Old Mandurah Road, where sweeping vistas across the lakes are often available. Landscape values will be impacted in the following ways:

- the rapid transport route along the eastern verge of Ennis Avenue may interrupt views of the bushland from the road; and

- the possible removal of Tuart woodland immediately south of Dixon Road, coupled with the future presence of both the railway line and the Garden Island Highway, will alter views from that section of Dixon Road.

These impacts can be mitigated by sensitive design and provision of landscaping features such as trees. However, they cannot be avoided altogether. In this regard, it is important to bear in mind that the visual landscape of the whole South West Corridor will change dramatically with the developments foreshadowed in the Structure Plan.

8.2.5.2 Conservation of Flora and Fauna

A summary of the impacts of the rapid transport route and rezoning proposals is provided below, followed by an overall assessment of cumulative effects.

(i) Rapid Transport Route

The most significant impact of the proposed rapid transport route on M103 will be in the north where high-quality Tuart woodland and Blackboy scrub will be removed within the reserve and other areas isolated as a consequence of the alignment. Management of this impact will be limited to minimising the width of the rapid transport corridor, and optimising both the horizontal and vertical alignment of structures within the reserve so as to minimise disturbance.

In the regional planning context, the rapid transport route has been sited to provide an acceptable compromise between minimisation of adverse impacts and provision of transport services to the South West Corridor. In some areas, such as along Ennis Avenue, impacts are minimised by utilising as much as possible of the existing road

reserve. In other areas, such as at the northern end of M103, options for the location of the rapid transport route are restricted by the requirements of railway engineering (in terms of the required radius of curves) and terrain.

It is not possible at this stage to be more precise regarding the magnitude of impacts on M103. This is not only due to the subjective elements of conservation value assessment, but also due to the fact that alternative alignments of the rapid transport route may be achievable now that the Hillman area will not be developed for a tertiary institution. It is sufficient to say that the conservation values of large parts of the northern sector of Lake Cooloongup are regionally significant for vegetation associations, habitat and fauna.

(ii) Rezoning Proposals

The net effect of the additions to and subtractions from M103 will be to increase the size of the contiguous open space associated with M103 by about 5%.

The ecological values of the areas to be added and removed in the south-west of M103 are different; notably in respect of vegetation condition but only marginally in respect of fauna values. An important improvement is that the changes will also create a reserved link between M103 and M106 (Port Kennedy). This link (despite being broken by Ennis Avenue and the rapid transport route) will be increasingly important in years to come as an ecological corridor between the Rockingham Lakes and the coast. It will also help to preserve a continuous geomorphic record of the evolution of the beach ridges of the Rockingham-Becher Plain.

The addition of the Tamworth Hill area represents a net gain to the value of M103, while the changes in the south west sector constitute a loss of conservation value when considered in isolation. Overall, it can be concluded that the ecological values *per se* of M103 will be somewhat reduced by the rezonings, but this may be considered to be balanced by the linkage of M103 to M106.

(iii) Cumulative Effects

The cumulative effect of the rezoning and infrastructure proposals discussed above will be to somewhat reduce the conservation and recreational values of specific parts of M103. The extent of reduction in conservation values is particularly sensitive to the proposals in

the northern sector near Hillman. The proposals here are currently being re-examined. In broader terms, however, the conservation estate in the study area will be enlarged by the creation of major new Parks and Recreation Reserves at Port Kennedy, Paganoni Swamps, Stakehill Swamp and other, smaller areas. This is seen as a major benefit of the Stage B Amendment.

Management of M103 will become more complex with the general intensification of land use and population pressure as the area becomes progressively more urbanised. This will be offset by positive effects of the amendment, including the provision of a fenced boundary in some parts and the linkage of M103 to Tamworth Hill Swamp and Port Kennedy.

8.3 Impacts on Other System 6 Areas

The full suite of impacts and beneficial effects on existing System 6 areas are discussed in Part I from the broader perspective. Some specific impacts within System 6 areas M92, M93 and M104 require further assessment and this is briefly described below.

8.3.1 M92 - Cockburn Wetlands - Beeliar Drive

A narrow north-south strip in the centre of M92 at Coogee is crossed by an existing (undeveloped) road reserve for Beeliar Drive. It is proposed that this alignment by relocated approximately 100 metres to the south. The new road reserve will be 56 metres wide and will pass close to the northern end of Lake Coogee.

The majority of both the new and old alignments is cleared, and therefore the impact will be confined to a 60-100 metres segment of paperbark over sedge wetland fringing a drainage line that runs into Lake Coogee, from a broad marshland to the north. This part of M92 is actually a continuous wetland chain with a long north-south axis of about 4 kilometres. The proposed alignment crosses at one of the narrowest points in order to minimise adverse effects on the remnant fringing vegetation. The fringing vegetation of Lake Coogee is saltwater paperbark which is recognised as uncommon in the metropolitan area. It is unknown whether the road is proposed to cross the drainage line by means of a causeway or a bridge. Bridging would be preferable from a conservation viewpoint as it would have much less effect on the vegetation and hydrology of the wetland.

Lake Coogee, the marshland to the north, and part of the drainage line (including the part affected by the existing and proposed Beeliar Drive alignments) are all gazetted under the Lakes EPP.

8.3.2. M93 - Cockburn Wetlands - Russell Road

Russell Road traverses M93 on an east-west alignment between Thompsons and Banganup Lakes, which is near the southern end of this chain of wetlands extending from North Lake in the north to Wattleup Lake in the south. It is proposed to increase the width of the road reserve from 20 to 25 metres to accommodate improved drainage and a dual use path. This will cause a small loss of area from either one or both of two "A" class reserves, A15556 (Thompsons Lake) or A29241 (Harry Waring Marsupial Reserve).

The additional 5 metres of vegetation and habitat disturbance alongside the existing single carriageway is not considered to be a significant adverse impact on the conservation values of M93 because it is such a narrow strip of land and will occur in an area of existing edge effect. It is considered preferable from the perspective of habitat disturbance to extend the road reserve on the southern side, against the Harry Waring Marsupial Reserve. This is because the Marsupial Reserve habitat, and particularly its fauna, are confined within a vermin-proof fence, which provides an abrupt demarcation of habitat in this sector. On this basis, disturbance on this side of Russell Road would avoid encroachment within the habitat continuum on the northern side of the road.

8.3.3 M104 - Leda Open Space - Rapid Transport Reserve

The proposed rapid transport route passes through vacant Crown land in the north-west corner of M104. It passes close to a small wetland in that corner of M104 (refer to Section 8.4.2). The rapid transport route will remove about 2.8ha of natural vegetation from M104 and will isolate about 12.5ha in the north-west corner of the area. However, this "isolated" portion of M104 will have direct continuity with remnant bushland in the expanded M104 which is proposed as additional Parks and Recreation Reserve. In the context of the major expansion to M104, the rapid transport route is considered to have minimal potential for adverse effects in this area, other than for wetlands (discussed in Section 8.4.2).

8.3.4 Regional Perspective of Effects on Other System 6 Areas

The direct impacts on the three System 6 areas (M92, M93 and M104) examined above are only minor in the context of the total area of each System 6 'reserve' affected. Only a small proportion of natural vegetation and fauna habitat will be removed in each case.

Despite the relatively small magnitude of each impact, it is also recognised that the potential cumulative effects of such small scale impacts are an important consideration, including the associated indirect effects.

Two of the principal indirect impacts of corridor infrastructure are edge effects and barrier effects. Edge effects arise due to the 'migration' of disturbance from the road or rail route into the adjoining natural environment (e.g. weed invasion, dieback spread). Barrier effects arise due to the hindrance to species interaction and movement across the land alienated by the corridor; pockets of bushland and resident fauna can become isolated, to variable degrees, from nearby areas which were previously in continuity.

The magnitude of these indirect effects will vary due to a range of factors, including the width of the corridor, the fixtures within the corridor, intensity and type of use, and the relative sizes and shapes of adjoining remnant habitat areas which have been 'isolated'.

Consideration of aspects such as the above allows some overall conclusions to be made regarding the significance of impacts on System 6 areas M92, M93 and M104 on a comparative basis. These conclusions are as follows:

- Initial appraisal of the Beeliar Drive crossing of M92 suggests that the poor boundary-to-area ratio of this proposed Parks and Recreation Reserve would be exacerbated by construction of the road. However, the shape of M92 (a long north-south axis and narrow east-west axis) indicates that the edge effect of Beeliar Drive will not be substantial in comparison to the situation which would arise if the road was aligned in a north-south direction. Lake Coogee and associated wetlands are already exposed to significant edge effects due to adjoining land uses on the eastern and western sides. The east-west alignment of Beeliar Drive will have a comparatively minor effect on a system which is largely affected by other stresses.

- The widening of Russell Road through M93 will not adversely affect the boundary-to-area ratio of the Thompsons Lake and Banganup Lake sector because of the favourable dimensions of the site. It will also have minimal barrier effect because the Banganup Lake area has been established as an isolated marsupial research facility and is managed accordingly.

- The crossing of M104 and Leda open space by the rapid transport route will not adversely affect the boundary-to-area ratio of this area because of the favourable dimensions in the vicinity of the alignment. If the route is ultimately developed as a rail system and securely fenced, then it will form a significant barrier, especially to the movement of some fauna species. However, because the areas of remnant bushland either side of the transport route are substantial, they are most likely to maintain self-sufficient populations of resident fauna species.

Beeliar Drive, Russell Road and the Rapid Transport Reserve are just three examples of linear infrastructure issues in respect of System 6 areas. The barrier effects and edge effects of such corridor developments are of obvious concern. However, these negative effects need to be balanced by the proposed additions to Parks and Recreation Reserves and System 6 areas within the South West Corridor, as discussed in Part I and summarised on Figure 7. Reference to Figure 7 (Part I) will clearly demonstrate the improved boundary-to-area ratios of specific System 6 areas as a result of enlargements proposed in the Stage A and B Amendments and the overall Structure Plan. The proposed additions to M94, M97, M99, M104, M106 and M108 will all assist in enhancing the conservation values of the original System 6 areas.

8.4 Impacts on Individual Wetlands

As mentioned in Section 7.6.2, a number EPP and Structure Plan wetlands have the potential to be impacted by changes to rezonings proposed under the MRS Amendment.

8.4.1 The Spectacles

Surveys of The Spectacles in the 1970s and 1980s have shown that the area contains significant conservation values, including:

- a large, relatively undisturbed jarrah/banksia woodland;
- the largest and best-preserved example of a mature, closed *Melaleuca* wetland;
- a Declared Rare Flora (DRF) species, *Dodonaea hackettiana;*
- a rare lizard spcies *(Lerista lineata)*;
- a frog species, *Crinia georgiana*, which is rare on the Swan Coastal Plain;
- good water quality; and
- a nesting colony of the Rufous Night-heron.

There are three options for the rapid transport route in the vicinity of The Spectacles. Two options deviate from the existing Kwinana Freeway reserve and cross Johnson Road and cut across the south-eastern corner of The Spectacles, before exiting across Thomas Road in the vicinity of the Peel Main Drain. The third option continues alongside the Kwinana Freeway reserve until about Orton Road, Casuarina, before diverging west to rejoin the other routes just north of Bertram Road, Casuarina.

This latter option has the disadvantage of passing through or very close to a small, perched wetland that contains the DRF species *Diuris micrantha*. Nevertheless, CALM is actively pursuing flora studies of the alignment with a view to recommending this option. Another disadvantage is that the railway line would pass further away from the current urban areas of Kwinana. However, by the time such a railway line is built, the Kwinana urban areas are likely to have grown out at least as far as the eastern alignment.

The vegetation in the south-east corner of The Spectacles (near Small Eye) comprises Melaleuca spp. over an understorey of sedges. The ground over most of the area is seasonally waterlogged and would require substantial filling to support a railway line or bus route. The vegetation in the far south-eastern corner is drier and includes Woollybush *(Adenanthos sericea)*, Sheoak *(Allocasuarina fraseriana)* and several eucalyptus.

The impacts of the options which cross the south eastern corner of The Spectacles will be:

- alienation and isolation of a small part of the reserve;
- noise impacts from trains or buses on habitats within the reserve; and
- effects on the public facilities (existing and proposed) such as visual and noise disturbance.

The significance of these impacts will generally be low to moderate, although it is difficult to assess the likely impacts of noise disturbance on the resident fauna.

The removal and isolation of land from the south-east corner of the reserve will reduce somewhat the buffer available for the Small Eye. This will be the only direct physical impact on The Spectacles reserve.

All three options for the location of the rapid transport reserve in this vicinity are still being considered and will be subject to further consultation.

Four species of Declared Rare Flora (DRF) occur nearby.

8.4.2. Leda Wetlands

Appendix D presents a detailed description of the three wetlands in Leda that are close to the rapid transport route. Only one, the most westerly, will be directly affected.

The westernmost, unnamed wetland (an EPP wetland) will be bisected by the rapid transport route. The major potential impacts are filling, hydrological disruption, barrier effects. The degree of these impacts will depend on the nature of the crossing - whether by causeway (filling) or bridging. The crossing method has not yet been determined. If a causeway were used, the impacts of all kinds could be minimised by the provision of culverts and wildlife underpasses.

The impacts of the rapid transport route on the Leda wetlands can be managed if measures are taken to minimise clearing and barrier effects. It should be noted that the effective conservation of the wetlands depends partly on the protection of enough of the surrounding bushland to act as a buffer and to preserve ecotones.

8.4.3 Stakehill Swamp

The rapid transport route will pass within about 20 metres of, but will not touch, the extreme south-west corner of Stakehill Swamp. This area is cleared for farmland and no significant adverse impacts are expected, although a detailed management plan would be required for the construction phase. The protection status of Stakehill Swamp will increase with its rezoning from Rural to Parks and Recreation.

8.4.4 Anstey Swamp

Anstey Swamp is a long, narrow EPP wetland that lies east of Mandurah Road in Karnup. The rapid transport route will encroach between 20m and 60m into the fringing tall Tuart woodland west of the swamp. The rapid transport route has been kept as close to the Mandurah Road reserve as possible, or coinciding where possible, so as to minimise this disturbance. The transport reserve will have the benefit that the fenced transport route, when constructed, will limit human and domestic animal access to the swamp, thereby reducing the potential for disturbance in an increasingly urbanised environment. However, it will represent a substantive direct impact on the western edge of the swamp.

8.4.5 Regional Perspective of Effects on Wetlands

V & C Semeniuk (1991) recognised a number of consanguineous (related) wetland suites in the South West Corridor. These are listed in Table 12.

The overall effect of the Stage A and B Amendments and Structure Plan proposals will be to increase the degree of reservation of the major wetland suites in the study area. This is particularly so for the Becher Suite, which will be largely reserved in the Port Kennedy Parks and Recreation Reserve, and the Stakehill Suite, whose protection status will be increased by the creation of the Stakehill Swamp, Tamworth Hill and Paganoni Swamp Parks and Recreation Reserves. Of the other suites:

- the Swan River Suite will be unaffected, as it is outside any areas to be rezoned;
- the Peelhurst Suite will not be represented in reserves as it will remain within the Urban zoned area of Secret Harbour; and
- a small portion of the Goegrup Suite south-east of Stakehill Swamp will be rezoned from Public Purposes to Parks and Recreation.

Table 12

Wetland Suites of the South West Corridor

(Source: V & C Semeniuk, 1991)

Suite	*Landform Unit*	*Characteristics*
Peelhurst	Quindalup	Microscale to leptoscale sumplands and damplands formed in a dynamic blowout-parabolic dune terrain.
Becher	Quindalup	Microscale to leptoscale sumplands and damplands formed by prograding beachridge processes.
Cooloongup	Quindalup	Mesoscale to macroscale lakes developed by former marine barriers.
Stakehill	Spearwood	Linear macroscale to microscale sumplands and damplands formed in large scale interdunal depressions
Swan River	Pinjarra Plain	Microscale channels, palusplain with associated microscale deepened/altered wetland basins.
Goegrup	Pinjarra Plain	Microscale basins (sumplands and damplands).

Definitions:

Leptoscale	-	Minute
Microscale	-	Small
Mesoscale	-	Intermediate
Macroscale	-	Large
Sumpland	-	Seasonally inundated
Dampland	-	Seasonally waterlogged

8.5 Regional Implications for the Conservation of Flora, Fauna and Ecosystems

Appendix D presents a detailed discussion of the conservation status of the Quindalup Complex and Cottesloe Central and South Complex and the implications of the proposed MRS amendments. A summary is presented here.

The Quindalup Complex is considered poorly conserved in the region between Perth and Mandurah. The area of Quindalup Complex vegetation under reservation will increase, provided that the Parks and Recreation zoning at Port Kennedy is managed with conservation as a priority. Certain unusual vegetation associations within the Quindalup Complex, including beach ridge plains, Tuart tall open woodland and *Banksia littoralis* dune swales, may decrease in area through being removed from M103.

The Cottesloe Central and South Complex is a variable complex that is also poorly conserved between Perth and Mandurah. The area of reservation will increase under the MRS amendment.

V & C Semeniuk (1991) pointed out that, due to the long history and pervasive nature of settlement in the South West Corridor, any remnant vegetation in reasonable condition is likely to be of regional conservation significance because it will be truly isolated and representative. This implies that any proposal that impacts on remnant vegetation in the Corridor is environmentally significant.

Semeniuk identified four main areas of high quality remnant vegetation in the South West Corridor: Tamworth Hill, the Becher Point-Secret Harbour-Lark Hill area, the Paganoni Swamp area and the area east of Peelhurst and Singleton. Of these, the conservation status of all but the last will increase substantially.

9.0 ENVIRONMENTAL MANAGEMENT PRINCIPLES

Management of environmental impacts at this planning stage has consisted of:

- avoiding rezonings that would cause unacceptable impacts;
- drawing boundaries that avoid or minimise adverse impacts on areas identified as having high conservation value; and
- compensating for unavoidable impacts by other measures that produce net gains for the environment of the area.

The principles for management of the major environmental issues arising from the MRS Amendment are summarised below.

- Effects on System 6 Areas.

  A number of elements of the MRS Amendment bear on existing System 6 areas. The approach taken in the MRS Amendment has been to treat the System 6 boundaries as flexible and able to be modified to better reflect a balance of conservation priorities and urban development imperatives. The result has been a substantial increase in the area of the South West Corridor set aside as Parks and Recreation Reserves, at the expense of a small number of specific areas with conservation value.

- Effects on EPP Lakes and Other Wetlands

  The degree of reservation of wetlands in the Corridor is markedly increased under the amended MRS. Where individual wetlands are affected by road reserves and the rapid transport route, Environmental Management Plans should be prepared to minimise the impacts of construction. To mitigate adverse effects on EPP wetlands, replacement wetlands of equivalent size and function will be created or restored.

- Effects on Regional Conservation Values

A loss of overall conservation value is inevitable and unavoidable when a sparsely settled rural area changes to a densely populated urban one. Within this framework, the MRS amendments seek to achieve the maximum retention and beneficial incorporation of the conservation values of the South West Corridor into the MRS. This is achieved with a substantial improvement in the size, linkage and protection status of most of the features identified by various studies as being the most important conservation attributes of the South West Corridor.

The areas to be rezoned to Parks and Recreation by the MRS Amendment should have management plans prepared for them by the responsible authorities. These management plans should address, among other things, the management of increased public usage so as to maintain their natural values.

10.0 COMMITMENTS BY THE PROPONENT

Subject to the understanding that DPUD is not a statutory decision making body (except in a minor way by delegation) and that DPUD has only an advisory role to the Minister for Planning, the State Planning Commission and the Metropolitan Planning Council, and subject to the understanding that many decisions made on the advice of DPUD can be overturned on appeal, and subject to the understanding that DPUD does not have responsibility for the actual construction of major roads and other items of transport infrastructure, DPUD, as proponent of this PER makes the following commitments.

1. The additional areas proposed for rezoning to Parks and Recreation in the 1993 Structure Plan for the South West Corridor will be zoned for this purpose. That is, subsequent to implementation of the current Stage A and B Amendments, DPUD will recommend that additional amendments are initiated to achieve all of the Parks and Recreation allocations as proposed in the Structure Plan.

2. In the event that minor modifications to proposed Parks and Recreation Reserves are considered desirable prior to formal zoning, then DPUD will recommend that adjustments be made to ensure that there will not be a reduction in the overall allocation of open space for conservation purposes in the South West Corridor.

3. During future implementation of infrastructure proposals within transport reserves established by the Stage A and B Amendments, DPUD will recommend that a detailed Environmental Management Program (EMP) is required prior to construction (to be prepared to the satisfaction of the EPA). In particular, the following elements will be addressed by future EMP's:

    - the rapid transport route and its effects on important areas of natural environment, including but not limited to System 6 area M103 (Rockingham Lakes), The Spectacles, Stakehill Swamp and Anstey Swamp;

    - the Eighty Road extension and its impingement on the Tamworth Hill EPP wetland;

    - the proposed Beeliar Drive and its crossing of M92 and an EPP wetland;

- the widening of Russell Road through the Beeliar Regional Park (M93), and

- the proposed upgrading of Safety Bay Road through System 6 area M103.

4. As urbanisation of the South West Corridor progresses, DPUD will endeavour to ensure that the environmental protection requirements implicit to this PER are implemented, where appropriate, in Town Planning Schemes, District and Local Structure Plans and Subdivision Plans. In general, the aim will be to achieve adequate protection of Structure Plan wetlands (including EPP wetlands) and the following specific environmental features;

- the EPP wetland in the proposed regional sporting centre for the City of Cockburn (part of a proposed Parks and Recreation Reserve north of Beeliar Drive and east of the new Forest Road alignment) will be protected from recreational development;

- the two small wetlands in an area of proposed Urban Deferred (west of Hammond Road and north of Russell Road) will be incorporated within open space;

- the extreme north-eastern side of Tamworth Hill Swamp extends into a proposed urban area and, whilst completely degraded, it will be protected from adverse drainage and water quality changes which may affect Tamworth Hill Swamp;

- the small areas of System 6 area M92 which are not included as Parks and Recreation Reserve will be incorporated into local open space; and

- the southern 'spur' of System 6 area M93, which includes two wetlands, will be protected in local open space.

5. Where the rapid transport reserve crosses public land, such as the Leda open space and northern sector of M103, flexibility in the alignment will be accommodated via minor amendments to the MRS in the event that detailed environmental assessment (during preparation of the EMP) identifies an alternative, acceptable alignment with reduced environmental impact.

6. A detailed re-assessment of the configuration of the Garden Island Highway and rapid transport reserve will be conducted for the interchange area in the vicinity of Dixon Road (east) and the Mundijong railway, to determine whether or not the EPP wetland can be avoided and the rapid transport route deviated further to the north from Lake Cooloongup.

7. DPUD will prevail upon the City of Rockingham to negotiate with Special Rural landholders adjacent to the Nairn Road reserve to attempt to avoid the EPP wetland which will currently be affected by future road construction. The option of wetland replacement will be discussed with the City of Rockingham.

8. DPUD will conduct further assessment of the alternatives for the rapid transport reserve in the vicinity of The Spectacles, with a view to minimising potential adverse effects on this important area.

9. DPUD will recommend that the proposed Hillman Public Purposes Reserve be deleted from the Stage B Major Amendment to the Metropolitan Region Scheme on the basis of findings of this PER.

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APPENDIX A

Environmental Protection Authority Guidelines for the PER

PROPOSAL TO CHANGE LAND USE AFFECTING SYSTEM SIX AREAS AND LAKES PROTECTED UNDER THE ENVIRONMENTAL PROTECTION POLICY TO URBAN, INDUSTRIAL, SPECIAL USES, AND TRANSPORTATION PURPOSES, TO BE REFLECTED IN THE SOUTH WEST CORRIDOR MAJOR MRS AMENDMENT (STAGE B)

GUIDELINES FOR THE PUBLIC ENVIRONMENTAL REVIEW

In Western Australia, the environmental assessment process is about protecting the environment. The fundamental requirement is for the proponent to describe the proposal, to discuss the environmental impacts and potential environmental impacts of the proposal, and then to describe how those environmental impacts are going to be avoided, ameliorated or managed so that the environment is protected.

