LESCHENAULT INLET MANAGEMENT AUTHORITY

Collie and Brunswick Rivers Foreshore Study

Waterways Commission Report 48 June 1994

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Collie and Brunswick Rivers Foreshore Study

Prepared for the Leschenault Inlet Management Authority by the Waterways Commission

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Waterways Commission
216 St Georges Tce
Perth

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CHAIRMAN'S FOREWORD

In 1992 the Leschenault Waterways Management Programme was released. The management programme identifies a range of issues of concern to people with an interest in the waterway and makes recommendations to deal with them.

Of particular concern are the Collie and Brunswick Rivers which are under increasing pressure from urban expansion. To assist LIMA in providing concise and consistent advice to decision making authorities, developers and landowners, this document focuses attention on areas where the protection of waterways and its margins is of high priority.

Furthermore, this study makes recommendations to conserve, protect and rehabilitate the ecosystem and landscape whilst maximising public access and recreational opportunities for the community in a manner sympathetic with the surrounding environment. The study identifies a Waterways Protection Precinct which is the area of critical importance in maintaining and therefore protecting the waterways ecosystem.

Public comment was invited on a draft document and seven written submissions were received. Concerns focused on how the Waterways Protection Precinct would be implemented. Section 6 of this document has been added to clarify this issue. LIMA appreciates the effort people made in preparing submissions and hopes that the community continues to support LIMA in its efforts to manage the waterways.

Sir Donald Eckersley OBE

Chairman

Leschenault Inlet Management Authority

(Plate 1 : Willy wagtail)

Intact native understorey provides a habitat for songbirds such as the Willy wagtail.

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SUMMARY

In recent years the Leschenault Inlet Management Authority's (LIMA's) advice has been sought on an increasing number of development proposals around the Leschenault waterways. These proposals include large scale structure plans for Australind and Eaton, special rural subdivisions, individual residential properties, and tourism nodes on the mouth of the Collie River as well as the Draft Bunbury - Wellington Region Plan.

LIMA has attempted to provide consistent advice on such proposals to government, local government and individual developers. One issue has been the need for and size of foreshore reserves required around the waterways, particularly when an area is sought for conservation or recreation purposes. LIMA's advice however has not always been accepted possibly because much of it was based on general knowledge about waterways rather than the particular needs of the Leschenault system. Many agencies or individuals considered the proposed foreshore reserve boundaries to be arbitrary rather than based on sound ecological principles. This has highlighted the need for comprehensive planning for foreshore reserves.

In order to overcome this problem, the concept of a Waterways Protection Precinct has been employed. The precinct focuses attention on areas where the protection of waterways and adjacent foreshore margins is of high priority. The limit of the precinct is illustrated by a line. The depth of the Waterways Protection Precinct varies as it is based on a number of factors including the extent and quality of the vegetation, the floodway, the floodfringe, erosion, topography and landscape aesthetics. It also incorporates planning considerations such as existing reserves, public access, recreation needs and miscellaneous constraints and the results of strategic planning reports.

Accordingly, the Waterways Protection Precinct describes the area of critical importance in protecting the waterways ecosystem. This area includes the waterway and adjoining foreshore which form the waterway environment. The area is highly valued by the community for its aesthetic appeal and high conservation values, as well as for its attraction for tourism and leisure activities. Within the precinct Leschenault Inlet Management Authority will see to limit the extent and nature of environmental change and thus protect this valued asset. To further refine the role of the precinct, specific planning considerations and recommendations are listed adjacent to the maps to delineate suitable boundaries in terms of conservation and land use planning values.

Mechanisms to protect the waterways protection precinct are examined as well as strategies for the rehabilitation of the ecosystem, landscape and general environment of the Collie and Brunswick Rivers. Finally, guidelines for the establishment of bridges over waterways and for the provision of retention basins within proposed developments are outlined for the use of LIMA, decision making authorities and proponents.

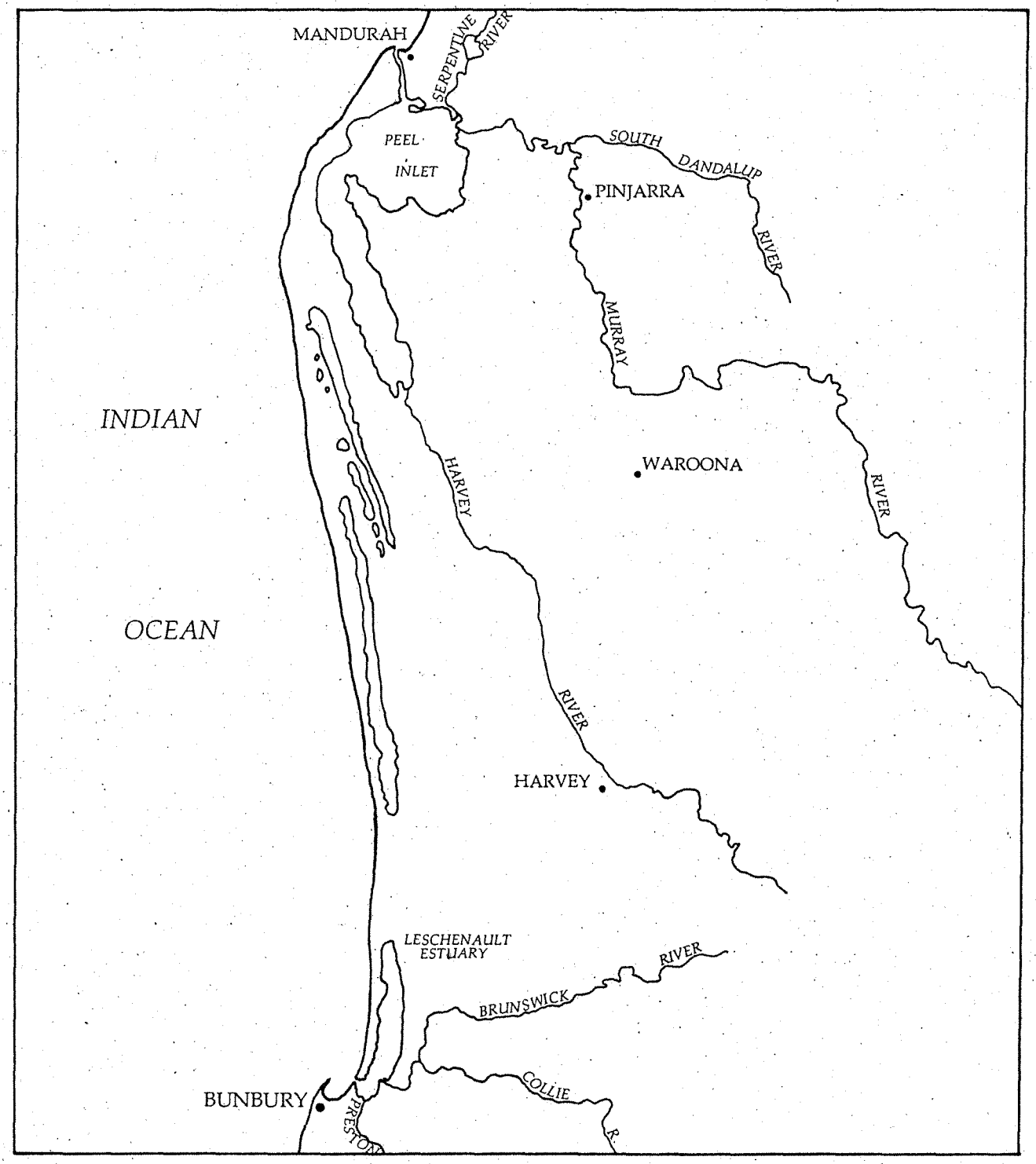


FIG. 1: Regional Map

1. Introduction

1.1 Background

The Leschenault Inlet Management Authority (LIMA) is responsible for the management of the Leschenault Inlet Management Area declared under the Waterways Conservation Act (Amended) 1976.