Throughout the process, it is the aim of the Environmental Protection Authority (EPA) to advise and assist the proponent to improve or modify the proposal in such a way that the environment is protected. However, it is the responsibility of the proponent to design and implement proposals which protect the environment, and to present the design proposals for review.

These guidelines have been prepared to assist the proponent in identifying issues which should be addressed within the Public Environmental Review (PER) for certain proposed land use changes within the South West corridor. They are not intended to be exhaustive and the proponent may consider that other issues should also be included in the document.

The PER should facilitate a review of the key environmental issues The purpose of the PER should be explained, and the contents should be concise and accurate as well as being readily understood. Specialist information and technical description should be included only where it assists the understanding of the the proposal. Where specific information has been requested by a Government Department or the Local Authority this should be included in the document.

It is not intended that the document be unduly lengthy. Rather it is intended that all relevant material should be succinctly presented in order that the key environmental issues may be assessed.

The principal function of the PER is to place this proposal in the context of the regional environment and progressive developments, including the cumulative impact of these proposed land use changes. It seeks to explain why this proposal is being put forward in the way it is, at this place and at this time. It should also set out the environmental impacts the proposal will have, and what management steps the proponent intends to use to avoid, ameliorate or mitigate any negative environmental impacts.

The PER will provide the basis for the Environmental Protection Authority to provide advice to the Government on protecting the environment.

A copy of these guidelines should appear in the PER document.

PROPOSAL DESCRIPTION

It is important to include a description of the proposal itself, including specifically what is proposed, how it is to be carried out, the timing of the project, and what measures will be taken to ameliorate possible negative effects.

Plans of the areas affected should be included showing:

- existing land uses and land status;
- adjacent land uses;
- proposed land uses;

- System 6 area boundaries; and
- wetland and EPP Lake boundaries.

These plans may be included in the text, or included as appendices to the report.

ENVIRONMENTAL IMPACTS AND MANAGEMENT

The key issues for this proposal should be clearly identified and the content of succeeding sections determined by their relevance to these issues.

In this case the key issues include:

Impact on System 6 Area M103

That is, impact of the land use change proposals on:

- the intent and objectives of the System 6 Recommendation;
- future planning, values, integrity and management of M103;
- the ecological function of the System Six area; and
- landscape values.

Conservation of flora, fauna, and ecosystems

Investigation should be undertaken of:

- the significance of the native flora and fauna within the System 6 area, including their regional significance and their representation within the region in other reserves; and
- impact on flora, fauna and landscape values of areas outside System 6 M103.

Lakes and wetlands

Investigation should be undertaken of:

- impact on lakes protected by the Environmental Protection (Swan Coastal Plain Lakes) Policy; and
- impact on wetlands.

Other issues which may become apparent or raised during the preparation of the PER should also be included.

Predicted environmental impacts and proposed measures to overcome or minimise these problems should be discussed in sufficient detail so as to allow an adequate assessment to be made.

PUBLIC PARTICIPATION AND CONSULTATION

A description should be provided of the public participation and consultation activities undertaken by the proponent in preparing the PER. Cross reference should be made with the description of environmental management for the proposal which should clearly indicate how community concerns have been addressed. Where these concerns are dealt with via other procedures outside the Environmental Protection Authority process, these can be noted and referenced in this section.

APPENDIX B

Original System 6 Recommendations for Areas Affected by the MRS Amendment

SYSTEM SIX AREAS
STATUS OF RECOMMENDATIONS
(source: DEP, 1994)

M99 - Reserve A25886, West of Byford

- M99.1 Implemented. DPUD proposes that the area be included in the Jandakot Botanic Park which was proposed as a regional park in Metroplan.

M100 - Reserve C38167, South of Byford

- M100.1 Implemented. DPUD proposes that the area be included in the Jandakot Botanic Park which was proposed as a regional park in Metroplan.

M101 - Cape Peron, Shoalwater Bay and Warnbro Sound

- M101.1 Unresolved Issues. The area is the Shoalwater Islands Marine Park (gazetted 25/5/90) and this is a use which could satisfy the regional park recommendation.
- M101.2 Implemented.
- M101.3 Implemented. C Class reserve gazetted in September 1992. The northern island shown as VCL in the Red Book was a sand cay and no longer exists.
- M101.4 Implemented. The Shoalwater Islands Marine Park was gazetted on 25/5/90.
- M101.5 Unresolved issues. CALM has prepared a management plan for the terrestrial portion and has begun preparing a management plan for the marine portion. The Port Kennedy Land Conservation District Committee has an interest in this area.

M102 - Lake Richmond, Rockingham

- M102.1 Unresolved issues. The local authority will not approve implementation of the recommendation until it is confirmed that the alignment of the proposed Garden Island Expressway and the recreation oriented recommendations of the Cape Peron Study will not be compromised. The Cape Peron Study recommends that, with some exceptions, the part of Cape Peron within the study area (including Lake Richmond) should be an A Class reserve for recreation, conservation and holiday accommodation. The new

Expressway alignment is being surveyed. Following survey, agreement has been reached to vest the reserve in the LGA for conservation and recreation.

- M102.2 To be implemented along with M102.1.
- M102.3 To be implemented along with M102.1.
- M102.4 Unresolved issues. Vesting and purpose need to be negotiated and finalised. Council and local naturalist's club will prepare a management plan once vested in LGA.

M103 - Lakes Cooloongup and Walyungup

- M103.1 Unresolved Issues. Proposed as a regional park in the Regional Parks Task Force and in Metroplan (1990). Regional park proposal has been agreed to by Government.

M104 - Reserves C31102 and C33581, Leda

- M104.1 Implementation progressing. CALM and Shire of Kwinana have agreed that CALM could manage the reserve. Structure Plan outlining conservation proposals has been prepared. DPUD is progressing MRS amendments. DOLA is progressing reservations.
- M104.2 Implementation progressing, as above.
- M104.3 Implementation progressing, as above. The Wetlands Conservation Society has an interest in this area.

M106 - Port Kennedy

- M106.1 Unresolved issues. Proposed as a regional park in Metroplan (1990).
- M106.2 Unresolved issues. A portion of the area is proposed to be developed as a tourist resort, with most of the area to be set aside for conservation and recreation. Stage 1 of the development has been approved and is progressing with some alterations to the boundary.

M107 - Peelhurst, Singleton and Madora

- M107.1 Implemented. Vested in the local authority for Public Recreation.
- M107.2 Implemented. Vested in the local authority for Public Recreation.

- M107.3 Unresolved issues. EPA has released report and recommendations for development of this area. East-west links to be developed, additional foreshore reserve to be set aside. Singleton Ratepayers' Association has an interest in this area.

M108 - Goegrup Lakes

- M108.1 Implementation progressing. The portion of M108 outside the metropolitan region is being considered as part of the Peel Regional Park study being coordinated by DPUD. CALM;s 1992 Draft South-weest Forests Strategy recommends part fo area to be nature reserve.

- M108.2 Unresolved issues. Local authority's current position still to be determined. The local authority had previous concerns regarding adequate mosquito control. Discussions between the LGA and CALM on this issue have since occurred. LGA is negotiating for a small area for drainage purposes before vesting is finalised.

Conservation Reserves

for Western Australia

as recommended by the
Environmental Protection Authority — 1983

THE DARLING SYSTEM - SYSTEM 6

Part I: General Principles and Recommendations

On 19th March, 1984 State Cabinet accepted in principle Part I of this report and approved of the progressive implementation, as far as possible, of the detailed recommendations in Part II.

Report 13
October, 1983

Department of Conservation and Environment
Western Australia

Chapter 5

MANAGEMENT OF PARKS, RESERVES AND OPEN SPACE

5.1 General

Taken as a whole, the developing open space network presents formidable problems of management. Since resources for the purpose are scarce, it is important that they are effectively deployed, and that the activities of the many agencies involved are coordinated.

In Systems 1 and 2 in particular, implementation of our earlier proposals based on the CTRC recommendations has led to some movement in the direction of integrated management. This has been effected very largely by *ad hoc* working groups, such as those in the Leeuwin-Naturaliste and the Esperance areas. There has been most activity in the coastal areas of the south-west following earlier work by the Department of Conservation and Environment on the development of the policy for the coastal zone, and the appointment of a Coastal Planning and Management Adviser.

Our recommendations made here draw on these experiences, and while they are aimed at the problems of the System 6 area, they clearly have relevance beyond it, especially in the south-west.

5.2 Current Management

System 6, for a relatively highly developed part of the State, is extremely well endowed with open space, although, as argued already, it is a resource to be conserved. Management difficulties arise because of limited resources and the complexities and forms of tenure involved. These have evolved over time with the change from a pioneering community struggling to survive to one which now sees conservation of nature and public amenity values as increasingly important.

The main components of the system of parks, reserves and open space and their management agents are:

- State Forest with its MPAs for conservation of flora, fauna and landscape, and for recreation, managed by the Forests Department;
- Nature Reserves — reserved under the Land Act and managed by W.A. Wildlife Authority;
- National Parks — reserved under the Land Act and managed by the National Parks Authority;
- Parks and Reserves reserved under the Land Act for a variety of conservation and recreational purposes, managed by local authorities and some by special boards, e.g. Kings Park and Rottnest Island. Some have been created as a condition of subdivision approvals;
- Freehold land acquired by the Metropolitan Region Planning Authority and local authorities following "reservation" as open space, and MRPA land managed under interim arrangements;
- Freehold land "reserved" by planning authorities, but not acquired, managed with varying competence by current owners;
- Functional open space of various kinds (farmland, forest, vacant Crown land, land awaiting development) managed with varying competence by the owners.

The State Forest already has a developed system of integrated management in a land use planning framework, which is published in the Forests Department's Working Plan.[7] Priority uses are identified for each forest block, together with other compatible and permitted uses. Though managed by a single agency, its management policies clearly take account of interests other than forest protection and production, including conservation of flora and fauna and the safeguarding of important water resources. The Nature Reserves too are managed by a single agency under the W.A. Wildlife Authority, and in general are designated for a single primary purpose, namely the conservation of flora and fauna. Our concern, therefore, in this Chapter is more with the remaining components listed. These form a system of parks and reserves and open space of great complexity, in terms of ownership, form of tenure, and purposes of management.

A large proportion is managed by the National Parks Authority. It is responsible for numerous parks in a range of conditions for a variety of purposes*. Some are in scenic areas of significant size, often in the more remote parts of the State, which meet IUCN's criteria for a "National" park. Others, particularly in the more settled areas like System 6, are smaller, and more intensively used. While they attract use from a wide area, the latter are hardly of national significance, and should be more properly termed provincial or regional parks. Some have little or no component of natural area. Their place under National Parks management reflects the historic development of that Authority. The staff of the Authority constitutes a body of expertise, skilled in management of natural areas, both for their protection and to facilitate public use.

There still is, however, a substantial body of reserved land in the remainder of the foregoing list, where management arrangements could be improved, especially in relation to those parks and reserves which attract regional visitors. It includes land held by the smaller local authorities who may not have the necessary technical and financial resources to manage these parks and reserves, though they often have the labour and plant readily available, and the large areas under MRPA freehold ownership amounting to 10 230 ha for which there are only interim management arrangements. Areas "reserved" as open space through planning procedures but still held by their original owners may deteriorate due to neglect.

* Between the Kimberley and the south coast region there are 52 National Parks, occupying a total area of 4 414 266 ha and ranging in size from 33 ha to 1 569 459 ha.

5.3 Regional Parks

The concept of Regional Open Space introduced to Western Australia by Stephenson and Hepburn in 1955[18] was intended to provide for the protection of open space of regional significance. They gave as examples:

i) ocean beaches
ii) rivers and their foreshores
iii) areas of landscape value
iv) picnic areas, camping rounds, tourist cabin areas etc.
v) nature reservations
vi) central parks (e.g. Kings Park, Bold Park)
vii) zoological gardens
viii) motor parkways (i.e. scenic drive areas)
ix) open country

Planning procedures such as those discussed in Chapter 4 tend to produce concentrations or nodes of open space in the more attractive areas, often connecting along such linear natural features as rivers, foreshores and beaches. The concept clearly involves private as well as public land, with National Parks often forming the core of the major concentrations of open space of regional significance (Figure 1).

There is, of course, a definitional problem of when open space is regional in character, as distinct from a local amenity. If regional, in the sense of attracting users from beyond the locality, then there is a case for external funding, whether through direct government grant or by some form of regional rating system. Whatever the means of funding adopted, there are administrative advantages in the clear recognition of the areas to which they are appropriate and applicable.

Recommendation

15. Areas identified through planning procedures as open space of regional significance should, where appropriate, be designated as Regional Parks.

5.4 Coordination of Management

Management of the system of regional open space involves both conservation and provision for public access, it requires the coordination of the activities of the government agencies and other holders of land affected, and it may call for technical advice and financial assistance to owners and managing agencies which require them. If it affects privately owned land, and our earlier Recommendation 14 suggests that it should, then it implies constraints on development or incentives to ensure compatible management. It could also involve negotiation to provide managed access to private land or provision for passage through it. This is not so revolutionary as it may seem, since the public will inevitably attempt to reach attractive features, especially if in rural areas. Managed access, directed to where it will do least harm, would thus be in the interests of owners as well as the public. Again, there may be a case for financial compensation or assistance to owners in return for the acceptance of constraints or for maintenance made necessary by public use of the land.

There will be thus a variety of tenure, ownership and management agencies in a Regional Park with, in most cases, a substantial proportion of publicly owned land, some of it presently classified as National Park or recreation reserve. It will be necessary to define management objectives for each Regional Park and its component parts, designated for differing primary purposes, taking account of its role in relation to others; leading then to the identification of the most suitable managing agencies for each component, and a recognition of the need for coordination of their activities.

There would appear to be advantages in giving these functions to a body with appropriate expertise and experience on the ground. The National Parks Authority, with its capability in the management of natural areas while permitting use and enjoyment by the public, is immediately indicated.

Recommendation

16. The National Parks Authority should be given the responsibility for coordinating the planning and management of areas identified as Regional Parks, and for the following functions:
    i) the provision of technical and other advice to managing agencies and owners;
    ii) an examination of the present funding and coordination of development programmes.

These changes to the role of the National Parks Authority may require some legislative changes.

5.5 Staffing and Funding for Management

The number of staff and funds required for the management of open space areas are presently inadequate, and have also failed to grow with the increase in the amount of land set aside for this purpose. For example, in 1968 the National Parks Authority (then Board) employed about forty rangers and ancillary staff to manage 3 500 ha of National Parks. By 1982 the area of National Parks increased over a thousand fold to 4.4 million ha and was accompanied by only a doubling in staff numbers together with a decreasing trend in the discounted Treasury Grants for management purposes.

The additional roles proposed in 5.4 above for the National Parks Authority in coordinating management of regional parks and providing technical support and advice to other managers will make even further demands.

Recommendation

17. The Government should give urgent consideration to providing adequate staffing and funding for the National Parks Authority and other agencies concerned with management of parks and reserves.

Chapter 6

CONCLUSION

The main purpose of the System 6 Study was to ensure that the remaining opportunities for the conservation of natural areas in the area of System 6 were recognised, and to recommend ways and means of setting them aside for their protection after proper consideration of competing uses.

In submitting our recommendations to the Government for its consideration, we recognise the immense amount of work of those participating in the Study, not only the members of the several committees, but also all the organisations, groups, and individuals who made submissions. These submissions were always informative, and often constructive.

It has not been possible to accept all the proposals made, even some of those strongly supported by the constituent committees, and published in the Report of the Study.[1] In many cases this was because they involved broad issues of resource planning, management and inventory, properly the concern of other authorities and agencies, or under study elsewhere. Consideration of them is a matter for the type of town and country planning which we argue for in Chapter 4. In three main areas — conservation in State Forest, Land Act reservation and public planning — there are problems of lack of information for decision making, and in the means by which options for the future may be kept open.

Postponement of decisions for lack of information carries the implication that the information will be sought, so that the position will in some way be capable of resolution in the future. There are a number of areas where better inventory is required, some of which were remedied during the course of the Study with the production of the System 6 Atlas.[19]

It is recognised that inventory, particularly detailed inventory, is costly. Yet its lack, at some appropriate level of detail, may also have considerable disadvantages. A telling example of this problem is the lack of inventory for the fauna of the Darling Range. Opposition to a proposed development may be generated when intensive investigation, preceding a major project, finds species assumed to be rare because they were previously unrecorded.

A number of agencies have resource inventory responsibilities, including the Mines Department, Department of Agriculture, Forests Department, W.A. Wildlife Authority, W.A. Museum, and the Water Supply Authorities. Some coordination of their contribution to the resource data base for land use planning is probably needed. It will no doubt be a consideration during the development of the Western Australian Conservation Strategy which has the objective of integrating conservation and development.

We endorse, in principle, the Recreation Areas Strategy Plan proposed in the Study Report[1], and recommend accordingly below. It essentially is a survey of the resources available in System 6 for recreation in natural surroundings in relation to estimated demands.

Recommendations

18. A coordinating committee responsible for the land resource inventory required for planning purposes should be established.

Conservation Reserves

for Western Australia

as recommended by the
Environmental Protection Authority – 1983

THE DARLING SYSTEM – SYSTEM 6

Part II: Recommendations for Specific Localities

Report 13
October, 1983

Department of Conservation and Environment
Western Australia

M92 COCKBURN WETLANDS — WESTERN CHAIN

The recommended area is situated between 5 and 12km south of Fremantle and comprises Reserve C26870, for Recreation, not vested; part of Location 83, lot 9 (Location 3), lot 61 (Location 81), lot 10 (Location 84), part of lots 11 and 65 (Location 109), part of lot 2 (Location 102), lots 1, 21, 27, 37, 50, 78 and part of lots 35 and 36 (Location 280), lot 38 (Location 150), and part of Location 133, freehold land mostly owned by the MRPA **(Manning Lake)**; Reserve C22227 for Drainage, not vested; part of lots 1 to 4, 7 to 9, 14 to 19, 23, 50 and 505 (Location 2), lot 23 (Location 951), lots 1 and 3 and part of lot 4 (Location P18), part of lots 1, 2, 9, 11 Rockingham Road, 2 and 12 Mayor Road (Location 300), part of lots 19 to 21 (Location P11), lot 23 and part of lots 22 and 24 (Location 154), part of lot 503 (Location P10), part of lots 1 Rockingham Road, 3, 21 to 27, 1 Hamilton Road, 33 to 36 and 52 to 54, all of Location 264, part of lots 17, 18, 21 to 23 (Location 150), privately owned freehold land **(the Market Garden Swamps and surrounding land)**; Reserve C30861, for Recreation, vested in the City of Cockburn and part of lots 26 and 27 (Location 404) privately owned freehold land **(Lake Coogee)**; Cockburn Sound Locations 1841, 2074 and part of Cockburn Sound Locations 1843 and 2197, land held in the name of the Crown; and part of Locations P13 to P17, privately owned freehold land **(Mt. Brown, Mt. Brown Lake and Brownman Swamp)** (Figures 153A and B).

The MRPA has "reserved" Manning Lake and surrounding land and most of the Mt. Brown, Mt. Brown Lake and Brownman Swamp area for Parks and Recreation under the Metropolitan Region Scheme. The MRPA has recognised that other land in the area may be suitable for "reservation" for Parks and Recreation under the Metropolitan Region Scheme. All the land owned by the Industrial Lands Development Authority which is "reserved" for Parks and Recreation under the Metropolitan Region Scheme is in the process of being transferred to the Crown.

The amended route for the Cockburn Road controlled access highway passes through the area. There are SEC lines in the area, and a section north of Naval Base is used for motor sports. The MWA states that the lakes may be used as a drainage compensating basin. A fly ash disposal site is to be located immediately north of the railway reserve, on MRPA land. The whole of the area is located within the South-West Corridor.

The area has been the subject of the Cockburn Wetlands Study, the Woodman Point — Jervoise Bay Study, the Coogee Air Pollution Study and the Kwinana Air Modelling Study. Current studies concerned with the area are the Coogee Coastal Area Study, the Packham Town Planning Scheme Study and a study of groundwater management around Lake Coogee by a Working Group under the Groundwater Management Committee of the W.A. Water Resources Council.

Manning Lake

The land surrounding Manning Lake has been cleared to within twenty metres of the foreshore. The remaining vegetation consists of swamp paperbark, some tuarts and *Melaleuca teretifolia*. The understorey mainly comprises species of saltmarsh reeds. Samphire covers the lake bed at the northern end of the lake. Manning Lake has been polluted by fertilisers and possibly by horse manure entering the lake, causing a build up of bacteria and an excess of nutrients.

The Market Garden Swamps

The three Market Garden Swamps, which are small, seasonal and highly eutrophic, are all vegetated with saltwater and swamp paperbark, the structure varying from low closed-forest to low woodland. The predominant understorey species are saltmarsh reeds. The swamp bed of the southern-most swamp is almost covered by two water plants, while those of the other two are partially covered with saltmarsh plants. The Market Garden Swamps are comparatively unimportant for water-birds, but the vegetation is worth preserving since there are only a few stands of saltwater paperbark in the metropolitan area.

Lake Coogee

Lake Coogee is shallow and nearly as saline as sea water. It is also highly eutrophic, the main source of nutrients probably being fertilisers from nearby market gardens. Except for a narrow strip 5 to 10m wide little vegetation remains around the lake. It consists mostly of low woodland and low open-forest of saltwater paperbark with some understorey. Wattles and young tuarts are scattered amongst the paperbark along the western shores.

The population of water-birds in Lake Coogee includes grey teal, mountain duck and black duck which loaf on the lake. The great crested grebe and the hoary-headed grebe are also present; the lake's expanse of open, brackish water is ideal for the latter, which appears to breed there. Waders include the white-headed stilt, the red-necked stint and the white-faced heron. A small fish that can tolerate high salinity inhabits the lake.

Brownman Swamp, Mt. Brown Lake and Mt. Brown

Brownman Swamp is a series of seasonal paperbark swamps, surrounded by extensive open-forests of tuart of good quality. To the west is woodland of tuart and banksia with open-heath and shrubland on low limestone hills. The wetlands and the tuart forest have high conservation values.

Mt. Brown Lake is small, saline and usually dry in late summer, but supports several species of water-birds for most of the year. It is fringed with stands of paperbark and tussock sedge, while woodland of tuart and banksia and shrubland dominated by chenille honeymyrtle surround the wetland vegetation.

Mt. Brown and the low limestone hill to the north are covered by open-heath with many species typical of the coastal limestone, including spider-net grevillea, chenille honeymyrtle and cockie's tongues. Also present are two uncommon species, button runner and *Hemigenia sericea*. On the slopes and in the valley is deep sand supporting low woodland and low open-woodland, mainly of banksia with some jarrah and limestone marlock. The understorey contains a good variety of species. The Cockburn Wetlands Study and Woodman Point — Jervoise Bay Study both recommend that the Brownman Swamp, Mt. Brown Lake and Mt. Brown area should be retained for recreation and conservation. The Coogee Air Pollution Study had earlier concluded that this area was not suited for urban use.

The recommended area constitutes open space of regional significance (see Figure 1, Chapter 4) because of its high conservation and recreation value and its proximity to the Perth residential areas. Land tenure is varied and not all the land has conservation or recreation as primary management objectives: to enhance these values the area's management structure requires coordination. Major management considerations include: preserving the wetlands and fringing vegetation; rehabilitation of the Market Garden Swamps and Manning Lake; linking the wetlands by open space; and preventing activities (e.g. off-road vehicle use) likely to adversely affect the flora and fauna.

Recommendations:

M92.1 That our general recommendations on planning and management of Regional Parks be applied to this area (see Recommendations 15 and 16, Chapter 5).

M92.2 That the Metropolitan Region Planning Authority consider "reserving" those portions of the recommended area not already "reserved" for Parks and Recreation under the Metropolitan Region Scheme.