1.1.1 What LIMA does

Its roles include :

- Preparation of a management programme for the Leschenault Inlet Management Area.
- The day-to-day management of the river including such aspects as beach cleaning, erosion control works, water quality sampling.
- Establishment of facilities such as jetties, boat ramps, change rooms, toilets, recreation areas and barbecue sites, normally in conjunction with local government.
- Advising the Department of Planning and Urban Development (DPUD), local government and the Department of Transport (DOT) on the impact of developments on the foreshore and river.
- Making and enforcing by-laws pursuant to the Waterways Conservation Act.
- Control of pollution and licensing of industrial discharges under powers delegated by the Environmental Protection Authority (EPA).

1.1.2 Need for the study

In recent years the Leschenault Inlet Management Authority's advice has been sought on an increasing number of development proposals around the Leschenault waterways. These proposals include large scale structure plans for Australind and Eaton, special rural subdivisions, individual residential properties, tourism nodes on the mouth of the Collie River as well as the Draft Bunbury - Wellington Region Plan.

LIMA has attempted to provide consistent advice on such proposals to government, local government and individual developers. One issue has been the need for and size of foreshore reserves required around the waterways, particularly when an area is sought for conservation or recreation purposes. LIMA's advice however has not always been accepted possibly because much of it was based on general knowledge about waterways rather than the particular needs of the Leschenault system. Many agencies or individuals considered the proposed foreshore reserve boundaries to be arbitrary rather than based on sound ecological principles. This has highlighted the need for comprehensive planning for foreshore reserves.

In order to overcome this problem LIMA has sought to increase the knowledge of the Leschenault waterways to provide a basis for advice on development proposals adjacent to the waterways. Priorities have been set for a series of studies for waterways within LIMA's management area. These are:

- Lower Collie and Brunswick Rivers
- Wellesley River
- Preston and Ferguson Rivers
- Upper Collie and Brunswick Rivers

1.2 Aim of the study

The aim of the study is to

"delineate suitable boundaries in terms of conservation and land use planning values, for proposed conservation and recreational use within the study area".

The boundaries should provide for :

(a) the long term health, conservation, recreation and management of the Collie and Brunswick Rivers,

(b) the adequate provision of foreshore reserves within the Shires of Harvey, Dardanup and the City of Bunbury.

The report contains recommendations to maintain and enhance the public reserves and vacant crown land whilst providing public access where appropriate. Furthermore, the possibilities for future foreshore reserves are examined. In effect, the report will replace the previous ad hoc management planning with a consistent holistic approach to the reserves and the waterway by establishing a **"Waterways Protection Precinct"** for the study area (see

Chapter 3 for further explanation of this concept).

1.3 Vision of the future

The implementation of the aims and recommendations of the study will facilitate considerable improvements in the planning and management of the rivers' foreshore. It will shift the focus of development approvals toward proactive assessment where both the developer and council will have a keener understanding of the rivers' and foreshores' needs. A development proposal which addresses LIMA's concerns will expedite the approval process and minimise the impact on the environment.

> THE STUDY SHOULD SHIFT THE FOCUS OF RELEVANT DEVELOPMENT APPROVALS TOWARD PROACTIVE ASSESSMENT WHERE BOTH THE DEVELOPER AND COUNCIL HAVE A KEENER UNDERSTANDING OF THE RIVERS' AND FORESHORES' NEEDS.

The implementation of the recommendations should allow for the adequate provision of vegetation, wildlife corridors, fauna habitats, protection of floodplains, control of erosion, maintenance of ecosystem function and a continuation of species diversity. Furthermore, the recommendations provide for a linear system of foreshore reserves containing recreation nodes linked by a network of dual use paths. They maintain public access to the foreshore consistent with protection of river environment whilst preserving the unique landscape character of the waterways.

In summary, the study suggests an overall vision of how the rivers will be in the future, a vision which takes into account existing ecosystem and community needs but provides flexibility and opportunity for the future.

1.4 The Committee

A committee was convened to consider a variety of options, provide technical advice and review the direction of the study. Complete agreement, particularly at the draft stage, was not essential but the discussion was useful in highlighting the various concerns of the particular agencies.

The Collie and Brunswick Rivers Foreshore Reserves Study Committee consisted of representatives from the

- Department of Conservation and Land Management
- Department of Planning and Urban Development
- Leschenault Inlet Management Authority
- Shire of Dardanup
- Shire of Harvey
- Waterways Commission

Table 1 outlines the primary concerns raised by each of the agencies.

Table 1. Committee Members' Primary Concerns

AGENCY	ISSUES
CALM	Conservation of Vegetation and Fauna/Wellesley River
DPUD	Draft Bunbury - Wellington Region Plan / Landscape Protection / Implementation
LIMA	Minimum Water Flows To Support Waterway Dependent Ecosystems / Compensating Basin Guidelines / Recreation Nodes / Public Access
Shire of Dardanup	Guidelines for Establishment of Bridges over Waterways.
Shire of Harvey	Acquisition / Vesting / Funding of Management
Waterways Commission	Report Structure/ Content / Implementation

1.5 Public consultation

A draft report and recommendation was released for public comment in June of 1993. During this period seven submissions were received. Comments made in the submissions were carefully considered during preparation of the final document.

Details of the submissions received and the amendments made to the draft document as a result of these submissions are contained in Appendix 1 at the back of this document.

1.6 Land and waterways planning

The Leschenault Inlet Management Authority is only one of a number of other agencies involved with land and waterways planning. Numerous other major land and waterway planning documents provide an overview of the study.

1.6.1 Leschenault Waterways Management Programme 1992

In 1992 the **Leschenault Waterways Management Programme** was prepared by the Waterways Commission. The purpose of the programme is to develop a strategy for the management of the entire Leschenault waterways management area.

This study will represent the first step in implementing general recommendations 2, 4, 10, 13, 37 and 42 of the Leschenault Waterways Management Programme 1992 (WWC, 1992a).

1.6.2 Draft Bunbury - Wellington Region Plan

The Department of Planning and Urban Development released the **Draft Bunbury-Wellington Region Plan**; Regional Open Space Working Paper, in 1992. The document presents the Department's current vision of the future in terms of

(a) the existing and possible CALM estates,

(b) existing parks and recreation,

(c) possible foreshore reserves, and

(d) proposed rural landscape amenity areas.

This information is presented in the context of the present infrastructure, development and natural resources.

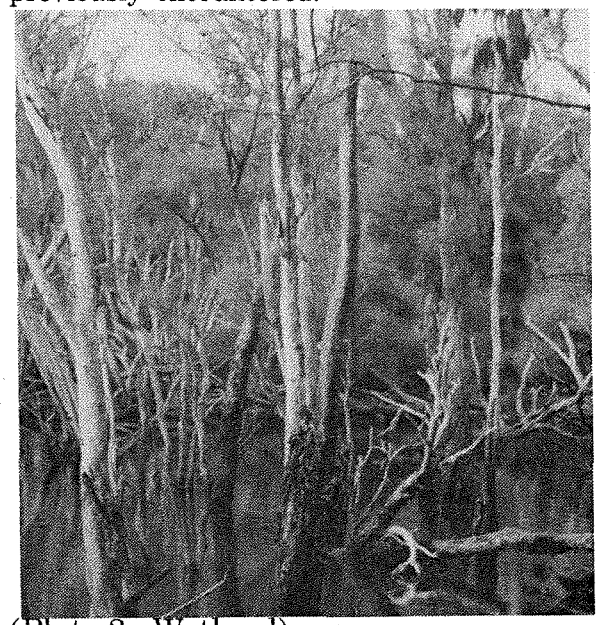
Because of the size of the study area, the plan is only a broad scale planning guide. The results are illustrated as a map drawn at 1:100 000.