M93 COCKBURN WETLANDS — EASTERN CHAIN

The recommended area is situated in the City of Cockburn, and comprises Reserve A6208, for Recreation, under the control of the Cockburn City Council; Reserve C27488, for Hall Site, not vested; part of Reserve C31968, for University Site, also not vested but the subject of a Crown Grant in Trust to the Murdoch University Planning Board; lots 38, 39, 54 to 59 and part of lot 37 (Location 235), part of lots 1, 4, 7, 52, 53 (Location 10), lots 1 and 2 (Location 405), part of Locations 21, 35, 50, 65, 179, 387, 393, 438, 485, 552 and 772, freehold land mostly owned by the MRPA **(North Lake and Bibra Lake)**; lots 2 to 6 (Location 541), part of lots 9, 10, 20 (Location 21), and part of Locations 21 and 542, freehold land mostly owned by the MRPA **(South Lake and Little Rush Lake)**; lot 1 and part of lots 2, 5 and 7 (Location 406), and part of Location 298, freehold land partly owned by the MRPA **(Yangebup Lake)**; part of Reserve C31829, for Drain, vested in the City of Cockburn; lots 1 to 4, 6 to 9, 12 to 15 (Location 391), lots 1, 7 and 8 (Location 677), Locations 756, 759, 763 and 766, and 769 to 771, and part of Locations 433 and 751 to 755, privately owned freehold land **(Kogolup Lake)**; Reserves A15556, for Fauna Conservation and Research and Drainage, vested in the W.A. Wildlife Authority; C29241, for Conservation of Fauna (University Marsupial Research), vested in the Minister for Fisheries and Wildlife; C31882 for Recreation, vested in the City of Cockburn, part of lot 1 (Location 464) and Location 2017, privately owned freehold land **(Thompson Lake and Banganup Lake)**; lots 63 to 65, 86 and part of lots 57 and 59 (Location 15), and part of lots 1, 2, 3, 612 and 615 (Location 16), privately owned freehold land **(Wattleup Lake)** (Figure 154). Much of the area from North Lake to Yangebup Lake has already been "reserved" for Parks and Recreation under the Metropolitan Region Scheme, and the section from Kogolup Lake to Wattleup Lake is recognised by the MRPA as suitable for possible future "reservation".

Some of the lakes are subject to pollution caused by drainage from the Jandakot rural areas, an old sanitary landfill site and industrial effluent. Should urban development occur in the vicinity of these lakes it is probable that the MWA will have to utilise some of them as drainage sumps.

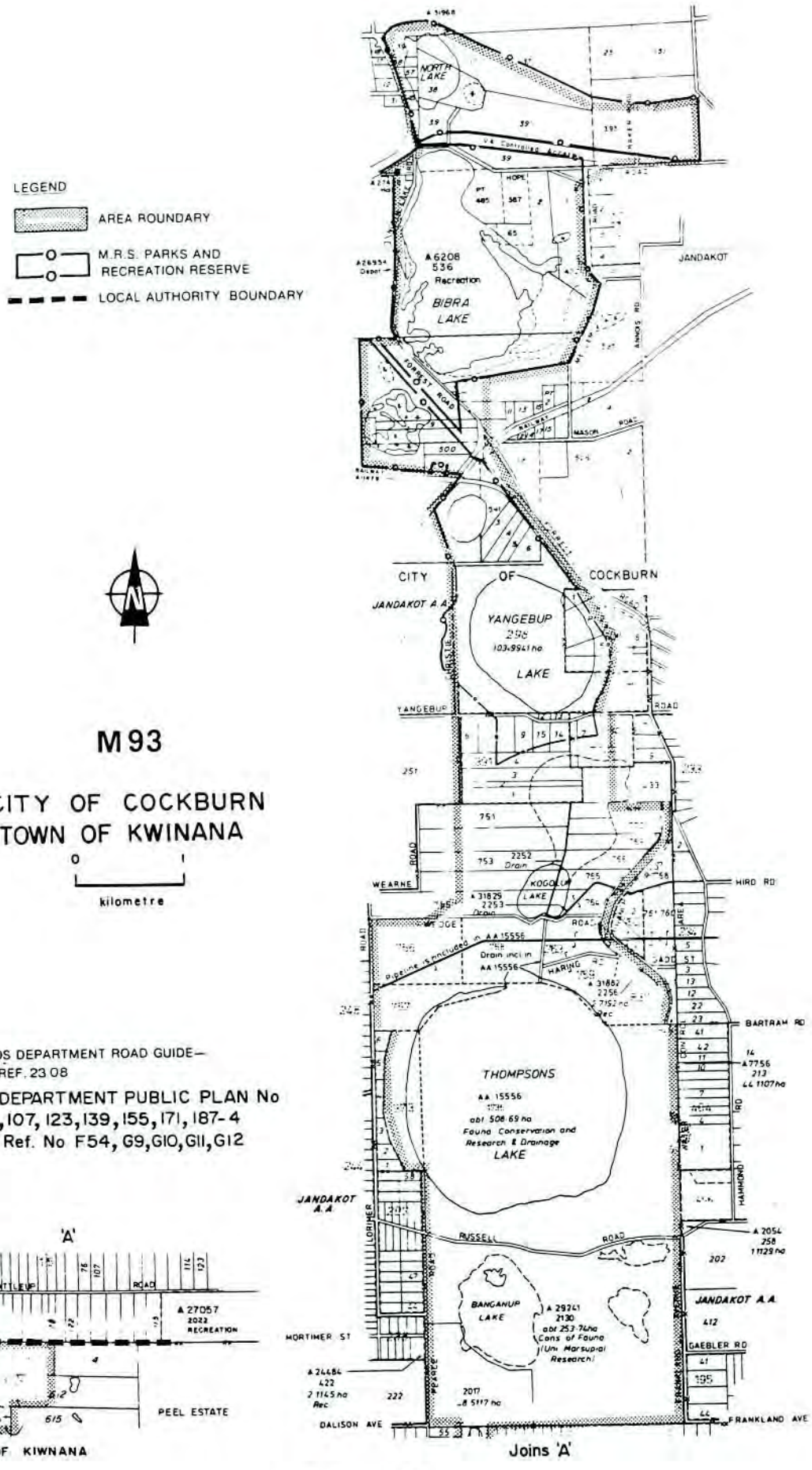

LEGEND
AREA ROUNDARY
M.R.S. PARKS AND RECREATION RESERVE
LOCAL AUTHORITY BOUNDARY
M 93
CITY OF COCKBURN
TOWN OF KWINANA
0
1
kilometre
1980 LANDS DEPARTMENT ROAD GUIDE—
MAP 97 REF. 23 08
LANDS DEPARTMENT PUBLIC PLAN No
F 75, 91, 107, 123, 139, 155, 171, 187-4
D C E Ref. No F54, G9, G10, G11, G12
NORTH LAKE
BIBRA LAKE
A 6208
536
Recreation
JANDAKOT
FOREST ROAD
MASON ROAD
CITY OF COCKBURN
JANDAKOT A.A.
YANGEBUP
298
103.9941 ha
LAKE
YANGEBUP ROAD
WEARNE ROAD
KOGOLUP LAKE
HIRD RD
HARING ROAD
THOMPSONS
AA 15556
abt 508.69 ha
Fauna Conservation and Research & Drainage
LAKE
BARTRAM RD
HAMMOND RD
RUSSELL ROAD
BANGANUP LAKE
A 29241
2130
abt 253.74ha
Cons of Fauna (Uni Marsupial Research)
GAEBLER RD
FRANKLAND AVE
MORTIMER ST
DALISON AVE
Joins 'A'
'A'
WATTLEUP ROAD
A 27057
2022
RECREATION
WATTLEUP LAKE
PEEL ESTATE
TOWN OF KWINANA

Figure 154

This could cause some contamination of the lakes and affect groundwater levels. A railway crosses the recommended area west of Forrest Road and there is a proposal to link Bibra Lake to Forrestfield by rail which will affect the area. The area is dealt with in the Cockburn Wetlands Study and the South-West Corridor Planning Structure.

North Lake and Bibra Lake

North Lake is mostly open water. In the northern section there are a few small patches of jointed twig rush and of paperbark. Around the western and southern sides of the lake there is a fairly broad band of woodland of flooded gum, associated with paperbark around the fringes of the lake. Only in the south-eastern section has extensive clearing taken place right down to the water. East of the lake and north of Hope Road there are two areas of open-woodland, east of which there is low woodland of paperbark.

Bibra Lake is also mostly open water. In the east there are extensive areas of paperbark. Bordering the open water in the northern and south-western sections there are sedgelands of jointed twig rush and bulrush. In the western section between the lake and the road, there is a fringing belt of flooded gum and paperbark and further north there are about 20ha of open-woodland of jarrah and banksia, with an understorey containing large numbers of blueboy, prickly moses, zamia and blackboy. Most of the remainder of the area is cleared, much of it used for summer pasture.

Both lakes are semi-permanent and important as summer refuges for water-birds. Good numbers of grey teal, pink-eared duck, shoveller, mountain duck, and white-eyed duck use the lakes, far more than are seen on most other metropolitan lakes. The lakes' expanses of open water favour species such as musk duck, blue-billed duck, coot and hoary-headed grebe.

Bibra Lake is the more important lake, owing to its larger size and greater variety of habitat. The large expanses of closed-scrub of paperbark and nearby muddy shallows provide an ideal habitat for a wide variety of wading birds, one of which, the yellow-billed spoonbill, is uncommon in south-western Australia. The paperbark also provides an ideal habitat for a number of bush birds, including willy wagtail, silvereye, spendid blue wren and western thornbill. This area is of prime importance for preservation since it provides one of the few productive breeding habitats for birds in the metropolitan area.

The area is likely to be subjected to increased pressure for recreation as the population increases. At present, part of the wooded area to the west of both lakes is misused by the public for trail bikes and cutting of wood. Part of Bibra Lake's western shore has been developed into a popular picnic area and children's playgrounds. The Bibra Lake Adventure World complex is to the west of Forrest Road and car parks for the complex are situated to the south of Bibra Lake.

North Lake is threatened as an area for conservation and recreation by the proposed extension of Farrington Road as a dual carriageway around the north of the lake. The Cockburn Wetlands Study recommended that the proposed extension should not be built. The proposed Roe Freeway is planned to run between the lakes. The Cockburn Wetlands Study recommended that the Freeway should be modified to reduce its impact on the wetlands in the area.

Private groundwater extraction and stormwater drainage affect water levels in the area and there is evidence of pollution of the lakes as a result of inflow of nutrients from nearby paddocks and septic systems. The area will be affected by drainage and sewerage works proposed by the MWA. The southern end of Bibra Lake was used as a rubbish tip, but this has been closed.

South Lake and Little Rush Lake

South Lake is shallow and extensively covered by reed beds. It is surrounded by a diversity of dense vegetation, which provides a habitat for a wide variety of birds. In the open water aquatic weed attracts large wading birds. The area may be affected by the MRD requirements to construct the proposed Albert-Forrest Road link.

Although the vegetation has been cleared around Little Rush Lake, there is a diversity of habitats providing a summer refuge for water-birds. The lake is ideal for passive recreation (e.g. picnic areas, children's playground) and the disused railway line running through the area could be suitable for a cycle track, linked to nearby urban development.

Yangebup Lake

The vegetation surrounding the lake has died. Although the loss of vegetation has obviously affected some populations of water-birds, the lake has particular value in that it is used by two uncommon species, the pink-eared duck and blue-winged shoveller. Other species of water-fowl that use the lake are grey teal, black duck and white-eyed duck. The red-necked stint, a wader that is seen in great numbers at Yangebup Lake, is rarely observed in fresh water environments.

It does not use any of the other lakes in the eastern chain of the Cockburn wetlands. Other species of waders at Yangebup Lake include red-necked avocet and white-headed stilt.

MWA groundwater extraction and water drainage may affect water levels. There are SEC lines in the area. A number of industries, including a tannery, discharge effluents into ponds near the lake.

Kogolup Lake

The lake consists of two separate expanses of water, linked by a low-lying area which is subject to winter flooding. The area supports a wide range of vegetation types, with all of the vegetation types of the Cockburn wetlands being represented. The waters of the lake contain sedgelands, mostly of bulrush, but with smaller areas of jointed twig rush and spike rush, the last named being normally found only in the north-west of Western Australia and in the Eastern States.

Bordering the lake are areas of open-forest and woodland of flooded gum associated with paperbarks, or with undershrub acacia. The rare Hackett's hop bush is another shrub of the understorey, as are broom ballart, stinkbush and native broom.

The surrounding woodland vegetation is varied, since the lake is situated at the junction of two major soil associations. The dense vegetation, particularly to the west, and the relative isolation of Kogolup Lake attract birds which prefer seclusion. Uncommon species have been seen in greater numbers at Kogolup Lake than elsewhere in the Cockburn wetlands. The old drain between Kogolup and Thompson Lakes has a high and diverse population of birds. The north-eastern part of the area is suitable for passive recreation, and is at present used by a riding school.

MWA groundwater extraction may affect water levels. The area has potential for diatomaceous and other earths and is affected by existing claims.

Thompson Lake and Banganup Lake

Thompson Lake is the largest water body of the Cockburn wetlands and contains about 150ha of semi-permanent open water. Around the margin of the lake is a narrow belt of sedgeland dominated by jointed twig rush. In the east the sedgeland is flanked by open-scrub of stinkbush and prickly moses, and in the south and west by a narrow strip of bare ground.

In low-lying land to the north and east of the lake is a woodland of flooded gum and paperbark. In the north flooded gum also forms an open-forest with orange wattle as an undershrub. Hackett's hop bush occurs in this association and being fire-sensitive it is important that a number of populations be reserved to ensure its survival. It is apparent that frequent burning has reduced the diversity of vegetation surrounding the lake. Retention of an expanse of tuart-jarrah-banksia forest to the west would provide a valuable buffer zone to the lake.

The lake has an abundance of bird life, both water-fowl and bush birds, forty-four species of the latter having been recorded. Many birds of prey use the area, the most note-worthy being the wedge-tailed eagle.

Reserve C29241 which contains Banganup Lake is leased to the University of Western Australia and used extensively for the breeding of marsupials, including the grey kangaroo, brush wallaby, short-nosed bandicoot, brush-tailed possum and quokka, for research purposes.

The area's vegetation types are similar to those at the adjacent Thompson Lake. There are more than three hundred and fifty species of plants in the Reserve. They include two uncommon species, babe-in-a-cradle orchid on the swamp margin, and Hackett's hop bush in the sandy rise near the swamp. The lake does not support many water-birds as it almost always dries up in summer.

MWA groundwater extraction will affect water levels. There are SEC lines in the area. Increasing quantities of pollutants appear to be entering Thompson Lake.

Wattleup Lake

The lake is within freehold land and the surrounding land includes a thoroughbred stud and a piggery. A variety of birds use the lake for summer loafing.

Although most of the lakeside vegetation is cleared, the southern foreshore is grassed. The uncleared eastern shore makes the lake attractive and picturesque and the owners are keen to prevent further deterioration of vegetation. The lake has recreation value, and is included in land which has value for residential development.

The recommended area constitutes open space of regional significance (see Figure 1, Chapter 4) because of its high conservation and recreation values and its proximity to the Perth residential area.

Land is under a wide variety of tenure in the area and not all of this land has conservation and recreation as primary management objectives: to enhance these values the management structure requires coordination. Important management considerations include:

i) ensuring that the lakes are managed primarily for conservation of flora and fauna and/or recreation;

ii) encouraging the growth and regeneration of local indigenous flora and preventing further deterioration of the vegetation;

iii) retaining the diversity of the wetlands;

iv) establishing adequate recreational facilities, and allowing only recreation consistent with the purpose of conservation of flora and fauna;

v) establishing adequate buffer zones around the wetlands, particularly around South Lake so as to protect it from industrial and major road developments;

vi) limiting development on the eastern margins of North and Bibra Lakes to facilities for nature study;

vii) providing access appropriate to usage, including walk and cycle tracks linking the lakes as a linear access system;

viii) preventing use of any part of the area for sanitary landfill;

ix) monitoring the water quality of the wetlands and groundwater.

Recommendations:

M93.1 That our general recommendations on planning and management of Regional Parks be applied to this area (see Recommendation 15 and 16, Chapter 5).

M93.2 That the Metropolitan Region Planning Authority consider "reserving" the area from Kogolup Lake to Wattleup Lake for Parks and Recreation under the Metropolitan Region Scheme.

M93.3 That the recommendations of the Cockburn Wetlands Study (that Farrington Road should not be extended around the north of North Lake and that the proposed Roe Highway be modified to reduce its impact on the wetlands in the area) are endorsed.

M94 JANDAKOT AIRPORT

The area comprises Jandakot AA lots 127, 161 to 165, 295, 411, 438 and parts of Locations 126, 128, 129, 159, 160, 168, 439 and 440, freehold land owned by the Commonwealth of Australia (Figure 155).

Private groundwater extraction may affect water levels. There are drainage works and SEC lines in the area. Further drainage works have been proposed.

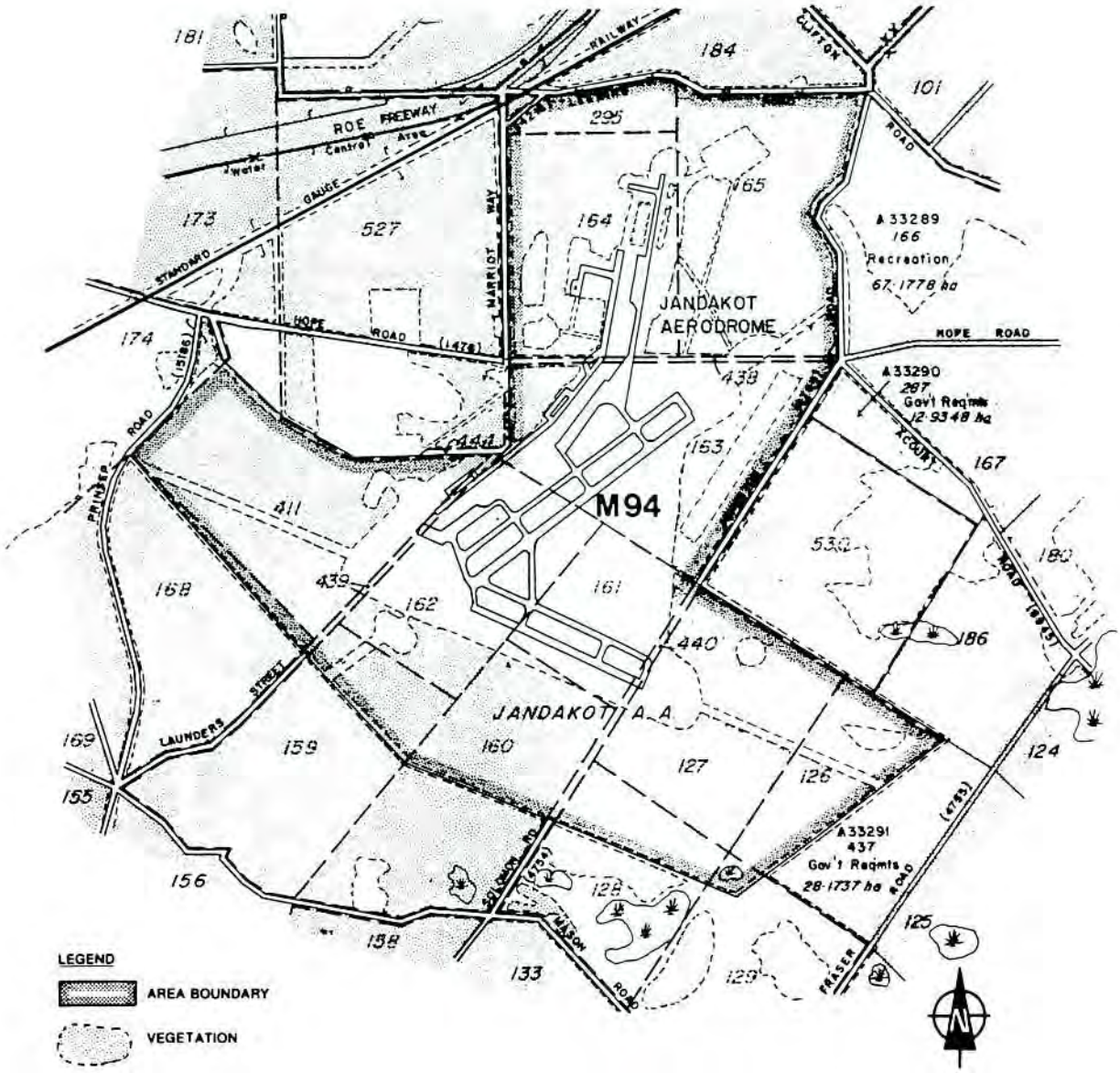
Over half of Jandakot Airport is uncleared. The vegetation is predominantly low open-forest of banksia, sheoak, Christmas tree and pricklybark, and in the north-eastern section low woodland of paperbark with swamp banksia and Christmas tree. One of the understorey species, *Leucopogon kingianus*, is an unusual heath known from only three other localities, all of which are vulnerable to surrounding development. The vegetation is undisturbed, with a dense understorey, which is largely due to the effective system of fire breaks within the airport.

The airport's fauna includes the ant *Iridomyrmex conifer* which has disappeared from many localities around Perth.

To enhance the area's high conservation value it is important that management consideration be given to retaining and encouraging the growth of local indigenuous flora where possible.

Recommendation:

M94.1 That the Commonwealth of Australia retain as much uncleared land as possible.



1980 LANDS DEPARTMENT ROAD GUIDE—MAP 88 REF.28.16
LANDS DEPARTMENT PUBLIC PLAN No
F 92·4, F93·4, F108·4, F109·4,
F124·4, F125·4,
D C E Ref. No F 23

CITY OF COCKBURN
0 500
metres

Figure 155

M97 RESERVE C36110, WANDI

The recommended area is situated about 5km north-east of Orelia and comprises Reserve C36110, for Quarry, vested in the Town of Kwinana (Figure 158).

Future MWA groundwater extraction will affect water levels. SEC lines may pass through the area and there is a mineral claim for silica sand.

The Reserve contains an undulating area of grey sands and is in an undisturbed condition. The vegetation consists of an open-woodland of banksia with some emergent jarrah and sheoak, and tall shrubs including stinkwood and spearwood. The lower storey comprises a variety of species including woollybush, blackboy and zamia; also there are a number of orchid species and the rare epachrid *Brachyloma preissi*, which is confined to the Coastal Plain near Perth and has not been recorded from any other Reserve.