With reference to the Regional Open Space Working Paper, it is apparent that the majority of the Collie and Brunswick Rivers' study area is designated as Parks and Recreation (up to the Australind Bypass) with the remainder being proposed for a Rural Landscape Amenity Area.

1.6.3 This study's role

LIMA's Waterways Management Programme 1992 and the Department of Planning and Urban Development Draft Bunbury Wellington Region Plan therefore provide a framework in which this study can examine the issues in a local perspective, incorporating both planning and environmental concerns.

It is the role of this study to provide recommendations for adequate waterways protection based on a detailed environmental assessment of the rivers and foreshores rather than the reactive approach previously encountered.



(Plate 2 : Wetland)

Wetlands provide valuable nesting sites for colonies of Darters

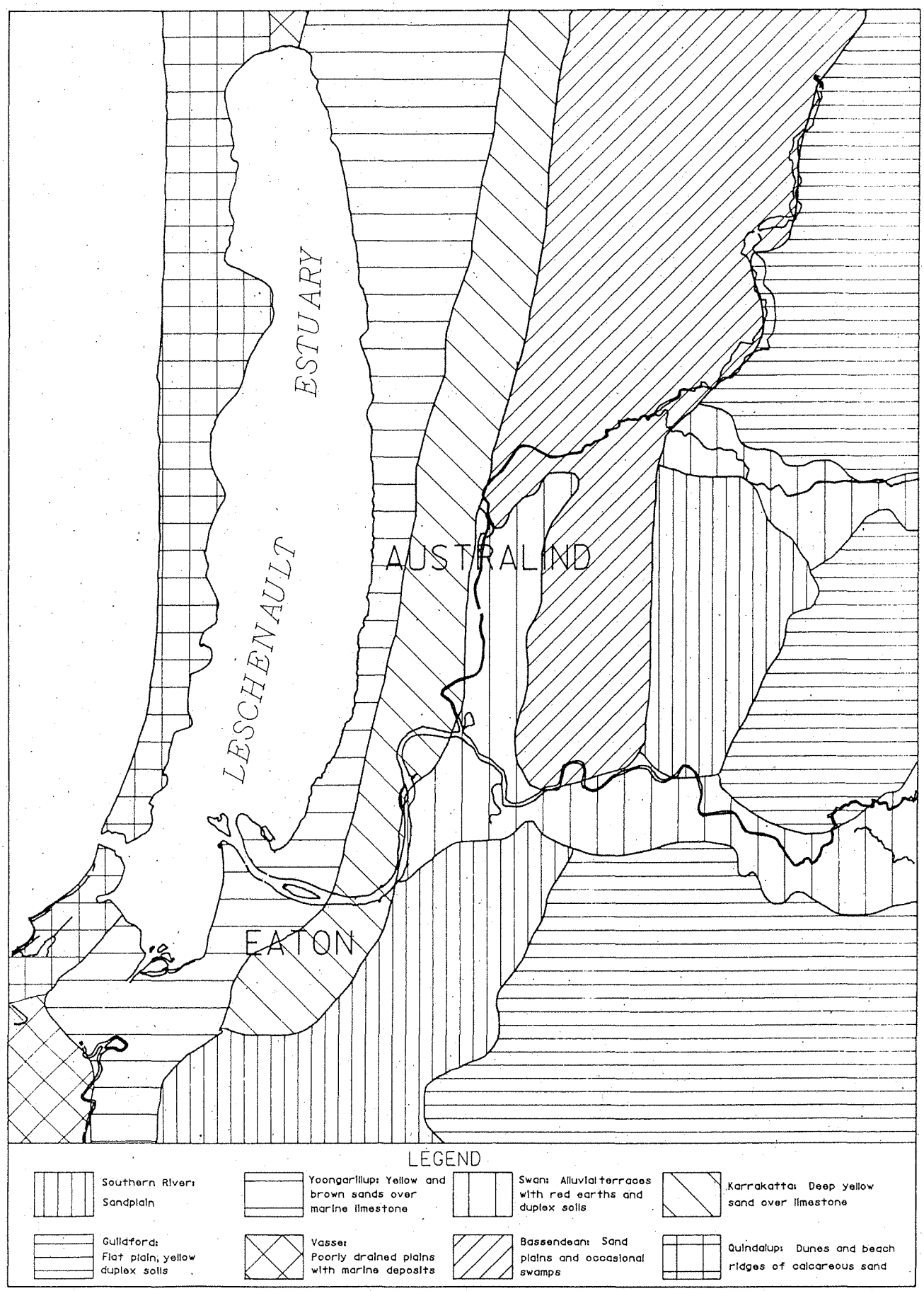


FIG. 2: Landforms and Soils Map (Churchward and McArthur, 1980)

2. Study Area

2.1 Location

The study area is defined by the

(a) Collie River west of the bypass road ($115^0$44'15"E, $33^0$18'00"S) through to the Collie River mouth ($115^0$41'30"E, $33^0$18'00"S).

(b) Brunswick River west of the Wellesley River confluence ($115^0$41'30"E, $33^0$18'00"S). (See Figure 1)

The study area was limited to focus on the issues of current concern, to maximise detail, and due to the lack of resources available. The boundary was chosen by analysing proposed residential expansion (through current literature) and identifying major landmarks to clearly define the extent of the project.

The width of the foreshore under examination is variable (see Chapter 5), depending upon the vegetation complexes present, the topography and the extent of the floodway. For the purposes of this study the maximum width of the study area does not exceed 1 kilometre from the centre line of the river.