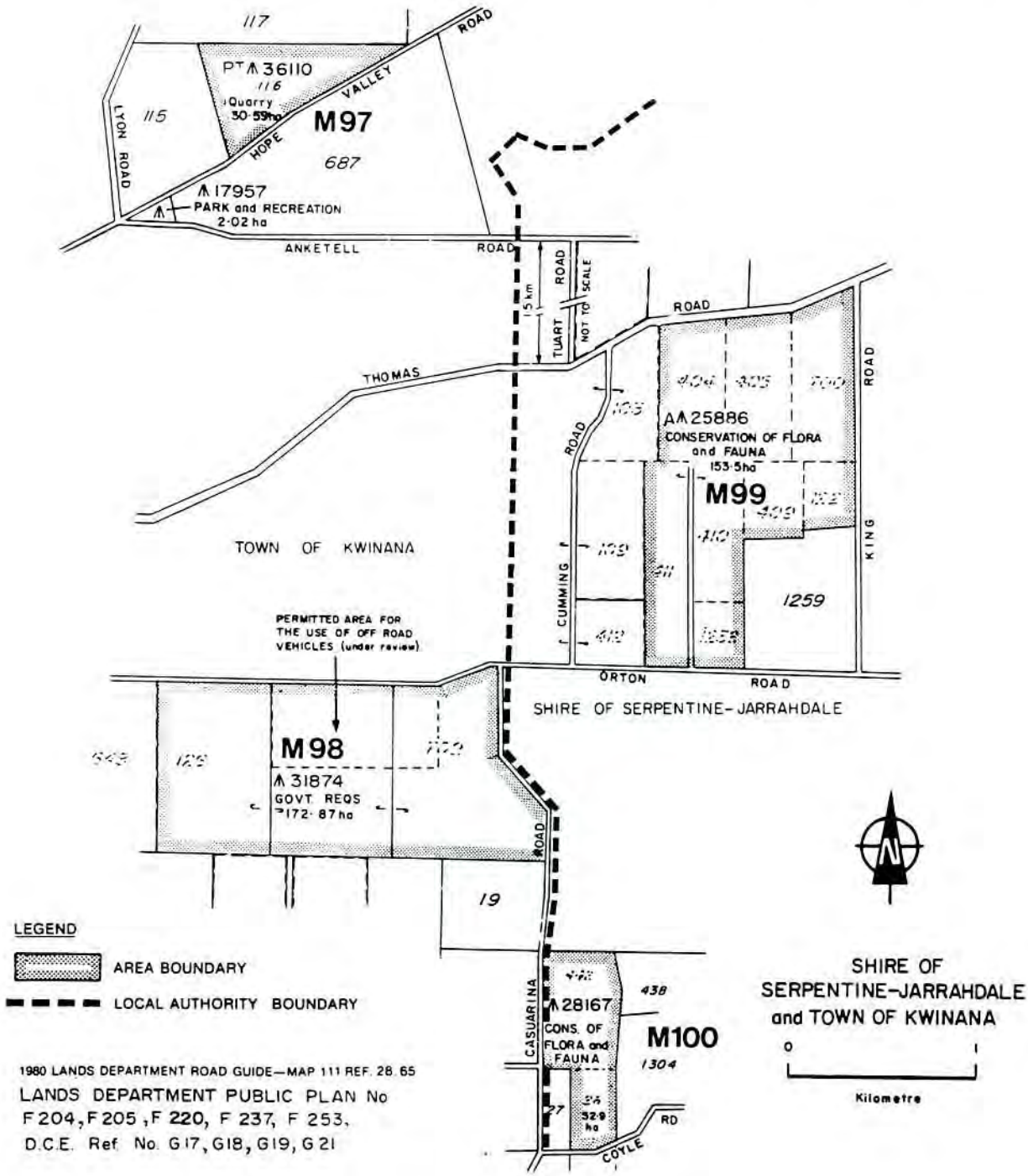


Figure 158

Recommendations:

M97.1 That the purpose of Reserve C36110 be amended to Conservation of Flora and Fauna, and Water, and that the Reserve be vested in the W.A. Wildlife Authority for a limited term of 10 years (see Recommendations 7-12 inclus., Chapter 3) and managed under a published management plan.

M97.2 That access to Reserve C36110 for the purposes of exploration and evaluation of mineral potential be permitted where necessary under conditions specified in the vesting order which should be such as to protect the area's conservation value.

M98 RESERVE C31874, CASUARINA

The recommended area is situated about 4km east of the suburb of Orelia and comprises Reserve C31874, for Government Requirements, not vested (Figure 158).

In October 1979 approximately 60 hectares in the north of the Reserve was designated for the use of off-road vehicles. Use of that permitted area has since been suspended, while the effect of the off-road vehicles is further assessed. Future MWA groundwater extraction will affect water levels. There are SEC lines in the area.

The landform consists of consolidated dunes. The vegetation is open-woodland of jarrah, sheoak, Christmas tree and banksia. The Reserve is a good habitat for orchids and research on orchid pollination has been undertaken nearby. It is important to retain representative habitats to support the insect populations involved in such pollination.

Recommendation:

M98.1 That the purpose of Reserve C31874 be amended to Conservation of Flora and Fauna, and Water, and that the Reserve be vested in the W.A. Wildlife Authority.

M99 RESERVE A25886, WEST OF BYFORD

The recommended area is situated about 9km west of Byford and comprises Reserve A25886, for Conservation of Flora and Fauna, vested in the W.A. Wildlife Authority (Figure 158).

The Reserve is within a possible artesian intake area. MWA groundwater extraction is likely to affect water levels.

The vegetation is characterised chiefly by low woodland, though there are also some swampy areas within the Reserve. The low woodland is dominated by three species of banksia, with some jarrah, sheoak, Christmas tree and woody pear. Tall shrubs in the understorey include spearwood and woollybush, and both blackboy and zamia are common. Swampy areas are dominated by Moonah paperbark with an understorey of species such as basket flower and white myrtle. The vegetation is undisturbed and in good condition.

Recommendation:

M99.1 That the existing purpose and vesting of Reserve A25886 is endorsed.

M100 RESERVE C28167, SOUTH-WEST OF BYFORD

The recommended area is situated about 10km south-west of the suburb of Orelia and comprises Reserve C28167, for Conservation of Flora and Fauna, vested in the W.A. Wildlife Authority (Figure 158).

MWA groundwater extraction is likely to affect water levels.

The reserve contains grey sands and vegetation consisting of low open-forest and low woodland of jarrah, sheoak, banksia and Christmas tree. A small swamp in the southern section contains Moonah paperbark. The Reserve is significant in conserving vegetation typical of a district which is being increasingly cleared, the Reserve being bounded by partly cleared land on its northern and western sides and by a sand quarry on its eastern side. The Reserve also provides habitats for a variety of wildlife, especially birds.

Recommendation:

M100.1 That the existing purpose and vesting of Reserve C28167 is endorsed.

M101 CAPE PERON, SHOALWATER BAY AND WARNBRO SOUND

The recommended area is situated off the coast between Cape Peron and Port Kennedy and comprises Reserve A17070, for Recreation, Camping and Enjoyment by the Public and Purposes Ancilliary Thereto; Reserves C24204, C31893 and C31894, for Conservation of Fauna, all vested in the W.A. Wildlife Authority; and four small islands — Passage Rock, First Rock, Second Rock

and another between White Rock and the mainland — being vacant Crown land (Figure 159).

Penguin Island, Reserve A17070, is the subject of a management plan being developed by the Department of Conservation and Environment together with the National Parks Authority, for the enhancement of the Island's high conservation, education and recreation values. The area is affected by the construction of the Cape Peron effluent disposal pipeline.

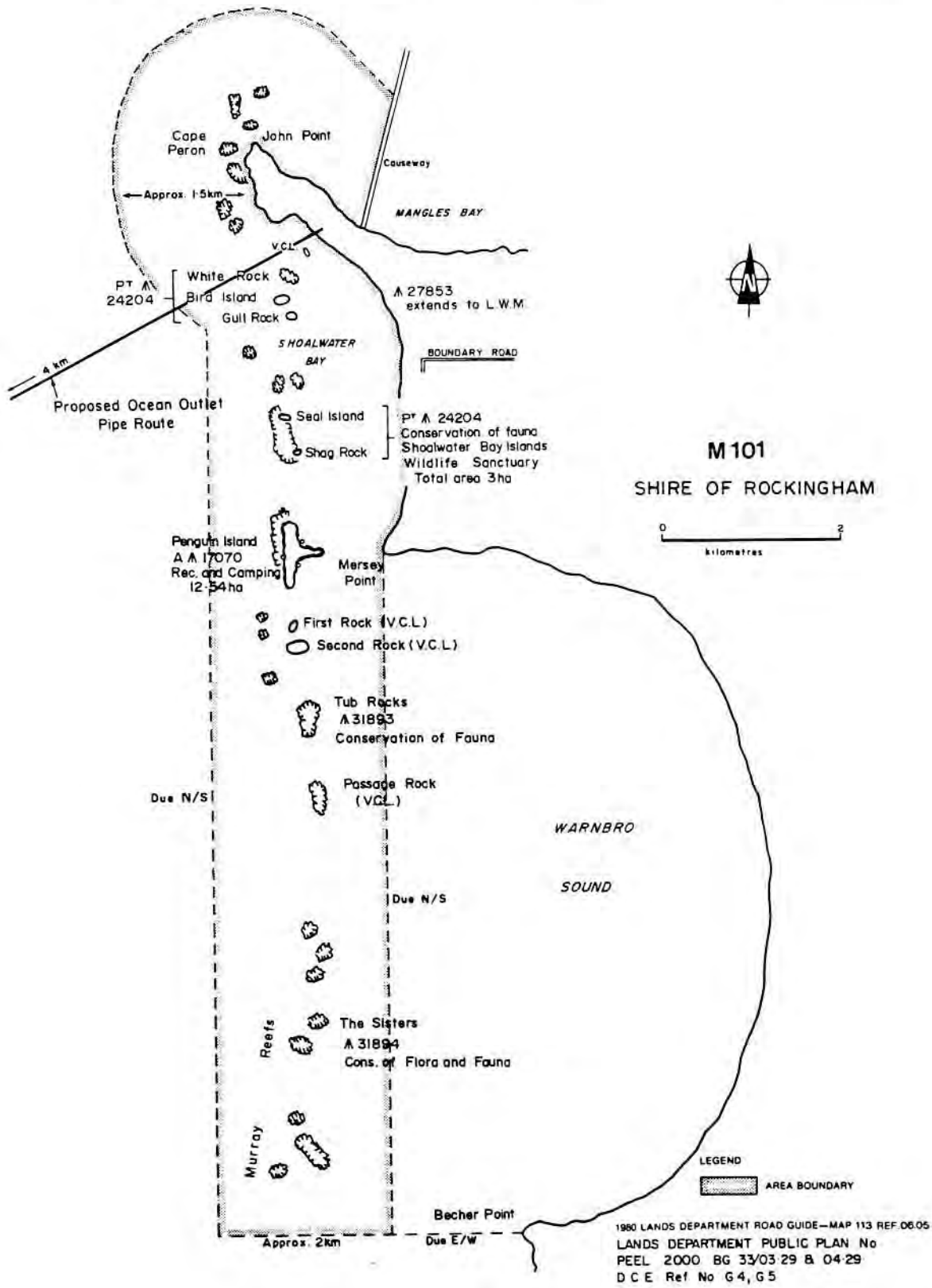


Figure 159

M103 LAKES COOLOONGUP AND WALYUNGUP

The recommended area is situated about 9km south-east of Rockingham and is often known as either White Lakes or Rockingham Lakes. The area comprises Reserves A24411 and A23780, both for National Park, and A18452, for recreation and Picnic Ground, all vested in the Shire of Rockingham; A22429, for Recreation and Parkland, not vested; lots 1 to 21, Dixon Road Subdivision (Cockburn Sound Location 16), lots 1 and 461 (Cockburn Sound Location 16), part of Cockburn Sound Location 16 (to the west of Lake Cooloongup); Peel Estate Lots 314 to 316; 318 to 322, 327, 328, 333, 579 to 583, 661, 662, 757, 765, 1127 and part of Peel Estate Lots 317, 334 and 336, all owned by the MRPA; part of Peel Estate Lots 337, 342, 658 and lot 14 of Peel Estate Lot 317, being privately owned freehold land (Figure 161). Most of the area has been "reserved" for Parks and Recreation under the Metropolitan Region Scheme.

The lakes are within the area for possible unconfined groundwater extraction which may be used by the MWA before the year 2000. Public access may eventually be restricted by Catchment Zone regulations. Groundwater extraction is likely to affect water levels. There are SEC lines in the area. The Rockingham Shire Council and the MRD currently extract marl from the area and will continue to do this on an occasional basis.

The area is the subject of ongoing planning activities conducted by the Town Planning Department on behalf of the MRPA.

The area includes thirteen different vegetation formations. Lake Cooloongup and the south-eastern section of Lake Walyungup are surrounded by tall open-forest of tuart. On moist soils west and north of Lake Cooloongup the understorey includes swamp paperbark, slender banksia and blackboy. Swamp paperbark also occurs as closed-forest between the two lakes and along their western sides. On dry land south and east of Lake Walyungup there is a large area of tall shrubland and open-heath. The lakes support mixed associations of algae of which stonewort is the most extensive and important.

Closed-sedgeland of bare twig rush surrounds both lakes and also covers an extensive area between the lakes. Open-sedgeland dominated by coast saw-sedge extends northwards from Lake Walyungup.

Seventy-three species of birds have been recorded in the area. Species include the little pied cormorant, white-faced heron, grey teal, red-capped dotterel and little grassbird. Water-fowl can be very abundant on Lake Cooloongup during summer. Animal life in Lake Cooloongup includes the water snail, the koonac, an endemic fish and the long-necked tortoise.

Reserve A22429 consists of brown and yellow sand over limestone, the predominant vegetation being tuart woodland. The Reserve has been disturbed and is infested with weeds. It does, however, occupy a high ridge and forms an important backdrop to Lake Cooloongup.

The area constitutes open space of regional significance (See Figure 1, Chapter 4) because of its conservation value and because as a large, attractive area within the South-West Corridor its recreational importance is likely to grow in the future. Not all the land under the area's various tenures has conservation and recreation as primary management objectives, and to enhance these values, the area's management will require coordination. Important management considerations are: ensuring that Lake Cooloongup is managed primarily for the conservation of flora and fauna; and ensuring that Lake Walyungup is managed to permit development for recreation use.

Recommendation:

M103.1 That our general recommendations on planning and management of Regional Parks be applied to this area (see Recommendations 15 and 16, Chapter 5).

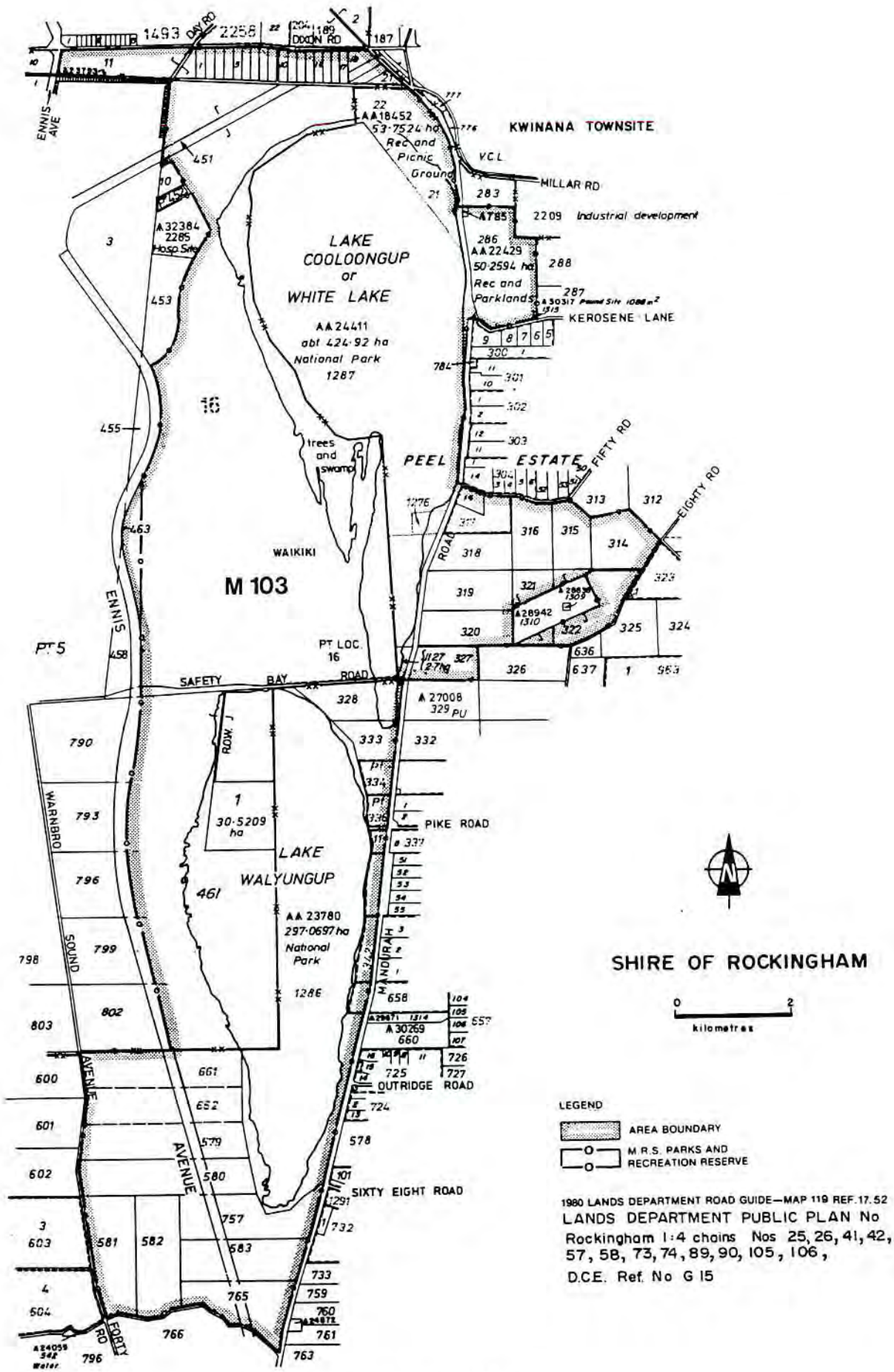

KWINANA TOWNSITE
LAKE COOLOONGUP or WHITE LAKE
AA 24411
abt 424·92 ha
National Park
1287
AA 18452
53·7524 ha
Rec and Picnic Ground
MILLAR RD
2209 Industrial development
AA 22429
50·2594 ha
Rec and Parklands
KEROSENE LANE
PEEL ESTATE
FIFTY RD
EIGHTY RD
WAIKIKI
M 103
PT 5
PT LOC. 16
ENNIS AVE
SAFETY BAY ROAD
PIKE ROAD
LAKE WALYUNGUP
AA 23780
297·0697 ha
National Park
1286
WARNBRO SOUND
MANDURAH
OUTRIDGE ROAD
SIXTY EIGHT ROAD
FORTY ROAD
SHIRE OF ROCKINGHAM
0 2
kilometres
LEGEND
AREA BOUNDARY
M.R.S. PARKS AND RECREATION RESERVE
1980 LANDS DEPARTMENT ROAD GUIDE—MAP 119 REF. 17.52
LANDS DEPARTMENT PUBLIC PLAN No
Rockingham 1:4 chains Nos 25, 26, 41, 42, 57, 58, 73, 74, 89, 90, 105, 106,
D.C.E. Ref. No G 15

Figure 161

M104 RESERVES C31102 AND C33581, LEDA

The recommended area is situated about 8km east of Rockingham and comprises Reserves C31102, for Cemetery Site, and C33581, for Parks and Recreation, both not vested; vacant Crown land; and Kwinana Lot S33, privately owned freehold land (Figure 162). The whole area is within the Shire of Kwinana.

The area may be affected by future groundwater development which could affect water levels. There is potential for limestone extraction, but there are no existing mineral claims. The area is affected by Important Regional Road alignments and partially by land zoned Urban Deferred under the Metropolitan Region Scheme. Some widening of parts of the north side of the railway reserve has occurred.

The area has considerable conservation value because it is a relatively large area in a district where most of the land is freehold and likely to be developed.

The western section contains a ridge of limestone, which carries low open-heath. The land falls away to a line of swamps running north-south which are fringed by low woodland of flooded gum and swamp paperbark. Closed-sedgeland of various species of *Cyperaceae* is associated with the swamps. Further east there is an area of consolidated dunes covered by low open-forest of jarrah, banksia, woody pear and sheoak. In each type of vegetation there is a different suite of shrubs and herbs in the understorey, with orchids being especially well represented.

Important management considerations include: the protection of areas of high conservation value during the development of the proposed road and urban developments; encouraging the growth and regeneration of local indigenous flora; and the area's potential for limestone.

Recommendations:

M104.1 That Reserve C33581 be vested in the Shire of Kwinana.

M104.2 That the vacant Crown land be made a C Class Reserve for Parkland and that the Reserve be vested for a limited term of 10 years in the Town of Kwinana (see Recommendations 7-12 inclus., Chapter 3) and managed under a published management plan.

M104.3 That ways and means of protecting the conservation value of Kwinana Lot S33 be sought through planning procedures to be developed as recommended in Recommendation 14, Chapter 4.

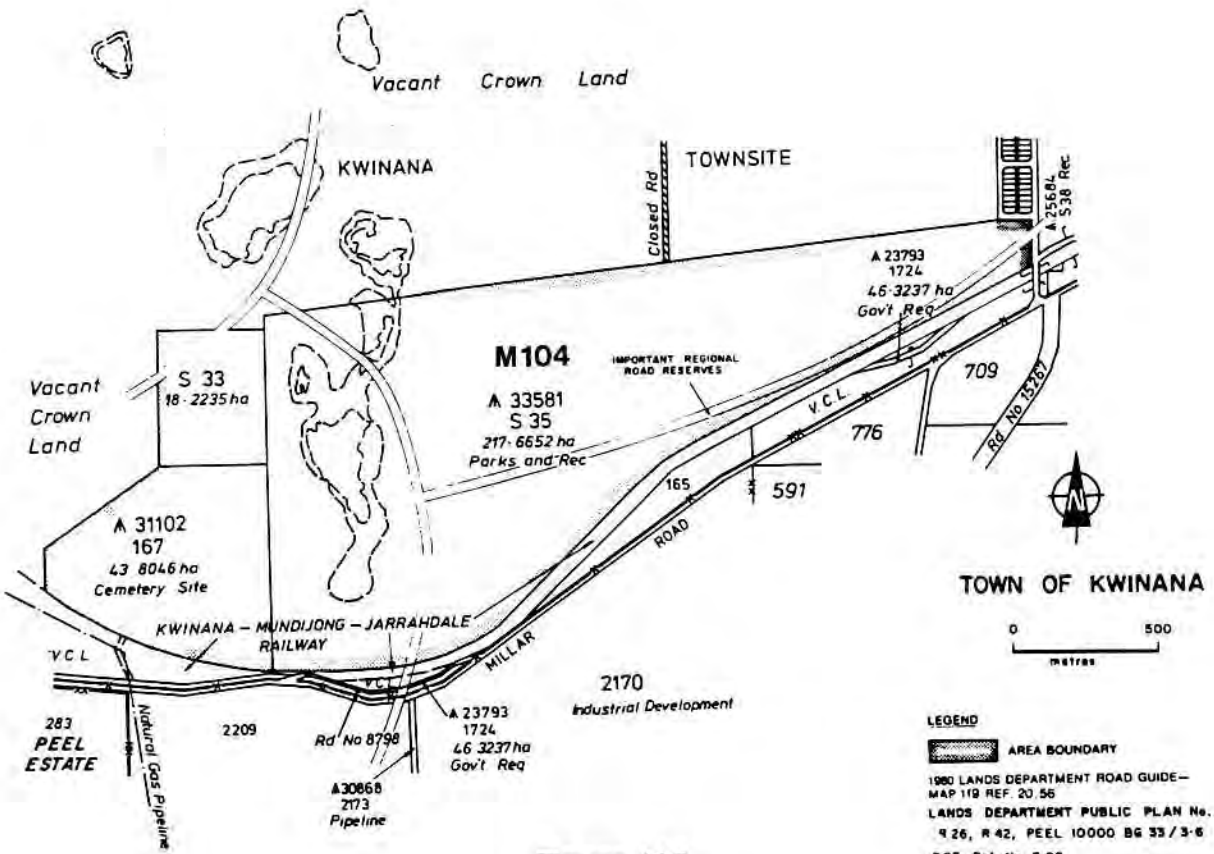


Figure 162

M106 PORT KENNEDY

The recommended area is situated about 50km south of Perth and comprises Reserves C20716, for Government Requirements, not vested; C33837, for Government Requirements (Community Welfare Department), vested in the Minister for Community Welfare; vacant Crown land; and part of Peel Estate lots 1092 to 1094, privately owned freehold land (Figure 164). Part of the area is "reserved" for Parks and Recreation under the Metropolitan Region Scheme.

The MRPA has recognised the potential for recreation of Port Kennedy and has prepared a design concept for a regional recreation centre, to help cater for the anticipated future development of the district.

The southern portion of the recommended area may possibly be subject to a land swap with the Secret Harbour development which may affect its boundary alignment. The area may be affected by a proposed MWA sewage treatment plant and outlet, and a drain.

The peninsula consists of parallel, curving dunes, typical of the Coastal Plain south of Rockingham. Much of the area retains its natural vegetation, which is quite rich in species. Thickets of wattle are common and there are numerous tall shrubs typical of coastal species. There are also many perennial herbs — mostly common species, and a less frequently seen species of climbing milkwort. The area's conservation value is high, because there is little similar land available between Fremantle and Mandurah.

The area has obvious potential for recreation, and is already used for fishing, camping and off-road vehicles. An area of 17ha from lot 606 in the north-east has been designated for the use of off-road vehicles. There are squatters' shacks near the beach. The recreation potential could be even greater if a link is provided between Port Kennedy and the White Lakes Region Open Space (M103), and if the Secret Harbour Project is developed. This project site adjoins the southern boundary of the area and involves a proposal to dredge an area behind the primary dune to form an inland harbour connected to the ocean. Residential, commercial, tourist and recreation development would follow.

The recommended area constitutes open space of regional significance (see Figure 1, Chapter 4) because of its high conservation and recreation value and its proximity to the Perth and Mandurah residential areas. Land tenure is varied and not all the land has conservation and recreation as primary management objectives: to enhance these values the management structure requires coordination. Important management considerations include: encouraging the growth and regeneration of local indigenous flora; removing shacks and tracks from the area; and providing direct public access to the open space of regional significance at M103 (Lakes Cooloongup and Walyungup).

Recommendations:

M106.1 That our general recommendations on planning and management of Regional Parks be applied to this area (see Recommendations 15 and 16, Chapter 5).

M106.2 That the Metropolitan Region Planning Authority consider "reserving" those portions not already "reserved" for Parks and Recreation under the Metropolitan Region Scheme.

M107 PEELHURST, SINGLETON AND MADORA

The recommended area is situated on the coast about 10km north of Mandurah, and comprises Reserve C25043, for Recreation, and part of Reserve C27066, for Recreation, both not vested; lots 2 to 9, 15 and 16 (Mandurah Road subdivision), lots 1, 7, 492 and 688, and parts of lots 2, 3, 4, 10 to 12 and 101 (Cockburn Location 16), all privately owned freehold land (Figure 164). A small part of the area is "reserved" for Parks and Recreation under the Metropolitan Region Scheme.

The eastern section is within an area for possible unconfined groundwater extraction. Groundwater extraction in the future may affect water levels and could involve the introduction of Catchment Zone regulations to restrict public access. The area will be slightly affected by widening requirements on the west side of Mandurah Road.

The MRPA's South-West Corridor Planning Structure advocated that the Peelhurst, Singleton and Madora townsites should become one urban settlement and the development of the strip on the west side of Mandurah Road for private recreation is considered a priority for implementation. The Mandurah Shire Council has recommended that the proposed east-west link between Singleton and Madora should be relocated further north to coincide with the Rockingham-Mandurah Shire boundary.

The area has extensive coastal dunes which are very valuable for their coastal vegetation and for recreational and aesthetic reasons. Their appearance and stability have been affected by nearby housing developments. Buffer zones of uncleared land should be left to preserve some

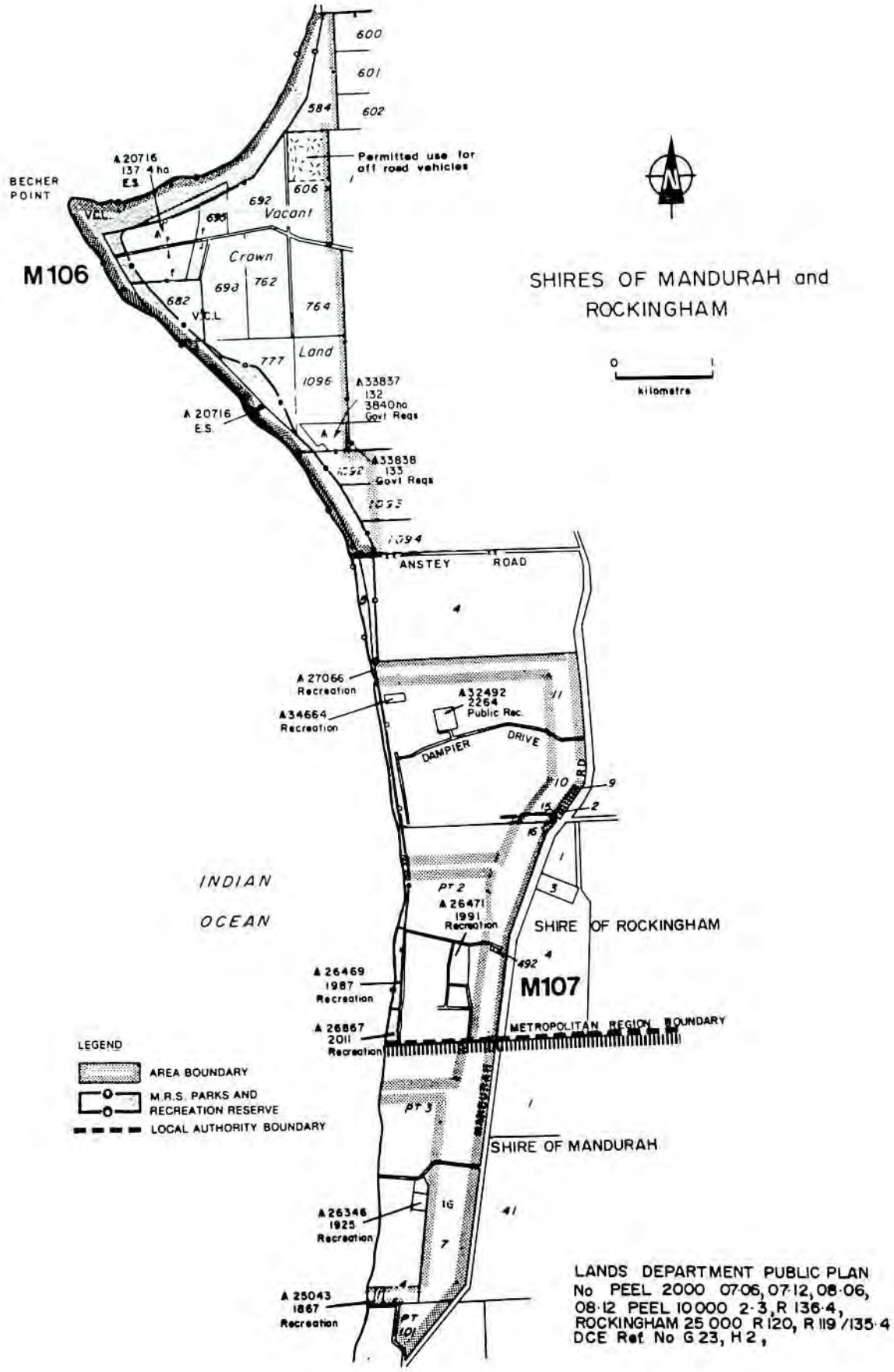

BECHER POINT
A 20716
137 4ha
E.S.
Permitted use for off road vehicles
Vacant
Crown
Land
M106
SHIRES OF MANDURAH and ROCKINGHAM
0
1
kilometre
A 20716
E.S.
A33837
132
3840ha
Govt Reqs
A33838
133
Govt Reqs
ANSTEY ROAD
A 27066
Recreation
A34664
Recreation
A32492
2264
Public Rec.
DAMPIER DRIVE
INDIAN
OCEAN
A 26471
1991
Recreation
SHIRE OF ROCKINGHAM
M107
A 26469
1987
Recreation
A 26867
2011
Recreation
METROPOLITAN REGION BOUNDARY
LEGEND
AREA BOUNDARY
M.R.S. PARKS AND RECREATION RESERVE
LOCAL AUTHORITY BOUNDARY
SHIRE OF MANDURAH
A 26346
1925
Recreation
A 25043
1867
Recreation
LANDS DEPARTMENT PUBLIC PLAN
No PEEL 2000 07·06, 07·12, 08·06,
08·12 PEEL 10000 2·3, R 136·4,
ROCKINGHAM 25 000 R 120, R 119/135·4
DCE Ref No G 23, H 2,

Figure 164

segments of the scenery and vegetation near the main Mandurah Road and between areas of housing. These buffer zones would restrict housing to west of the dune ridge, and provide east-west links of vegetation between Mandurah Road and the coast. The present practice of excluding housing from a strip adjacent to the shore should be continued. It is considered that these proposals would be to the benefit of all parties, as an enhanced residential environment has greater monetary as well as aesthetic value. In principle, public access to the reserved land would be unrestricted but, in practice, some advisory body would have to undertake development and maintenance of paths to avoid dune erosion. The onus would fall initially on the relevant local authority but might later devolve on a Residents' Association. Important management considerations include: the provision and maintenance of pathways; the prevention of dune erosion; the involvement of local residents in the management of the dunes; and the prohibition of active recreation activities which might disturb and inconvenience residents.

Recommendations:

M107.1 That Reserve C25043 be vested in the Shire of Mandurah.

M107.2 That Reserve C27066 be vested in the Shire of Rockingham.

M107.3 That ways and means of protecting the area's recreational and landscape values be sought through planning procedures to be developed as recommended in Recommendation 14, Chapter 4.

APPENDIX C

Public Consultation undertaken for the 1993 Structure Plan

APPENDIX I
CONSULTATION PROCESS

This section contains a summary of the public consultation process which was followed for the preparation of the SW Corridor Report.

Working Paper No 9 provides an overview of the Public Consultation Process undertaken in the review of the 1980 plan and a separate report has been prepared by the department summarising the submissions received in relation to the draft structure plan.

The department has a commitment to public consultation in the formulation of strategy and structure plans which affect large sections of the community, however no formal process has yet been established. In view of experiences in the North-West Corridor, where considerable criticism was directed towards the department for the consultation process in that corridor, it was decided to establish a Community Planning Advisory Committee to assist the department in the preparation of the SW Corridor Structure Plan.

Community Planning Advisory Committee

In January and February 1992 advertisements were placed in the community and metropolitan newspapers calling for nominations for the Advisory Committee. The advertisements were accompanied by press releases explaining the overall objectives of the consultation process which, in turn, generated other publicity.

At an initial workshop for those who responded to the advertisements, the objectives and methodology of the planning process were explained.

Sixteen members were selected to serve on the Advisory Committee drawn from a wide range of interest groups and individuals who had submitted an expression of interest. The meetings were chaired by the Manager of the Department's Community Liaison Group.

All meetings of the Advisory Committee were open to the public. Anyone attending the meetings was permitted to address the Committee or ask questions. At various times during the consultation process the Committee invited specialists from other government agencies and consulting firms to address it on specific issues.

All Advisory Committee meetings were open to the news media also. A number of meetings were attended by journalists from the local community newspaper and considerable publicity was given to the issues raised during the consultative process.

Minutes of all the meetings were recorded and circulated to Committee members, the local press, local authorities, the Conservation Council of WA and other persons who expressed an interest in receiving them.

As outlined previously the review of the 1980 Structure Plan was undertaken by the preparation of a series of working papers. As each working paper (1 to 8) was completed by the Department, a draft was circulated to all members of the Committee who were asked to review the content and suggest any editorial changes.

Working Papers

The following includes a brief summary of the contents of each of the working papers:

1. Background to the Current Round of Structure Planning.

   This paper provides an overview of the planning initiatives taken since the inception of structure planning for the SW Corridor in 1974 and since publication of the 1980 Structure Plan.

2. A review of the Major Road System as Planned 1980-1991.

Not all of the roads in the 1980 plan were implemented, especially in Mandurah. This paper reviews the changes that have been made and provides the rationale for the current major roads now reflected on the structure plan.

3. A review of Open Space and Conservation 1980-1991

   Since 1980 considerably more environmental research has been undertaken which provides greater understanding of the environmental issues in the SW Corridor as they affect urbanisation. This paper canvasses these issues and makes the proposals for conservation and open space included in the draft structure plan.

4. A review of Public Utilities and Services

   Issues affecting the provision of trunk services in the area of the structure plan are discussed in this paper. Only major servicing sites such as water storage and treatment sites are identified on the structure plan where as this working paper goes into more detail on locational requirements for trunk service routes.

5. A review of Constraints to Urbanisation

   Constraints to the urban development objectives for the SW Corridor come in many forms - social, economic, environmental or physical. Some are short term constraints, some medium or long term, while others are permanent. This paper addresses 13 constraints, mostly medium or long term, which will need to be resolved or accommodated in the future development of the SW Corridor.

6. A review of Population and Employment

   The ultimate population for the whole SW Corridor, at about the year 2050, is approximately 700,000 persons. The population for the area covered by the structure plan is approximately 200,000 by 2021. This paper addresses the issue of population and growth in the study area in the context of the whole SW Corridor.

7. A review of Social and Community Services

   This paper addresses the regional aspects of social infrastructure which will be required to serve the population of the study area.

8. A review of the 1980 Structure Plan

   This paper contains the draft structure plan and discusses issues related to the structure plan.

9. An overview of the Preliminary Public Consultation Process

   A collection of the minutes, briefing notes, copies of press advertisements, press releases that have contributed to public information or the consultation process.

Public Submissions

The draft structure plan (Working Paper No 8) and other working papers were released for public comment on February 1, 1993. Initially the submission period was to close at the end of April 1993 but was extended with the consent of the Hon Minister for Planning by one month until the end of May 1993.

A considerable number of submissions were received after the close of advertising and submissions received up to June 25 were included in the analysis. In total 135 submissions were received. During advertising, two workshops were held to

facilitate discussion on the draft structure plan and answer community concerns.

Many submissions raised a number of issues. Of the 135 separate submissions received, 143 separate issues were raised 424 times. All submissions and issues were categorised and entered into a spreadsheet for analysis. The issues raised were categorised into five broad headings as follows:

- Equity of the planning system and adequacy of the consultative process.

  Submissions were both complementary and critical of the planning process. Many people complained that the consultation process was a charade for decisions already made.

- Conservation Issues.

  A wide range of conservation issues featured prominently in the submissions and widespread comment came from within and outside the study area.

- General Planning Issues.

  Submissions addressing the SW Corridor as a whole or as part of the Perth metropolitan region.

- Specific Planning Issues.

  Submissions addressing a particular property or specific area generally prompted most changes to the draft structure plan.

- Major Infrastructure and servicing considerations.

  Government agencies and individuals commented on provision for roads and services.

Table 3 shows a summary of submissions and issues.

Overview of Contentious Issues

The majority of contentious issues in the draft structure plan which generated community concern were in the Baldivis / Stakehill area. Generally submissions received on aspects outside these areas were positive or made practical suggestions for improvement of the plan. The following contentious issues are identified in the general order of reaction generated:

Landscape Protection Areas

The proposals for Landscape Protection areas drew widespread condemnation. As discussed in the report, the deletion of Landscape Protection areas will overcome these objections.

TABLE 3: SUMMARY OF SUBMISSIONS AND ISSUES

	Issues	No Submissions	Percent
1.	Equity/Adequacy	101	24
2.	Conservation	221	52
3.	General Planning	47	11
4.	Specific Planning	44	10
5.	Infrastructure/Servicing	12	3
Total		**424**	**100**

Stakehill Swamp

Considerable concern was expressed in relation to the proposed Parks and Recreation reserve around Stakehill Swamp. Modification of the proposed reserve boundary with provision for a future buffer will partly overcome these concerns.

Alienation of Horticultural Land

Alienation of Rural land for horticulture purposes was vigorously opposed by the horticultural/market garden lobby. The objections were particularly directed to the Landscape Protection areas in West Baldivis and Stakehill and the proposed urbanisation of Baldivis.

The removal of Landscape Protection areas removes that objection. The objection to urbanisation in Baldivis is not considered unduly restrictive to market gardening as areas in North Baldivis are shown as Category B and are not expected to be developed for 20 years. Also, there are adequate buffers to protect market gardens from more imminent urbanisation which is likely to occur south of Eighty Road.

Lack of effective Public Consultation

A number of complaints referred to the consultation process as a charade for decisions already made. Most were not aware of *METROPLAN* or the *Urban Expansion Policy* or that these documents had also been through the public consultation process. Many people did not accept that the Department of Planning and Urban Development had a statutory responsibility to plan for the future.

The department recognises that this is a major public relations issue in its promotion of the public consultation process. To this end the department has established a Community Liaison Group to develop and improve public participation and consultation in the Strategic/Structure Planning field.

Changes to the Draft Structure Plan

The changes to the draft structure plan as a result of public submissions include the following:

- Landscape Protection zones are not reflected on the structure plan. These areas are shown as Rural on the structure plan and the landscape attributes of these areas are described in the text of the report.
- The boundary of the Stakehill Swamp reservation has been redrawn in accordance with the recommendations of the environmental consultants review of the boundary.
- Buffer areas in accordance with EPA policy will be identified for Stakehill Swamp. The buffer, a minimum of 50 metres or to a level of 1 metre AHD above the fringe vegetation level (whichever width is greater) should be given up at the time any new subdivision occurs adjacent to the wetlands.
- The System Six reserves in the SW Corridor are recommended to be amended for endorsement by Cabinet in accordance with the environmental recommendations for conservation and recreation in the structure plan.
- An option for a long term inter-corridor rapid transport route through the area is shown on the structure plan.
- The salient elements of the approved local structure plan for Madora have been reflected on the structure plan. This involves changes to the two remaining lateral wedges in Madora which are part of System Six Reserve M107.
- The area between the Kwinana Townsite and the Kwinana

Freeway, shown as Rural Living - Landscape Protection on the draft structure plan has been shown as Category A2 Urban.

- The area north of Safety Bay Road, bounded by Tamworth Hill Regional Open Space, Eighty Road and Baldivis Road shown as Category A2 Urban on the draft structure plan is upgraded to Category A1 Urban.
- The area south of Safety Bay Road, between Baldivis Road and Kwinana Freeway, shown as Category B on the draft Structure Plan is upgraded to Category A2.
- The western parts of lots 579, 580, 661 and 662 between Ennis Avenue and Warnbro Sound Avenue falling within System Six Reserve M103, reserved for Parks and Recreation in the MRS and shown as Open Space on the draft structure plan are shown as Category A1 Urban.
- Portions of Lots pt 901, pt 898, pt 897, pt 894 and lot 54 to the west of Mandurah Road are upgraded from Rural Living - Landscape Protection to Category A1 Urban with the exception of a narrow landscape strip fronting Mandurah Road.
- The area east of Warnbro Sound Avenue and north of Anstey Road is upgraded from Category A2 Urban to Category A1 Urban.
- The Lakeside Caravan Park, fronting Old Mandurah Road is shown as Tourist Development on the structure plan.
- Lot 884 Stakehill Road, west of Mandurah Road, is removed from Open Space and shown as Rural on the final structure plan.
- The inclusion of a Public Purposes reserve to accommodate a 5 hectare WAWA tank site in the Paganoni wetland reserve.

APPENDIX D

Report of Botanical Survey

A BOTANICAL SURVEY OF AREAS AFFECTED BY THE PROPOSED SOUTH-WEST CORRIDOR AMENDMENT WITH COMMENT ON CONSERVATION VALUES

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1.0 INTRODUCTION

1.1 Study Areas

This report describes and comments on the vegetation of areas in the South-west Corridor affected by proposed changes to land-use in that planning zone.

The areas are:

- south-west of Lake Walyungup, in the area approximately bounded by the Warnbro Sound Avenue alignment, Ennis Avenue, the Chelmsford Avenue alignment and an east-west line about 250 metres south of the western end of Stakehill Road;

- north-west of Lake Cooloongup, in the area approximately bounded by Dixon Road, Ennis Avenue, the Garden Island Highway alignment and two minor roads; and

- three small areas north-east of Lake Cooloongup where the route of the proposed rail transit corridor crosses or skirts three small wetlands.

Each of these areas will be discussed separately below (see section 3.0, 4.0 and 5.0 respectively).

1.2 Location

The study areas are all near the coast, east and south-east of Rockingham, in an area centred forty kilometres south-south-west of the centre of Perth.

1.3 Regional Soils and Geomorphology

The study areas are all on the Swan Coastal Plain. This plain has been divided into a number of landform/soil units that are generally parallel to the coast, are fairly narrow in

relation to their length and tend to occur as discrete occurrences rather than continuous strips (some units related to major watercourses cut across the others).

Two of the three small areas to the north-east of Lake Cooloongup are on the Cottesloe unit of the Spearwood Sands. This unit has a "low hilly landscape with shallow brown sands over limestone" (Churchward and McArthur 1980). The areas to the north-west and south-west of Lakes Cooloongup and Walyungup respectively and the western-most of those north-west of lake Cooloongup are on the Quindalup sands which are "dunes and beach ridges composed of calcareous sands" (Churchward and McArthur 1980). They lie on the on the inland side of the area of beach ridges known as the Rockingham-Becher Plain. This is a cuspate beach ridge plain made up of five dune types (Semeniuk et al 1989).

Lakes Cooloongup and Walyungup lie on or close to the border of the Cottesloe unit of the Spearwood sands and the Quindalup sands.

1.4 Regional Botany

The vegetation of the Swan Coastal Plain has been mapped by Heddle, Loneragan, and Havel (1980) into a series of "vegetation complexes" that correspond in distribution to the major landform and soil units defined by Churchward and McArthur (1980).

This is a quite broad scale of mapping that unites into vegetation complexes a variety of vegetation associations, and their component vegetation communities, that occur repeatedly in a vegetation complex in patterns that reflect the (repeated) variations in the soil, topography and water availability. These vegetation complex/soil unit pairs can be viewed as ecosystems consisting of sub-systems such as dunes, plains, swamps and other wetlands.

The study areas to the north-west of Lake Cooloongup and the south-west of Lake Walyungup both lie in the Quindalup Complex and two of the group of three small areas to the north-east of Lake Cooloongup lie in the Cottesloe - Central and South complex and one in the Quindalup complex (although, it may more accurately be in an area that has

been crossed by a low Quindalup dune before it was stabilised but, have soil and vegetation features more in common with the wetlands of the Cottesloe Complex - Central and South).

The vegetation of the complexes on the Swan Coastal Plain show a transition from south to north as rainfall decreases and as other climatic variables change. To reflect this, some of the landform/soil units have southern and northern vegetation complexes described for them. This is the case with the vegetation complex described by Heddle et al (1980) for the Cottesloe unit but, not for the Quindalup unit. In parallel with the changes in vegetation from south to north, there are significant changes in the flora species present in the complexes. For example, in studies of areas of Quindalup sands, 81 species were recorded in the Mandurah region but not at Alkimos, Ningana, Wilbinga or Breton Bay which are all in the northern Perth Metropolitan area or north of it and conversely, 52 species were recorded at Wilbinga or Breton Bay and not at Mandurah and Alkimos and/or Ningana (Trudgen et al 1990).

Apart from the broad scale work of Heddle et al (1980), and the similar scale mapping by Beard (1981) there is very little published on the vegetation of the region (Perth to Bunbury) that the study areas lies in. Although, there are a number of studies of smaller areas for environmental impact assessment and planning purposes. Even given these latter publications (many of which are superficial), the vegetation would have to be rated as poorly described and its variation largely not recognised.

The flora is moderately well known but, fairly poorly collected. However, it is at least covered by one of the few regional floras published for the State.

1.5 Conservation Status of the Vegetation of the Quindalup Complex and Cottesloe Complex - Central and South

1.5.1 Conservation Status of the Quindalup Complex

To gain a reasonably correct impression of the conservation status of the vegetation of the Quindalup dunes, it is important to hold in mind:

- that there are two major divisions of this dune system: these are the areas of beach ridges (small dunes formed in parallel sequences at the back of prograding beaches and stabilised where first formed) and the areas of larger dunes that have been mobile and have subsequently been stabilised by vegetation (this division has been further subdivided into four age groups);

- that the dune and beach ridge types do not occur uniformly along the coast. In fact they are quite irregular in their distribution;

- that the vegetation and flora changes significantly along the extent of the Quindalup Complex in response to changes in climatic variables(see 1.4 above); and

- that the beach ridge and dune types mostly have different vegetation although, many of the component species are the same;

- that the vegetation also changes across the Quindalup dunes and beach ridges, mostly in response to the age of the dunes/beach ridges (with consequent changes in soil structure) but, also in response to water availability (particularly in the swales). Other factors such as salt levels and wind blast may also have an impact in particular areas.

Given the above factors, adequate conservation of the Quindalup system would include representative areas of each of the major divisions along and across their distribution and these areas would be of sufficient size to maintain a reasonable proportion of their flora and fauna diversity and of their vegetation structure.