2.2 Geology

The soil associations of the region are described in detail by Churchward and McArthur (1980) in the "Atlas of Natural Resources Darling System Western Australia". Eight formations are illustrated in Figure 2 of which five relate directly to the river's landform. The five soils are :

(1) Yoongarillup

(2) Karrakatta

(3) Swan

(4) Bassendean, and

(5) Southern River

The Yoongarillup and Karrakatta formations are derived from the limestone which they overlay. These shallow soils are synonymous with the geographically restricted Tuart (*Eucalyptus gomphocephala*). The Bassendean and Southern River soils are commonly known as the "gutless grey sands" due to their poor phosphorus retention and the general lack of nutrients available to plants grown in them. Finally the Swan formation is typical of a terrace structure with its red earths and duplex soils. The Swan soil tends to be well drained.

2.3 Climate

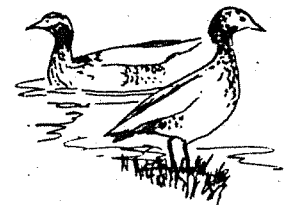
2.3.1 Rainfall

The climate experienced in the vicinity of Bunbury is described as Mediterranean which implies cool, wet winters and hot, dry summers. Rainfall is moderate and falls mainly between May and August. Rainfall is considered moderate at 1000 mm per year (LeProvost Env. Con. 1991).

2.3.2 Winds

The winds during summer are dominated by the easterlies originating from the anti-cyclonic belt (high pressure systems) to the south of Australia and by the south-westerly sea breezes coming in over the hot land. Inland temperatures tend to be hotter during the day as the cool sea breeze often cannot penetrate far in from the coast.

In winter, the westerlies and southerlies predominate as the cyclonic belt (low pressure systems) re-establishes itself over the southern section of Australia.