The major area of reservation of the Quindalup Complex is in Yalgorup National Park, where 64% of the area of the complex that is reserved is located (Portlock et al 1993). This is about 1600 ha (from map 4, Portlock et al 1993) of an original extent of the Quindalup of about 45,350 ha (P. Hanly pers comm) or approximately 3.5% of the original area of the complex. However, there are no areas of beach ridges in the Yalgorup National Park as they are not developed between Mandurah and Bunbury. There are also

significant areas of the Quindalup Complex reserved in the northern part of its distribution, well north of the Perth Metropolitan area, but very little between Mandurah and the northern limit of the Perth Metropolitan area.

The major area of beach ridges south of Perth is the Rockingham-Becher Plain. The vegetation of some of this plain is protected in the reserve including Lakes Cooloongup and Walyungup and more will be if the area proposed to be rezoned to "Parks and Recreation" at Port Kennedy is so rezoned and if the purpose is conservation. However, three of the areas proposed to be rezoned in the proposed South-West Corridor Amendment would reduce the area of beach ridges in the reserve (System Six M103) that includes Lakes Cooloongup and Walyungup.

Overall, about 5% of the Quindalup complex is reserved, with the major areas protected being in the southern part of its distribution (Yalgorup National Park) and in the northern part of its distribution. Therefore it would be reasonable to say that the complex is moderately well reserved for conservation in its southern and northern parts but, is poorly protected in the middle of its distribution, especially between Mandurah and Perth. Also, the areas protected are biased towards the dune division of the soil type the complex occurs on rather than a balance between this and the beach ridge component. That is, the beach ridge division is currently poorly protected.

1.5.2 Conservation Status of the Cottesloe Complex - Central and South

To gain a reasonably correct impression of the conservation status of the vegetation of the Cottesloe Complex - Central and South, it is important to hold in mind:

- that the Cottesloe soil unit it lies on varies in width and topography;
- that the different surface soil types (sand and limestone) that occur in it are not uniformly distributed; and
- that the vegetation and flora changes significantly along the extent of the Complex in response to changes in climatic variables.

The Cottesloe Complex - Central and South had an original extent of about 44,893 hectares of which about 3678 hectares (P. Hanly pers. comm.) or 8.2% is in conservation areas. South of the Swan River, the largest area of this vegetation complex in conservation reserves would be in Yalgorup National Park, which has about 1140 hectares (from map 5, Portlock et al 1993) or 2.5% of the original extent. Other than this, most of the reserved part of this vegetation complex would be in northern Metropolitan reserves such as Neerabup National Park.

A reasonable conclusion then is that the Cottesloe Complex - Central and South, while better reserved than the Quindalup vegetation complex, is still only moderately well conserved. Like the Quindalup Complex, it is best reserved at its extremities and is poorly reserved between Mandurah and Perth.

It is noted here that if the proposed Tamworth Hill amendment in the South-west Corridor Amendment is effected that this may protect more of the Cottesloe Complex - Central and South in the Perth-Mandurah region but, that the proposed zoning is parks and recreation rather than conservation and the area is very small.

1.6 Adequacy of Reservation in the Region Surrounding the Study Areas

From the discussion above of the conservation status of the Quindalup Complex and the Cottesloe Complex - Central and South vegetation complexes, it is obvious that the area that surrounds the study areas is in a region where there is a need for reservation of these complexes, as they are both poorly represented in reserves between Mandurah and the northern part of the Perth Metropolitan area.

1.7 Impact of Fire on the Vegetation of the Quindalup Complex and Effects on the Interpretation of the Vegetation

It is obvious from the aerial photographs used in this survey and from the ground survey itself, that there have been a number of fires in fairly recent times in the areas surveyed on the Rockingham-Becher Plain. In fact only two fairly small areas examined had escaped fire for a fairly long time (say at least 10-15 years). However, the good condition

of many stands of *Xanthorrhoea preissii* in the survey areas on the Rockingham-Becher Plain indicate that fire has not been extremely frequent in any one place. (Where fires are extremely frequent the cumulative impact on tall multi- branched *Xanthorrhoea preissii* is to reduce stem health and to kill many heads and this had not happened in a number of places examined.)

The different fire histories and ages make it difficult to compare different stands as they have probably caused some changes in abundance in some species. However, differences in species composition probably truly reflect real differences in vegetation type as many of the species are not "fire sensitive" (i.e. are not killed by fire). For example, the common ground cover species Stipa flavescens, Conostylis aculeata, Loxocarya flexuosa and Lomandra maritima all regenerate rapidly from their root stocks after fire as do the shrubs Acanthocarpus preissii and Melaleuca acerosa. Acacia rostellifera also usually regenerates prolifically from its roots after fire however, this does not seem to be happening as readily as usual in some of the areas examined. This species seems to grow fairly slowly in this area and it is likely that fire is too frequent or recent for it to reach its full size. In contrast to the species that regenerate from rootstocks after fire, *Jacksonia furcellata* and *Acacia saligna* seem to be relatively fire sensitive, so they may have lost cover in some vegetation types. Some other species may have suffered more significant losses of numbers, e.g. *Banksia littoralis* but, these species are likely to have been only small components of the vegetation anyway.

The overall impact of fire in the study areas is to mask some of the variation in the vegetation, making it more difficult to detect and to detract from the landscape value of the vegetation.

1.8 Apparent Weediness and Weeds in the Vegetation of the Quindalup Complex on the Beach Ridge Type

The Quindalup Complex vegetation on the beach ridge type of the Quindalup dune system is quite unusual for the vegetation of the South West Botanical Provence of Western Australia, in that it has a lower layer in the vegetation that often has a significant amount of native grasses and/or a grass-like species. The two major grasses are the perennial

clump species *Stipa flavescens* and *Poa poiformis.* The grass-like species are *Lomandra maritima,* a lily relative that forms clumps with grass-like leaves, and *Conostylis aculeata,* a relative of the Kangaroo Paw (*Anigozanthos manglesii*).

The presence of these species often makes people think that the vegetation on the beach ridge type of the Quindalup dune system is much weedier than it actually is.

This is not to say that weeds are not a significant problem on the beach ridge type of the Quindalup dune system, as they are. However, one of the most significant environmental parameters of this ecological type appears to be the variation from moist in winter to very dry in summer. Coupled with the poorness of the soils this seems to allow annual weeds to build up in winter without greatly impacting on the vegetation bulk that can survive through the summer. The net effect seems to be that weeds have less overall impact on the vegetation through crowding out of native species than in many other environments. Some of the swales do suffer more than the dunes because in the absence of weeds, they have more annuals than the dunes. Other swales which are damp for much of the year are invaded by perennial weeds and are more badly effected.

2.0 METHODS AND LIMITATIONS

2.1 Methods

This report is based on field work carried out in December 1993 and early January 1994 by the author of this report.

Each of the areas discussed (see introduction) was visited and the vegetation types present described and the flora species observed in the time available listed and limited collections made. The condition of the vegetation was recorded at the same time, it was ranked on a scale from "completely degraded" to "excellent" as follows:

E = Excellent

VG = Very good

G = Good

P = Poor

VP = Very poor

D = Completely degraded

The definitions of the terms used in the scale are given in Appendix A.

The vegetation classification used in this report is a modified version of that of Specht as given by Aplin (1979). Its use is further modified in that where there are two vegetation types with the same upper layer but, different lower layers, these are differentiated. That is, as the system is used here, the vegetation types are named for a combination of the dominant species in several layers and the structure formed. Only the more abundant species within a layer are included within the name of the vegetation unit.

2.2 Limitations

The main limitation of the vegetation survey is that as the total time available for this project was limited to six days, the field work was necessarily brief. This meant that description of the vegetation is limited, showing the types of vegetation present rather than describing all the variation, and that vegetation mapping was not possible.

The main limitation of the flora survey was also the lack of time, which meant it was not possible to carry out systematic searches for flora species (especially rare flora) or to spend time in the herbarium identifying specimens. Fortunately, the flora of the region is reasonably well known by the author of this report so that this limitation was significantly mitigated. A second significant limitation of the flora survey was the fact that the field work was carried out in summer. This means that most annual and cryptophyte (bulbous, cormous etc.) species (for example, the orchids) had flowered, set fruit and become dormant earlier in the season and were no longer available for observation or collection.

3.0 AREAS WEST AND SOUTH-WEST OF LAKE WALYUNGUP

The areas surveyed south-west of Lake Walyungup, are in the area approximately bounded by the Warnbro Sound Avenue alignment, Ennis Avenue, the Chelmsford Avenue alignment and an east-west line about 250 metres south of the western end of Stakehill Road. They are two areas within the System Six recommendation M103 area proposed to be rezoned to future urban and industry respectively and an area outside the System Six area proposed to be rezoned to parks and recreation.

3.1 Current Land Use

The two areas within the System Six area do not currently have any developments on them and are not used for grazing. The area proposed for rezoning to parks and recreation has a horse racing track and various developments for use by horse riders and is used for grazing horses.

3.2 Topography

All the areas have quite low topography, of irregular low dunes with a few higher dunes in places. In some places, the swales are low enough to be damp or occasionally wet, even in January.

3.3 Soil and Geomorphology

The areas are all on the Quindalup sands, on the Becher-Rockingham beach ridge plain. The soils are generally light brown at the surface and creamy white at depth. In some swales the soils are darker from the accumulation of organic matter. In one swale the soil was a pale grey silty sand.

3.4 Vegetation and Flora

The vegetation of the three areas will be described separately, and the occurrence of flora species noted.

3.4.1 Vegetation and Flora of the Area Proposed to be Rezoned to Future Urban

- *Jacksonia furcellata* shrubland over *Acanthocarpus preissii, Acacia lasiocarpa* low open shrubland over *Conostylis aculeata, Lepidosperma angustatum, Stipa flavescens, Loxocarya flexuosa* mixed sedgeland/grassland/herbfield.

This vegetation was observed on low dunes, extending well down into the swales, in the north-east corner of the block. Much of this part of the area was in Good to Very Good condition with patches of Poor condition. In places there was a layer (open to closed heath) of *Acacia rostellifera* between the *Jacksonia* and the *Acanthocarpus* layer. Other species recorded were **Avena barbata, Opercularia vaginata, Exocarpus sparteus, Acacia saligna, *Euphorbia terracina, Hemiandra pungens, Leucopogon parviflorus, Lomandra maritima, Kennedia prostrata, *Romulea rosea, Dianella divaricata, Adriana quadripartita, Hakea prostrata, Phyllanthus calycinus* and *Hardenbergia comptoniana.* Some other introduced annual grasses were also present.

- *Adriana quadripartita, Melaleuca acerosa* low open shrubland to low shrubland over *Stipa flavescens, Lomandra maritima, Conostylis aculeata, Lepidosperma angustatum, Loxocarya flexuosa* sedgeland/grassland/herbfield.

This vegetation was observed on the west side of the block, it formed a mosaic with stands (clones?) of *Acacia rostellifera* open to closed heath or tall shrubland on low irregular dunes, there were scattered large *Jacksonia furcellata* and *Acacia saligna* in the stand and occasional small trees of *Melaleuca preissiana.* This part of the area was in Good to Very Good condition, although it was too weedy to be classed as Very Good. Other species recorded were *Schoenus grandiflorus, Hemiandra pungens, *Euphorbia terracina, *Avena barbata, Exocarpus sparteus,* and *Kennedia prostrata.*

- *Hakea prostrata* open shrubland to shrubland over *Isolepis nodosus* open sedgeland to sedgeland.

This unit was recorded in a swale in the same area as the unit above, similar stands were observed in several swales in the same area. At the site recorded the stand was in Very Good condition, although it was a little weedy. There was considerable variation in the swales, with some having the *Hakea* but no *Isolepis*, over a ground layer like the dune community and some with the ground layer but no *Hakea*. The stand recorded had one tree of *Banksia littoralis*, a species which is very unusual for Quindalup sands. Others, that were damper, had *Isolepis* around the edges with *Centella* herbfield in the lower part. Other species recorded were *Poa poiformis, Adriana quadripartita, *Hypochaeris glabra, Sporolus virginicus?, Carpobrotus virescens* ?, **Euphorbia terracina* and a *Cyperus* species.

- *Acacia saligna, Jacksonia furcellata* open shrubland over *Acacia lasiocarpa* var. *lasiocarpa, Melaleuca acerosa* low shrubland to low open heath over *Lomandra maritima, Lepidosperma angustatum, Conostylis aculeata* open herbland/sedgeland.

This vegetation was recorded on a taller dune in the south-west corner of the block. As well as the vegetation unit described, there were scattered large patches of Acacia rostellifera. The area was in Good to Very Good condition although, it was a little too weedy for the very good category. Others species recorded were *Stipa flavescens, Cassytha* sp., *Loxocarya flexuosa, Acacia rostellifera, Acanthocarpus preissii* and **Romulea rosea.*

3.4.2 Vegetation and Flora of the Area Proposed to be Rezoned to Industry

- *Jacksonia furcellata* tall open shrubland over *Acacia rostellifera* shrubland over *Melaleuca acerosa, Acanthocarpus preissii* low open shrubland over *Stipa flavescens, Lepidium angustatum, Loxocarya flexuosa, Conostylis aculeata* mixed grassland/sedgeland/herbland.

This vegetation was observed on low dunes, extending well down into the swales, in the south side of the block. This part of the block was in Good to Very Good condition being just too weedy to be classed as very good. From the aerial photographs and driving past the area the rest of the block seems to be in similar condition. Other species recorded were **Avena barbata, Opercularia vaginata, Acacia saligna, *Euphorbia terracina, Hemiandra pungens, Lomandra maritima, Kennedia prostrata, *Romulea rosea, Dianella divaricata, Adriana quadripartita, Phyllanthus calycinus* and *Hardenbergia comptoniana.* Some other introduced annual grasses were also present.

- *Acacia rostellifera, Acacia saligna* high open shrubland to open scrub over *Adriana quadripartita, Melaleuca acerosa* low open shrubland over *Stipa flavescens, Conostylis aculeata* grassland/herbfield.

This vegetation was observed in a swale in the south side of the block. There was considerable variation in the swales in this area, with some having the diversity of the ground layer reduced to a *Lepidosperma angustatum* sedgeland but, being lined with shrublands of *Xanthorrhoea preissii,* while one just outside of the western side of the block had a small patch of *Melaleuca rhaphiophylla* low open to closed forest over *Gahnia trifida, Isolepis nodosus* open sedgeland. Other species recorded in the swales were *Rhagodia baccata, Centella asiatica, *Avena barbata, Jacksonia furcellata, Hakea prostrata, Loxocarya flexuosa, Opercularia vaginata, Kennedia prostrata, Cryptandra* sp., while *Melaleuca preissiana* occurred as isolated individuals.

3.4.3 Vegetation and Flora of the Area Proposed to be Rezoned to Parks and Recreation

Half or a little more of this area has been cleared for a racecourse for horses and (presumably) to promote pasture growth, although this has not been very successful. Most of the cleared areas away from the racecourse had only weeds, including **Euphorbia terracina* and **Avena barbata.* Much of the remaining vegetation in the northern part of the area is quite disturbed.

- *Acacia rostellifera* closed scrub with *Clematis* over *Stipa* spp., *Lomandra maritima* open grassland/herbland.

This vegetation type was recorded in the southern part of the block to be rezoned to parks and recreation that is next to the coastal highway, on a fairly flat area. The cover of *Acacia rostellifera* was very high, more than 90%. The *Clematis* (Old Mans Beard) is a native creeper that scrambles through the *Acacia.* The understorey was very open because of the density of the shrub layer. The only other species recorded were *Loxocarya flexuosa* and *Conostylis aculeata.*

- *Jacksonia furcellata, Acacia saligna* open shrubland over *Acacia rostellifera, Acanthocarpus preissii, Diplolaena dampieri* low open shrubland to shrubland over *Lepidosperma gladiatum* sedgeland over *Stipa flavescens, Conostylis aculeata, Lomandra maritima* mixed grassland/sedgeland/herbland.

This vegetation unit was observed on the northern side of the block on a higher dune than most of those seen on the areas of the Quindalup sands covered in this study, similar vegetation occurred on the lower dunes in the block. On the west slope there was also *Acacia lasiocarpa* var. *lasiocarpa* in the shrub layer. The vegetation on the dune was quite disturbed, being a mosaic of (mostly) Poor with some patches in Good condition. Other species recorded were *Hardenbergia comptoniana, *Avena barbata, Hemiandra pungens, Phyllanthus calycinus, Opercularia vaginata* and **Pelargonium capitatum.* This was the only site during the survey where *Diplolaena dampieri* and *Lepidosperma gladiatum* were recorded.

- *Melaleuca rhaphiophylla* low closed forest over **Chenopodium* sp. shrubland.

This vegetation type was observed in a swale that runs south from the north side of the block. It was the only stand of *Melaleuca rhaphiophylla* observed in the study areas on the Quindalup sands although, some other smaller ones were observed out of the study area and this species was common in the seasonal wetlands in the Cottesloe Complex - Central and South. The swale was quite disturbed, being in a paddock which is used to keep horses and having the best shade in the paddock. The understorey was rated as Poor but, the overstorey was in Good condition. The ground layer of the vegetation had been removed from most of the swale however, there are patches of a small *Isolepis* species under the denser parts of the *Melaleuca.* At the northern end of the swale there was an

open area that probably holds water in winter. On the slopes leading into this there was a stand of *Lepidosperma gladiatum, Isolepis nodosus* sedgeland, this was the only location where *Trymalium* sp. was observed. Parts of the sides of the swale had a shrubland of *Xanthorrhoea preissii,* this was probably more continuous before disturbance. There were also a few clumps of *Juncus kraussii* on the edge of the swale. This indicates that in winter it is quite wet. Other species recorded were *Cotula coronopifolia, Epilobium billardierianum, Triglochin striata, Acacia cyclops, Rhagodia baccata* and *Lobelia alata.* North across the road there is a continuation of this swale, which was very damp, even supporting a stand of *Typha,* as well as *Bulboschoenus caldwellii,* this was just out of the study area.

3.5 Comparison of the Botanical and Conservation Values of the Areas to be Subtracted From and Added To the M103 Area SW of Lake Walyungup

Four attributes of the blocks need to be considered in this comparison, these are:

- the condition of the blocks;
- the position and shape of the blocks;
- the vegetation of the blocks; and
- the flora of the blocks

3.5.1 The Condition of the Blocks

The two blocks to be subtracted from the M103 area are generally in Good to Very Good condition, although the area proposed to be rezoned to urban future has some small areas in its north-east corner that are in poor condition. Both have areas that have been fairly recently burnt but, these are regenerating very well.

Half or a little more of the block that it is proposed to add to the M103 area has been cleared for a racecourse and (presumably) to promote pasture growth. Much of the remaining vegetation in the northern part of the area is in Poor condition. The remaining areas are in Good to Very Good condition, but are divided up by the racecourse, a road and cleared areas.

3.5.2 The Position and Shape of the Blocks

The two blocks to be subtracted from the M103 area are contiguous with it, being separated from it only by Ennis Avenue. They have good boundary to area ratios and improve the boundary to area ratio of the remainder of the M103 area, improving the long term viability of the vegetation and flora populations in the southern part of it (it is noted that Ennis Avenue detracts somewhat from this).

The area to be added has only point contact with the remainder of the M103 area, and even there is separated from it by Ennis Avenue. It has a poor boundary to area ratio and this is particularly so when internal clearing is taken into account. Management to maintain conservation values of this block would be quite difficult.

3.5.3 The Vegetation of the Blocks

The two blocks to be subtracted from the M103 area have fairly similar vegetation to the dune vegetation on the area to be added although there are some differences to the vegetation on the high dune on the area to be added. However, in the area east of the racecourse in the area to be added there is a stand of very dense *Acacia rostellifera* that is not duplicated in the areas to be subtracted. Also, there is a wetland in the area to be added that is not duplicated in the areas to be subtracted however, it has been degraded by the grazing of horses and while the tree layer is in good condition, the ground layer is in poor condition.

3.5.4 The Flora of the Blocks

The flora of the blocks is very similar, with a few species e.g. an *Isolepis* sp, *Diplolaena dampieri, Melaleuca rhaphiophylla* and a *Trymalium* sp. recorded in the block to be added but not in the blocks to be subtracted. These species were associated with the wetland and the high dune, none of them is rare or restricted. There were also a few species such as *Melaleuca preissiana* and *Schoenus grandiflorus* recorded in the blocks to be subtracted but not in the block to be added.

3.5.5 Overall Differences in Values

The differences in the flora and vegetation present between the block to be added and those to be subtracted are relatively minor and of less weight than the differences in condition and position. Overall the blocks to be subtracted are of higher conservation value for flora and vegetation because they are in better condition and have a better long term viability.

4.0 AREA NORTH-WEST OF LAKE COOLOONGUP

The area is bounded by Dixon Road, Ennis Avenue, the Garden Island Highway alignment and two minor roads. The upper part has been unburnt for some time but the lower section has been burnt quite recently.

4.1 Current Land Use

The area is part of the System Six recommendation M103 area. Most of it is vegetated although, there area some areas in the north-west section of the block that have been cleared.

4.2 Topography

The area has low irregular dunes, with one channel area and flatter areas in the north of the block.

4.3 Soil and Geomorphology

The area is part of the Quindalup dune system, and is at the inland side of part of the beach ridge system at Port Kennedy. Soils are grey-brown at the surface over pale whitish-grey, or pale grey-brown sands.

4.4 Vegetation and Flora

- *Eucalyptus gomphocephala* (Tuart) tall open woodland over *Acacia rostellifera* heath to open scrub over *Xanthorrhoea preissii* low shrubland over *Lomandra maritima, Conostylis aculeata* open herbland.

This vegetation was recorded mid-way along the north side of the block, on a fairly flat area, it was in Good to Very Good condition. Similar vegetation was observed at the north eastern corner of the block, where there were also areas with *Gahnia trifida* in the understorey. Another area on the north side of the block was also inspected, it had been unburnt for a long time and was in Very Good condition. In this area, the *Acacia rostellifera* was forming a tall closed scrub with patches of *Xanthorrhoea preissiana* shrubland in between the *Acacia.* Other species recorded were *Eremophila glabra, Phyllanthus calycinus, Leucopogon parviflorus, Clematis microphylla, Hibbertia racemosa, Loxocarya flexuosa, Acanthocarpus preissii, Hardenbergia comptoniana* and *Lepidosperma angustatum.* Weed invasion was low except near the fence, where **Euphorbia terracina* was present in moderate amounts as well as introduced annual grasses.

- *Eucalyptus gomphocephala* tall open woodland over *Xanthorrhoea preissii* tall shrubland over *Acanthocarpus preissii* low open shrubland over *Lomandra maritima, Conostylis aculeata* herbland.

This vegetation was recorded in the south part of the block, on low dunes and was in Good to Very Good condition, even though it had been burnt 3-4? years ago and has probably had the amount of *Acacia rostellifera* reduced markedly. This area has the largest, best condition stand of *Xanthorrhoea preissii* seen during this survey, it is probably the best on the area of Quindalup beach ridges in the Port Kennedy area and is of significant value for conservation (there was not sufficient time available to see how far into the M103 area this stand extended). There were patches of *Acacia lasiocarpa* var. *lasiocarpa* on some of the dunes. Other species recorded were *Acacia saligna, Leucopogon parviflorus, Hardenbergia comptoniana, Eremophila glabra, Phyllanthus calycinus, Clematis microphylla, Loxocarya flexuosa, Kennedia prostrata, Acacia rostellifera, Hibbertia racemosa* and *Poa poiformis.*

- *Banksia littoralis* low open woodland over *Xanthorrhoea preissii* open shrubland over *Gahnia trifida, Lepidosperma* sp. open sedgeland.

This unit was seen in some of the swales between the dunes in the southern part of the block. These are true seasonal wetlands and are unusual for the Quindalup Complex in having *Banksia littoralis* as the tree layer.

4.5 Botanical Values of the Area to be Removed From M103 at the NW of Lake Cooloongup

The major botanical values of this area are:

- The presence of vegetation types on Quindalup soil with Tuart (*Eucalyptus gomphocephala*) forming an overstorey. This is quite unusual and these are rare vegetation types. The fact that they are in Good to Very Good condition is also of particular note as many areas of vegetation dominated by Tuart have been disturbed.

- The presence of the largest, best condition stand of *Xanthorrhoea preissii* seen during this survey, it is probably the best on the area of Quindalup beach ridges in the Port Kennedy area and is of significant value for conservation.

- The presence of swales with *Banksia littoralis* forming the overstorey. This is also very unusual on Quindalup soils and this is a rare vegetation type, with significant conservation value.

5.0 AREAS NORTH-EAST OF LAKE COOLOONGUP

5.1 Current Land Use

The three areas treated together here are all in an area that has been partially cleared, so that there is a mosaic of small parkland cleared areas mixed with areas that are in very poor to poor condition and others that are in good condition or good to very good condition. The whole area appears to have been used for grazing in the past but, there is no evidence of grazing occurring at the present time. There is active subdivision occurring on parts of the area to the north of the three areas. Two of the three areas contains an interdunal wetland with the third containing two.

5.2 Topography

The area is quite hilly, with a series of tall, irregular dunes roughly parallel to the coast. However, the area closest to the north-east corner of Lake Cooloongup is partly on a flat area. Within many of the swales between the dunes there are seasonal wetlands, including those within the three areas surveyed. The larger dunes have moderately steep to steep slopes.

5.3 Soil and Geomorphology

The area starts in the eastern edge of the Quindalup soil unit, as shown by the pale grey sand of the low dune between the two wetlands in the western of the three sites, although, the eastern part of this site is on the west facing slope of the first dune of the Cottesloe soil unit. The area then extends well into the dunes of the Cottesloe unit of the Spearwood dune system. These dunes have a limestone core, formed from the dissolution of the limestone component of the original sands and its precipitation out at depth, leaving a cover of siliceous sand over the limestone (Lowry 1974). The sands are greyish brown or brown at the surface and orange-brown to orange at depth. The wetlands in the swales have a variety of soils, including pale greyish silts and very dark brown to black humus rich soils.

5.4 Vegetation and Flora

The vegetation of the three small areas north-east of Lake Cooloongup will be described individually, starting with the one closest to Lake Cooloongup and working east.

5.4.1 Vegetation and Flora of the Area Closest to North-east Corner of Lake Cooloongup

This area had a small wetland separated from a larger one by a low dune (apparently of the Quindalup formation), and to the east of the larger wetland the west facing slopes of a large dune of the Cottesloe unit of the Spearwood dune system.

(i) The vegetation of the small wetland was:

- *Eucalyptus gomphocephala* (Tuart) tall open woodland over *Melaleuca rhaphiophylla* low open forest over *Acacia saligna* low open woodland over *Gahnia trifida* closed sedgeland over *Baumea juncea* open sedgeland.

  This wetland was in Good to Very Good condition (tending more to very good) although, there were a significant number of dead *Melaleuca* and Tuart trees, probably caused by too-frequent fires. However, there was regeneration of these species and also young individuals of *Gahnia.*

  Other species recorded were *Opercularia hispida, Muehlenbeckia adpressa, Templetonia retusa, Hardenbergia comptoniana, Melaleuca teretifolia* and the fungus *Polyporus cinnabarinus.*

(ii) The low dune had grey-brown sand at the surface, with pale grey sand at depth. It had been largely cleared, with the part of it in the study area parkland cleared (i.e. trees and a few shrubs left) with the vegetation remaining being:

- *Eucalyptus gomphocephala* tall open woodland over low open shrubland of *Phyllanthus calycinus* over **Avena fatua* grassland.

This area was Completely Degraded to Very Poor in condition, with the understorey mostly composed of introduced grasses and herbs.

The only native species in the understorey apart from the *Phyllanthus* was *Lepidosperma angustatum,* a small sedge. However, in a small swale between two parts of the dune there was a small area of *Gahnia trifida* sedgeland, with *Templetonia retusa, Hardenbergia comptoniana* and *Adriana quadripartita* also present.

(iii) Over most of its area, the larger wetland in this first area had:

- *Eucalyptus gomphocephala* tall open woodland over *Melaleuca rhaphiophylla* low open forest to closed forest over *Gahnia trifida* sedgeland to closed sedgeland in places over *Baumea juncea* sedgeland.

In places within this wetland (along the eastern edge) the *Gahnia* was replaced by *Baumea articulata,* another tall sedge. Also along the eastern edge, there was a tall, open shrub layer of *Acacia saligna* under the *Melaleuca.*

In the centre of the wetland there was a stand of :

- *Melaleuca teretifolia* open heath over *Gahnia trifida* sedgeland.

(iv) On the ecotone on the eastern edge of this wetland there was a narrow strip of;

- *Eucalyptus gomphocephala* tall open woodland over *Banksia littoralis, Melaleuca rhaphiophylla* low open woodland.

This strip was quite disturbed, with the understorey having been partially cleared at some time in the past. Species present below the trees were scattered individuals of *Rhagodia baccata, Muehlenbeckia adpressa, Templetonia retusa* and *Anthocercis littorea,* as well as introduced annual grasses and herbs (dead at the time of survey).

Other species recorded in the wetland were *Sporobolus virginicus, Lepidosperma gladiatum, Centella asiatica, Apium prostratum, Cassytha* sp., *Myoporum* sp., *Juncus* sp., *Logania vaginalis* and *Anthocercis littorea.*

(v) The large west facing dune. On the lower slopes this had:

- *Eucalyptus gomphocephala* tall open woodland over *Eucalyptus marginata* open forest over *Banksia attenuata* low open woodland over *Acacia pulchella, Xanthorrhoea preissii, Macrozamia reidlei* shrubland over *Phyllanthus calycinus* low shrubland.

The lower slopes were in Poor to Good condition with some patches in Good condition. There was only low weed invasion, giving a good chance of further regeneration. Some parts of these lower slopes had dense patches of *Acacia rostellifera* under the *Banksia attenuata.* Others had *Banksia grandis,* as well as *Banksia attenuata* under the Eucalypts, these patches may have had different understorey species as well.

Other species present included *Hakea lissocarpha, Conostylis aculeata, Hibbertia hypericoides, Stipa flavescens, Loxocarya flexuosa* and *Hibbertia racemosa.*

On the upper slopes, the large west facing dune had;

- *Eucalyptus gomphocephala, Eucalyptus marginata* woodland to open forest over *Banksia attenuata, Banksia grandis, Allocasuarina fraseriana* low open woodland to low woodland over *Xanthorrhoea preissii, Macrozamia reidlei* shrubland over *Hibbertia hypericoides, Hibbertia racemosa* low open shrubland over *Conostylis aculeata* open herbland.

The upper slopes were in poor to good condition, with low weed invasion, and regeneration of the *Banksia* species in the absence of fire. Other species present included *Hakea prostrata, Phyllanthus calycinus, Dianella divaricata, Hibbertia*

racemosa, Schoenus grandiflorus, Acacia pulchella, Ptilotus drummondii, Lepidosperma angustatum and *Dryandra nivea.*

5.4.2 Vegetation and Flora of the Area 1.8km From the North-east Corner of Lake Cooloongup

This area had an area of the south-south-east facing slopes of a large dune of the Cottesloe formation and part of a wetland at the base of the dune.

(i) The vegetation of the slopes of the Cottesloe unit dune had three vegetation types, with one the result of degradation of one of the others.

- *Eucalyptus gomphocephala* tall open woodland over *Eucalyptus marginata* open woodland over *Banksia attenuata, Banksia grandis* low open forest over *Macrozamia reidlei, Hakea lissocarpha* shrubland over *Hibbertia hypericoides* low open shrubland over *Loxocarya flexuosa, Conostylis aculeata* sedgeland/herbland.

  This vegetation unit was recorded next to the north-west corner of the wetland. It was in Good condition. It had very low weed invasion and some small bare patches but there is obvious regeneration in these. It had a relatively diverse flora with the species recorded including: *Hibbertia racemosa, Phyllanthus calycinus, Xanthorrhoea brunonis, Hardenbergia comptoniana, Leucopogon propinquus, Stirlingia latifolia, Dryandra nivea, Xanthorrhoea preissii, Rhagodia baccata, Schoenus grandiflorus, Xylomelum occidentale, Lepidosperma angustatum* and *Persoonia* sp.

- *Eucalyptus gomphocephala* tall open woodland over *Eucalyptus marginata* open woodland over *Banksia attenuata* low open woodland to low open forest over *Macrozamia reidlei* open shrubland over *Ehrharta calycina* open grassland.

  This vegetation unit was recorded upslope from the middle of the wetland, it probably represents the result of degradation of the preceding unit. It was in Very Poor Condition but was better than parkland cleared. Other species recorded were

Conostylis aculeata, Xanthorrhoea brunonis, Hibbertia racemosa, Hibbertia hypericoides, Pimelea sp., *Hardenbergia comptoniana, Dryandra nivea, Leucopogon propinquus* and *Hakea lissocarpha.* Large stumps of Jarrah (*Eucalyptus marginata*) indicated that logging had also taken place. There were some patches of *Isolepis nodosus* sedgeland in the understorey near the lower margin of this stand.

- *Eucalyptus calophylla* tall open woodland to tall open forest over *Banksia grandis* low open woodland over *Macrozamia reidlei* open shrubland over *Ehrharta calycina* open grassland.

  This vegetation unit was recorded upslope from the eastern part of the wetland. It represents the result of the degradation of a *Eucalyptus calophylla* (Marri)/*Banksia* original vegetation. It was in Very Poor condition. Other species recorded were *Leucopogon propinquus, Hardenbergia comptoniana, Conostylis aculeata, Xanthorrhoea brunonis* and *Loxocarya flexuosa.*

(ii) The vegetation of the wetland was quite diverse, with the following vegetation types:

- *Eucalyptus rudis* open forest over *Melaleuca rhaphiophylla* low open woodland to woodland over *Lepidosperma* sp. (1) sedgeland.

  This vegetation unit was observed at the outer edge of the wetland on a slight slope, with some channelling. There was a strip of *Acacia saligna* at the very outer edge of the stand and in some places there were patches of *Gahnia trifida.* Other species present were *Thelymitra* ? (fruit only), *Solanum symonii* and *Samolus junceus.* The stand was in Good to Very Good condition.

- *Eucalyptus rudis* forest over *Melaleuca rhaphiophylla* low open woodland to low open forest over *Baumea juncea* sedgeland.

This stand was observed next to the vegetation type described above, still on a slight slope. Other species observed in it were *Samolus junceus, Acacia saligna* and *Lobelia alata.* It was also in Good to very Good condition.

- *Melaleuca rhaphiophylla* low woodland over *Acacia saligna* high shrubland to open scrub over *Melaleuca teretifolia* high open shrubland over *Baumea juncea* open sedgeland over *Sporobolus virginicus* closed grassland.

This vegetation type was observed in the east end of the wetland on a slight slope. Down the slope the amount of *Melaleuca teretifolia* and *Acacia saligna* decreased and the *Sporobolus* was no longer present. Other species present were *Samolus junceus, *Anagallis arvensis, Gahnia trifida, Lobelia alata, Centaurium spicatum?* and *Cassytha* sp. The stand was in Good to Very Good condition.

- *Triglochin* sp. herbfield.

This vegetation type was observed around the edges of the bare area in the lowest part of the wetland. It may have been reduced in area by vehicle use in the wetland but some areas of it are in Good condition, others are poorer.

- *Typha domingensis* closed rushland.

Small areas of this vegetation type were observed next to the bare area in the centre of the wetland. They were in Good to very Good condition.

- *Baumea articulata* sedgeland.

Small areas of this vegetation type were also seen at the edge of the bare area. They were in Good to Very Good condition.

- *Melaleuca rhaphiophylla* tall shrubland to low open woodland over *Restio* sp. sedgeland.

This vegetation type was observed at the western end of the floor of the wetland, it covered a moderate sized area and was in Very Good condition. Other species present in it were *Centella asiatica, Typha domingensis* and *Lobelia alata.*

- *Melaleuca rhaphiophylla* high shrubland to closed scrub over *Baumea articulata* sedgeland with *Cassytha* sp.

This vegetation type was observed in the north-west corner of the wetland. The *Baumea* was over two metres tall and the *Cassytha* was quite abundant. The stand was in Very Good condition but was only about ten metres wide.

5.4.3 Vegetation and Flora of the Area 2.8km From the North-east Corner of Lake Cooloongup

This area had an part of the facing slope of a large dune of the Cottesloe formation and a wetland at the base of the dune.

(i) The vegetation of the slopes of the Cottesloe unit dune had two vegetation types.

- *Eucalyptus gomphocephala, Eucalyptus calophylla* tall open forest over *Jacksonia furcellata, Hakea prostrata* tall open shrubland over *Ehrharta calycina* open grassland.

This vegetation is the result of the degradation of a *Eucalyptus/Banksia* vegetation and was in Very Poor condition. Other species recorded were *Dianella divaricata, Isolepis nodosus, Lepidosperma* sp., *Crassula colorata, Macrozamia reidlei, Solanum symoni, *Solanum nigrum* and **Euphorbia* sp. The *Isolepis nodosus* occurred as a sedgeland in small patches and the Marri is increasing in numbers.

(ii) The wetland had the following vegetation types:

- *Eucalyptus rudis, Eucalyptus gomphocephala* woodland to open forest over *Melaleuca rhaphiophylla* open woodland over *Acacia saligna* low open forest.

This vegetation unit was observed at the outer edge of the wetland on a slight slope and had virtually no understorey, probably because of clearing. The condition was Poor (to Good?). Other species present were *Solanum symoni, *Anagallis arvensis* and **Carpobrotus* sp.

- *Eucalyptus rudis* open woodland over *Melaleuca rhaphiophylla* low open woodland to low open forest over *Lepidosperma effusum* closed sedgeland.

  This vegetation type occurred from the south side of the wetland to towards the centre. There were a few small patches of *Baumea articulata* in the understorey but no free water at the time of the survey. There was also one small area of a *Triglochin* species. Other species recorded were *Centella asiatica, Cassytha* sp. and a few individuals of Pampas Grass (**Cortaderia selloana*). The condition of the vegetation was Good to Very Good.

- *Eucalyptus rudis* woodland to open forest over *Melaleuca rhaphiophylla* open woodland.

  This vegetation type occurred on the eastern side of the wetland on a gentle slope. There was very little understorey, probably the result of clearing. Other species recorded were *Clematis microphylla, Microtis* ? (fruit only), *Lepidosperma* sp., *Baumea juncea* and *Gahnia trifida* (the last three forming small patches of sedgeland). The condition of the vegetation was Poor to Good.

5.5 Botanical Values of the Areas Surveyed Along the Rail Route

The major botanical values of the areas surveyed along the rail route are:

- the presence of wetlands in good to very good condition, with a significant range of vegetation types. The conservation value of wetlands on the coastal plain is generally acknowledged.

- the fact that the two wetlands in the area surveyed closest to the north-east corner of Lake Cooloongup had an overstorey of Tuart (*Eucalyptus gomphocephala*) rather than Flooded Gum (*Eucalyptus rudis*). This is quite unusual and again reflects the fact that the soil is Quindalup rather than the Cottesloe unit of the Spearwood dunes found east from these wetlands. This situation is quite rare, and these are rare vegetation types, although the lower tree layers, shrub and sedge layers are similar to ones found in wetlands in the Cottesloe Complex - Central and South.

- the presence of areas of the upland vegetation of the Cottesloe Complex - Central and South in Good condition. As noted in the introduction this vegetation complex is poorly conserved in the region that the study area lies in. This, in combination with the fact that there are limited opportunities to reserve this vegetation complex between Perth and Mandurah means these areas have significant conservation value, even though they are found in a mosaic with areas that are in Poor condition or Very poor Condition.

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APPENDIX A: Vegetation Condition scale

E = Excellent.

Pristine or nearly so, no obvious signs of damage caused by the activities of European man.

VG = Very good.

Some relatively slight signs of damage caused by the activities of European man. E.g. some signs of damage to tree trunks caused by repeated fire and the presence of some relatively non-aggressive weeds such as *Ursinia anthemoides* or *Briza* spp., or occasional vehicle tracks.

G = Good.

More obvious signs of damage caused by the activities of European man, including some obvious impact on the vegetation structure such as caused by low levels of grazing or by selective logging. Weeds as above, possibly plus some more aggressive ones such as *Ehrharta* spp.

P = Poor.

Still retains basic vegetation structure or ability to regenerate to it after very obvious impacts of activities of European man such as grazing or partial clearing (chaining) or very frequent fires. Weeds as above, probably plus some more aggressive ones such as *Ehrharta* spp.

VP = Very poor.

Severely impacted by grazing, fire, clearing or a combination of these activities. Scope for some regeneration but, not to a state approaching good condition without intensive management. Usually with a number of weed species including aggressive species.

D = Completely degraded.

Areas that are completely or almost completely without native species in the structure of their vegetation - i.e. areas that are cleared or "parkland cleared" with their flora comprising weed or crop species with isolated native trees or shrubs.

APPENDIX E

Report of Fauna Survey

SOUTH-WEST CORRIDOR AMENDMENT PUBLIC ENVIRONMENTAL REVIEW

Survey of fauna habitats in the region of Lakes Cooloongup and Walyungup, Rockingham

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31/12/'93

INTRODUCTION

As part of the Public Environmental Review of proposed amendments to the South-West Corridor in the vicinity of Lakes Cooloongup and Walyungup, we have been asked to undertake a survey of fauna habitats at sites affected by particular modifications to the corridor plan. These modifications are either in the vicinity of wetlands or affect System Six area M103, which encompasses Lakes Cooloongup and Walyungup and some associated areas of upland vegetation. The modifications are as follows:

1. Hillman Public Purposes Reserve (removal from M103).
2. Warnbro South-East Urban Zone (removal from M103).
3. Warnbro South-East Industrial Zone Extension (removal from M103).
4. Eastern section of Port Kennedy South Parks and Recreation Reserve, incorporating the Lark Hill Trotting Complex (addition to regional reserve system).
5. Railway corridor passing through or close to wetlands north-east of Lake Cooloongup.

The objectives of the survey were to:

i). compare the conservation values (fauna) of areas added to and removed from the regional reserve system south-west of Lake Walyungup (modifications 2, 3 and 4).

ii). assess the significance (for fauna) of the area to be removed from M103 at the north-west corner of Lake Cooloongup (modification 1).

iii). assess the importance of and probable impacts of the railway corridor upon three wetlands north-east of Lake Cooloongup (modification 5).

METHODS

All study sites were inspected on 30 December 1993. Notes were made on the types and condition of the vegetation, the sorts of fauna habitats present and any fauna observed. The emphacsis was upon vertebrate fauna. Sketch maps of the sites, indicating where ground inspections were carried out and illustrating locations and features described in the text, are given in Appendix One.

OBSERVATIONS

1. Hillman Public Purposes Reserve

The principal vegetation type in this site is Tuart *Eucalyptus gomphocephala* woodland which is badly degraded in the south and west but in good condition in the centre and east (see Appendix One). In less degraded areas, *Acacia* spp. and tall sedges form an understorey beneath the Tuarts.

In degraded areas, exotic grasses are abundant while in some degraded areas, dense regrowth of Blackboys *Xanthorrhoea* spp. is present. The site is at present part of an area of native vegetation that lies between Dixon Road and Lake Cooloongup.

The structural complexity of the less degraded vegetation types, the presence of old Tuart trees with many hollows potentially used by fauna for shelter and breeding and the linkage of the site to other vegetation types around Lake Cooloongup, mean that the site is of high conservation value for fauna. While published data are not available, anecdotal reports (The Western Australian Naturalists' Club and the WA Group of the Royal Australasian Ornithologists Union) suggest that 40-50 species of birds can be regularly observed in woodlands at the northern end of Lake Cooloongup. On the brief site inspection, 14 species were observed (Table 1). Several of these, including the Scarlet Robin, Weebill, Common Bronzewing and Splendid Fairy-wren, are generally uncommon in the Perth urban area. The Barn Owl *Tyto alba* is known to breed in the area (B.Goodale pers. comm.) and there are records of the Masked Owl *Tyto novaehollandiae* from the region. The latter species is classed as rare by Garnett (1992).

Evidence of the Quenda *Isoodon obesulus* (Southern Brown Bandicoot) was found amongst dense sedges and several species of bats could shelter in tree hollows. The Quenda is classed under Schedule 1 (likely to become extinct) of the Wildlife Conservation Act. The Brush-tailed Possum *Trichosurus vulpecula* may also utilize large tree hollows in the site.

The site probably supports a diverse reptile fauna; based on personal experience in the region, approximately 30 species could be expected. These would include the small skink *Lerista lineata* which is confined to the coastal plain south of Perth.

The value of the site for fauna cannot be quantified. The site, however, contains a substantial proportion of upland vegetation types, particularly Tuart woodland, at the northern end of Lake Cooloongup and therefore can be expected to be important for the maintenance of faunal diversity in this general region. The same vegetation types and therefore fauna habitats are represented in areas of M103 unaffected by the rezoning, but the loss of habitat area would be significant. The loss of Tuart woodland may be especially important as the trees provide hollows for a wide range of animal species. Populations of species of fauna will decline in proportion to the loss of habitat; possibly to a greater extent if the remaining habitat is too small to support viable populations. The most significant species in this respect is probably the Masked Owl.

In addition to the habitats for fauna found on the site, the site is a buffer to protect fragile vegetation associations fringing Lake Cooloongup. Therefore, any developments within the site have the potential to adversely impact upon the lake.

In conclusion, the Hillman Reserve, particularly the central and western sections, should be viewed as an integral part of M103.

2. Warnbro South-East Urban Zone

This is an area of degraded coastal shrubland; the least degraded areas are in the south-east, south and particularly the south-west. Some of the best vegetation in the south-west corner lies outside M103. Some dune valleys are seasonally damp and have associated vegetation but probably rarely, if ever, support surface water.

Even the least weed-invaded, most floristically rich vegetation provides only a limited range of fauna habitats and few animal species were recorded during the site inspection (Table 1). Because of the low vegetation, probably only 15-20 species of birds may use the site regularly, while up to about 30 reptile species could be expected. No species of native mammals were recorded although both Grey Kangaroos and several species of bats could visit the site.

The site may be regionally important for some fauna species mostly restricted to low shrubland vegetation, such as the White-browed Scrubwren and possibly some reptiles. For example, the Bluetongue Skink *Tiliqua occipitalis*, is at the southern limit of its coastal plain distribution in the region. Representation of similar low shrublands in the regional reserve system needs to be considered. The site may also be important in providing a link between Lake Walyungup and more coastal reserves.

In conclusion, the site is of restricted value for fauna, with the more floristically diverse southern region probably being of greatest significance. Its location between Lake Walyungup and reserves near the coast may give it some regional importance for fauna.

3. Warnbro South-East Industrial Zone Extension

This site consists of coastal shrubland similar to that of the Warnbro South-East Urban Zone, although it is generally in better condition and contains low trees up to 3 m in sheltered valleys. As a result, the site can be expected to

support a slightly higher diversity of fauna, particularly of birds, than the adjacent urban zone.

Like the adjacent urban zone, the industrial zone extension may be of regional importance for fauna because of the vegetation type it contains and because of its location between Lake Walyungup and reserves close to the coast. To some degree, its location may be more significant than that of the urban zone because it is close to the Port Kennedy South Parks and Recreation Reserve. Although smaller than the urban zone site, the quality of the habitat seems to be higher in general.

4. Eastern section of Port Kennedy South Parks and Recreation Reserve, incorporating the Lark Hill Trotting Complex

The purpose of this zoning modification is to compensate for the loss of parts of M103 (site 2 - Warnbro South-East Urban Zone and site 3 - Warnbro South-East Industrial Zone Extension). While potentially valid, such compensation depends upon sites having similar values for fauna.

Site 4 contains large areas of low shrubland similar to those found in sites 2 and 3, but they are substantially degraded. This appears to be due primarily to horse-grazing. The shrublands in the north-west part of the site have been mostly replaced by grasses and herbs and there are many tracks and areas of bare soil. The only areas of shrubland that are not badly degraded are just to the north of the trotting complex and at the southern tip of the site. The shrublands at the southern tip of the site are particularly rich floristically with very little invasion by exotic grasses and it was in this area that most birds were observed.

The site also contains vegetation types not well-represented in sites 2 and 3. To the east of the trotting complex is an area of dense *Acacia* shrubland which may be the result of regeneration after disturbance. Natural but degraded, seasonal wetlands form a chain between dunes running from the north-west to the south-east of the site. In the centre of the trotting complex, one of these wetlands appears to have been excavated to create a permanent lake which unfortunately has little fringing vegetation and is therefore of little value for wildlife. Nothing was observed around this lake during the site inspection, although there were tracks of a waterbird, probably a White-faced Heron *Ardea novaehollandiae*.

The diversity of vegetation types and therefore habitats probably means that site 4 supports a greater range of animal species that site 2 or 3. For example, waterbird

species could be expected to visit the wetlands when they contain water, while the small areas of high quality shrubland are presently connected to other areas of shrubland, particularly to the south. They therefore should support all the fauna species expected in shrubland. The areas of degraded shrubland probably support little wildlife, however, and these make up the bulk of site 4.

In terms of areas of similar habitat, site 4 contains less good quality shrubland than either site 2 or 3 while the degraded shrubland is of low conservation value. The seasonal wetlands, while present only in site 4, are mostly small and degraded. The only exception to this was one small wetland in the extreme southern end of site 4.

Sites 2, 3 and 4 all have weaknesses in terms of regional conservation. Ideally, the reserve system should link different landscape units from the coast to the wetland systems of Walyungup/Cooloongup and Stakehill Swamp. Sites 2 and 3 link to Lake Walyungup but not to more coastal areas, while site 4 is linked to the coast through the Port Kennedy Reserve but is not connected to the wetland areas. the coast. Opportunities for linkages through these sites could determine which will ultimately have the greatest importance in the local reserve system. The degraded state of much of site 4, however, could undermine its role in linking other areas.

In conclusion, site 4 has some weaknesses as an exchange area with sites 2 and 3, principally because much of it is badly degraded. Furthermore, it may become the subject for land-use conflicts. The local Rockingham Community Newspaper has carried articles concerning the sub-division of this site into 5 ha lots for low density housing combined with horse-grazing. This would further reduce the value of the site for fauna.

5. Railway corridor passing through or close to wetlands north-east of Lake Cooloongup

The railway corridor passes through *Eucalyptus/Banksia* woodland with degraded understorey, through a seasonal wetland immediately north-east of Lake Cooloongup and between two seasonal wetlands just to the south of suburban Leda. The wetland closest to Lake Joondalup consists of *Eucalyptus rudis* and *Melaleuca rhaphiophylla* over sedges. The central wetland is large with a band of *E.rudis*, *M.rhaphiophylla*, *Banksia littoralis* and a number of riparian shrubs around a central area of sedges and dry mud, which would be open water in winter. The third, easternmost wetland is small with *E.rudis* and *M.rhaphiophylla* over dense sedges. It lies less than 200 m south of the present limit of urban sprawl.

More fauna species were observed at site 5 than at any other site (Table 1) because of the diversity of habitats present. A number of the fauna species are significant. Evidence of the Quenda was abundant around the western and central wetlands while the Golden Whistler, observed around the central and eastern wetlands, is rarely recorded on the Swan Coastal Plain. Several other species, such as the Common Bronzewing, Red-capped Parrot and Splendid Fairy-wren, are uncommon close to Perth. This probably reflects the size of the block of uncleared native vegetation around these wetlands. Fauna that regularly uses site 5, including wetland and woodland habitats, probably includes approximately 80 species of birds, 8 species of frogs, 35 species of reptiles and 10 species of native mammals.

The wetlands are only part of the system of habitats present in site 5, but they are significant because of the loss of wetlands on the Swan Coastal Plain and because many of the fauna species rely on wetland habitats. Furthermore, while the main pressure on woodland areas is from clearing for urban development and clearing for the rail corridor will affect only a small proportion of the woodland, the wetlands are limited in area and therefore more sensitive to disturbance.

Of the three wetlands, the central wetland has the highest conservation value for fauna because it is large, isolated from cleared land and other sources of disturbance, and contains many different habitat types. It has, however, suffered some degradation from off-road vehicles and the like. This degradation will increase as urban areas develop nearby. The easternmost wetland is small, has little habitat diversity, is disturbed and lies on the urban development side of the railway corridor, so levels of disturbance are likely to increase rapidly. It therefore has low conservation value. The westernmost wetland is of intermediate conservation value, being large but with little habitat diversity, close to private property and a major road but a reasonable distance from future urban development.

The westernmost wetland will be most affected by the rail corridor as this passes directly through it, which is undesirable unless the railway can bridge the wetland. Destruction of habitat and disruption of movement of animals and flow of water will result from placing the rail corridor through this wetland. Creation of very wide (at least several metres) wildlife corridors beneath the rail system may be beneficial to species such as the Quenda.

The direct impact of the rail corridor on the remaining two wetlands should be slight, as long as development can be kept away from fringing vegetation. The railway will

isolate the small, easternmost wetland from the large, central wetland, which will reduce the conservation value of the small wetland. This is already degraded, however, and its position north of the rail corridor and adjacent to urban development will expose it to further pressures. If placed north of this wetland, the rail corridor would conflict with a new urban development. The central wetland may get some measure of protection from its position south of the rail corridor, as this will reduce uncontrolled access from urban areas. Without some form of management, this central wetland will inevitably decline in conservation value as urban development increases around it. Loss of adjacent woodland on the northern edge of the central wetland should be minimized and will increase the conservation value of adjacent woodland to the south and east.

CONCLUSIONS

i). Hillman Public Purposes Reserve

This reserve, particularly the central and eastern sections, is an integral part of M103. It contains a substantial proportion of important habitat types at the northern end of Lake Cooloongup. Loss of this area from M103 could result in the decline in abundance or loss of some fauna species from the reserve.

ii). Relative conservation values; removals and additions to M103 to the south-west of Lake Walyungup

The area to be added (site 4) to the reserve system in compensation for the removal of areas in Warnbro (sites 2 and 3) appears to be of lower conservation value than the areas it is supposed to replace. Site 4 contains some small, high quality areas of the shrubland habitat found in sites 2 and 3, but most of the shrubland in site 4 is badly degraded. Site 4 does contain small examples of some habitat types not represented in sites 2 and 3, however. Neither site 2, 3 or 4 is well located to contribute to regional conservation as neither singly nor in combination do they link coastal reserves with wetland systems of M103 and Stakehill Swamp Reserve. The degraded state of much of site 4, however, reduces its value in the regional context. The potential conservation value of site 4 is further weakened by proposals for low density housing in at least some of the area, discussed in the local newspaper. This issue needs to be resolved as it is unlikely that such housing would be compatible with the role of the site as part of the regional reserve system.

iii). Rail corridor and wetlands between Lake Cooloongup and Leda

Of the three wetlands potentially affected by this rail corridor, the central wetland has the highest conservation value, the westernmost wetland is of intermediate value and the small, easternmost wetland is of relatively low conservation value. The westernmost wetland would be most affected by the rail corridor as this cuts straight across it. This impact could be reduced by bridging the wetland or constructing wildlife underpasses. In general, wildlife underpasses have to be very wide to work. The rail corridor actually misses the other two wetlands, both of which are subject to degradation due to uncontrolled public use. This situation is worse with the easternmost wetland and the rail corridor will probably accentuate this. Priority should be given to minimizing impacts on the central wetland and to managing pressures on this wetland as developments proceed around it.

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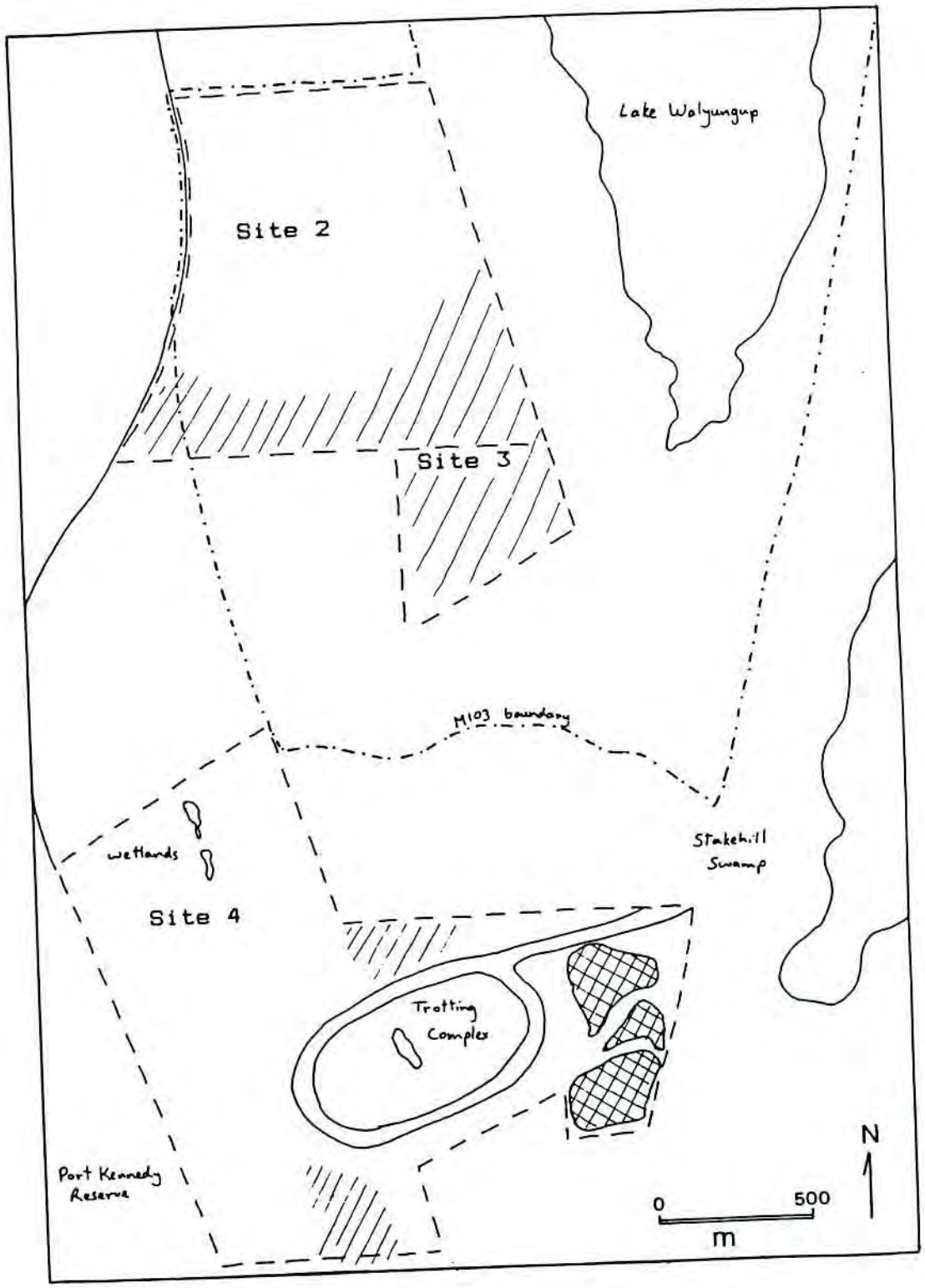
Table 1. Summary of fauna observations made at all sites, 30 December 1993. Common (where available) and scientific names are based on the following sources: reptiles (Storr *et al.* 1981, Storr *et al.* 1983, Storr *et al.* 1986 and Storr *et al.* 1990), birds (Schodde *et al.* 1978) and mammals (Strahan 1983). Site codes are: 1 - Hillman Reserve; 2 - Warnbro South-East Urban Zone; 3 - Warnbro South-East Industrial Zone; 4 - Eastern section of Port Kennedy Parks and Recreation; 5 - Railway corridor north-east of Lake Cooloongup. A question mark indicates that the species' identification was not definite. (I) indicates introduced species.

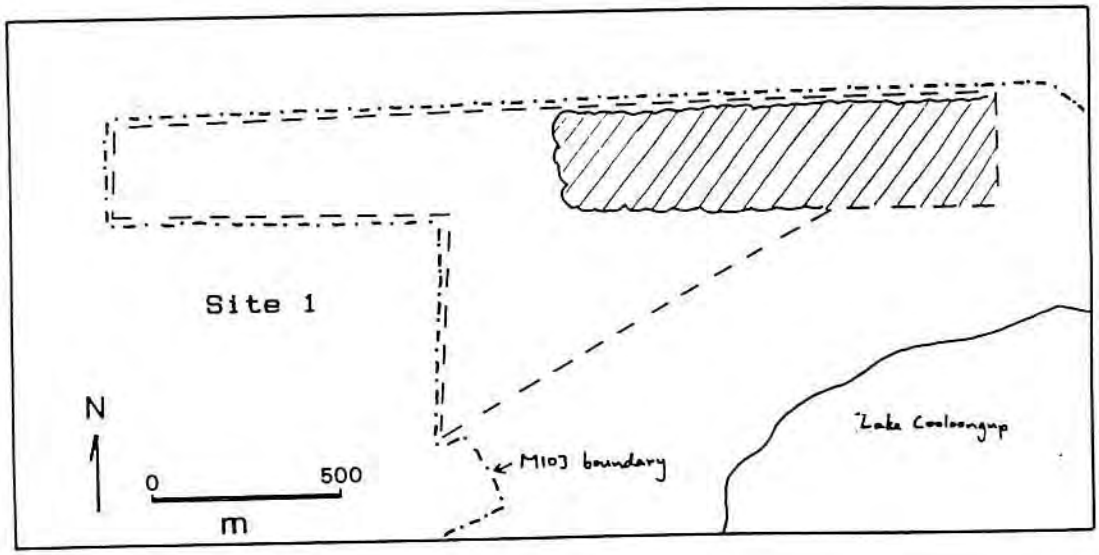
Species		Site				
		1	2	3	4	5
REPTILES						
Varanidae (monitors or goannas)						
	Varanus gouldii	?				?
Scincidae (skink lizards)						
	Ctenotus fallens		+			
Bluetongue	*Tiliqua occipitalis*				+	
Bobtail	*Tiliqua rugosa*	+	+	+		+
BIRDS						
Accipitridae (kites, hawks and eagles)						
Collared Sparrowhawk	*Accipiter cirrhocephalus*					+
Falconidae (falcons)						
Australian Kestrel	*Falco cenchroides*				+	
Phasianidae (true quails)						
Stubble Quail	*Coturnix novaezealandiae*			+	?	
Columbidae (pigeons and doves)						
Common Bronzewing	*Phaps chalcoptera*	+				+
Platycercidae (broad-tailed parrots)						
Red-capped Parrot	*Purpureicephalus spurius*					+
Port Lincoln Ringneck	*Barnardius zonarius*	+				+
Alcedinidae (kingfishers)						
Laughing Kookaburra	*Dacelo novaeguineae* (I)					+
Meropidae (bee-eaters)						
Rainbow Bee-eater	*Merops ornatus*					+
Motacillidae (pipits)						
Richard's Pipit	*Anthus novaeseelandiae*		+			
Campephagidae (cuckoo-shrikes)						
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*		+		+	

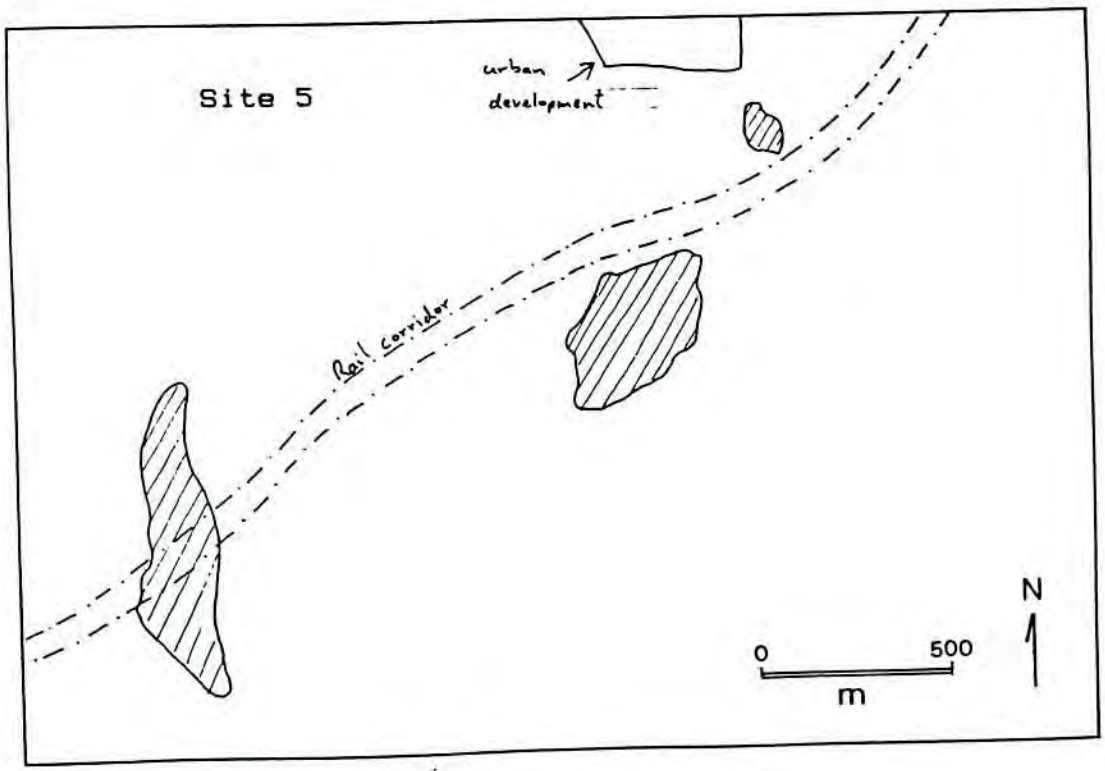
Species	Site 1	2	3	4	5
Muscicapidae (flycatchers)					
Scarlet Robin *Petroica multicolor*	+				
Golden Whistler *Pachycephala pectoralis*					+
Grey Shrike-thrush *Colluricincla harmonica*	+				
Grey Fantail *Rhipidura fuliginosa*	+				+
Willie Wagtail *Rhipidura leucophrys*				+	
Maluridae (fairy-wrens)					
Splendid Fairy-wren *Malurus splendens*	+	+		+	+
Acanthizidae (thornbills)					
White-browed Scrubwren *Sericornis frontalis*		+	+	+	
Weebill *Smicrornis brevirostris*	+				+
Western Gerygone *Gerygone fusca*	+				+
Inland Thornbill *Acanthiza apicalis*				+	
Yellow-rumped Thornbill *Acanthiza chrysorrhoa*	+				+
Neosittidae (sittellas)					
Varied Sittella *Daphoenositta chrysoptera*	+				
Meliphagidae (honeyeaters)					
Red Wattlebird *Anthochaera carunculata*	+				+
Pardalotidae (pardalotes)					
Striated Pardalote *Pardalotus striatus*	+				+
Zosteropidae (white-eyes)					
Silvereye *Zosterops lateralis*	+	+		+	+
Artamidae (woodswallows)					
Black-faced Woodswallow *Artamus cinereus*		+			
Cracticidae (butcherbirds)					
Grey Butcherbird *Cracticus torquatus*	+		+		
Australian Magpie *Gymnorhina tibicen*					+
Corvidae (ravens and crows)					
Australian Raven *Corvus coronoides*				+	+
MAMMALS					
Peramelidae (bandicoots)					
Quenda (Southern Brown Bandicoot) *Isoodon obesulus*	+			?	+
Macropodidae (kangaroos)					
Grey Kangaroo *Macropus fuliginosus*			+	+	
Leporidae (rabbits and hares)					
Rabbit *Oryctolagus cuniculus* (I)	+	+	+	+	+
Canidae (foxes and dogs)					
European Red Fox *Vulpes vulpes* (I)	+	+	+	+	+

APPENDIX ONE; figure 1.
Sketch map of sites 2 (Warnbro South-East Urban Zone), 3 (Warnbro South-East Industrial Zone extension) and 4 (eastern section of Port Kennedy South Reserve). Hatched areas indicate approximate distribution of high quality low shrubland; cross-hatched areas indicate *Acacia* shrubland.



APPENDIX ONE; figure 2.
Sketch map of sites 1 (Hillman Public Purposes Reserve) and 5 (railway corridor). Hatched area in site 1 indicates the approximate distribution of high quality woodland. Hatched area in site 5 indicates the locations of three wetlands.





APPENDIX F

Fauna Species Known or Expected to occur in the South West Corridor

APPENDIX F

FAUNA SPECIES KNOWN OR EXPECTED TO OCCUR IN THE SOUTH WEST CORRIDOR

(Note: * denotes introduced species)

REPTILES	
Western Tiger Snake	*Notechis scutatus occidentalis*
Dugite	*Pseudonaja affinis*
Gould's Snake	*Rhinoplocephalus gouldii*
Burton's Legless Lizard	*Lialis burtonis*
Skink	*Ctenotus fallens*
Skink	*Hemiergis quadrilineata*
Elegant Skink	*Lerista elegans*
Lined Skink	*Lerista lineata*
Western Bluetongue	*Tiliqua scincoides*
Garden Skink	*Cryptoblepharus lineocellatus amonalus*
Bobtail	*Tiliqua rugosa*
Long-necked Tortoise	*Chelodina oblongata*
AMPHIBIANS	
Western Banjo Frog	*Limnodynastes dorsalis*
Moaning Frog	*Heleioporus eyrei*
? Frog	*Ranidella subinsignifera*
? Frog	*Litoria moorei*
BIRDS	
Twenty Eight Parrot	*Platycercus zonarius*
Splendid Fairy-wren	*Malurus splendens*
Willie Wagtail	*Rhipidura leucophrys*
Grey Fantail	*Rhipidura fuliginosa*
Welcome Swallow	*Hirundo neoxena*
Grey Butcherbird	*Cracticus torquatus*
Australian Raven	*Corvus coronoides*
Australian Magpie-lark	*Grallina cyanoleuca*
Australian Magpie	*Gymnorhina tibicen*
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*
Red Wattle Bird	*Anthochaera carunculata*
*Spotted Turtle-dove	*Streptopelia chinensis*
*Laughing Kookaburra	*Dacelo novaeguineae*
Regent Parrot	*Polytelis anthopeplus*
Red-capped Parrot	*Purpureicephalus spurius*
Weebill	*Smicrornis brevirostris*
Scarlet Robin	*Petroica multicolor*
Common Bronzewing	*Phaps chalcoptera*
Western Gerygone	*Gerygone fusca*

Golden whistler	*Pachycephala pectoralis*
Rainbow Bee-eater	*Merops ornatus*
Silvereye	*Zosterops lateralis*
Masked Owl	*Tyto novaehollandiae*
Barn Owl	*Tyto alba*
Pacific Black Duck	*Anas superciliosa*
Grey Teal	*Anas gibberifrons*
Australian Shelduck	*Tadorna tadornoides*
Chestnut Teal	*Anas castanea*
Blue-billed Duck	*Oxyura australis*
Singing Honeyeater	*Lichenostomus virescens*
Silver Gull	*Larus novaehollandiae*
Crested Tern	*Sterna bergii*
Roseate Tern	*Sterna dougalli*
Richard's Pipit	*Anthus novaeseelandiae*
Pied Cormorant	*Phalacrocorax varius*
Little Pied Cormorant	*Phalacrocorax melanoleucos*
Nankeen Kestrel	*Falco cenchroides*
Tree Martin	*Petrochelidon nigricane*
Spotted Harrier	*Circus assimilis*
Marsh Harrier	*Circus approximans*
Curlew Sandpiper	*Calidris ferruginea*
Red-capped Dotterel	*Megalurus gramineus*
Brown Quail	*Coturnix australis*
White-browed Scrubwren	*Sericornis frontalis*
White-faced Heron	*Ardea novaehollandiae*
Black Swan	*Cygnus atratus*
Australian Pelican	*Pelicanus conspicillatus*

MAMMALS

Western Grey Kangaroo	*Macropus fuliginosus*
Western Brush Wallaby	*Macropus irma*
Brush-tailed Possum	*Trichosurus vulpecula*
Southern Brown Bandicoot	*Isoodon obesulus*
*Rabbit	*Oryctolagus cuniculus*
*Fox	*Vulpes vulpes*
*Cat	*Felis cattus*
*Black Rat	*Rattus*
*House mouse	*Mus musculus*

Figures 1 - 9 were produced by :
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