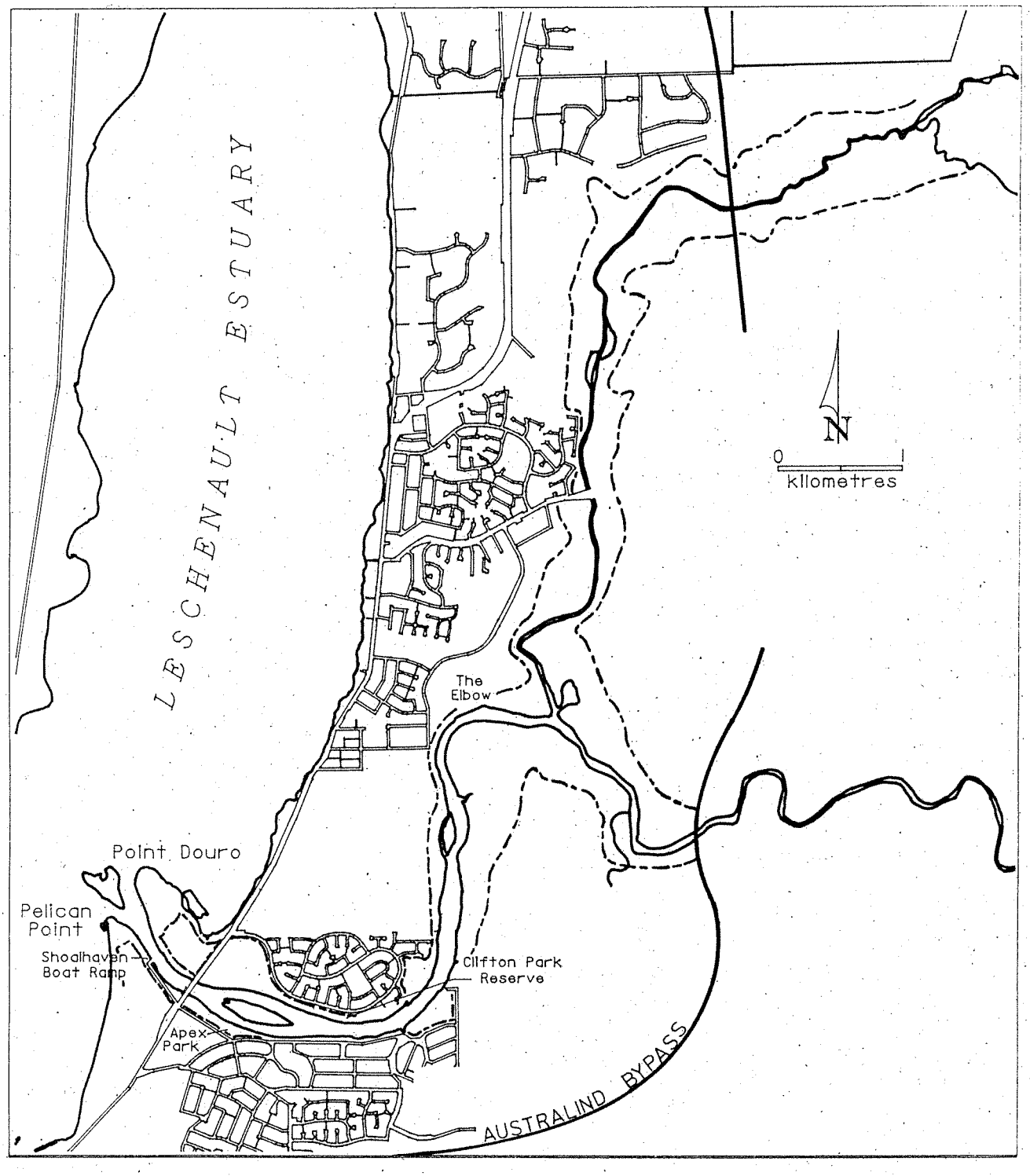


FIG. 3: Waterways Protection Precinct Locality Map

3. Methodology

To achieve the aforementioned aim a series of objectives has been developed. The objectives provide a framework in which the various recommendations of the study have been formulated.

3.1 Objectives

The study makes recommendations to facilitate the following objectives:

- conservation, protection and rehabilitation of the ecosystem, landscape, character and general environment of the abovementioned rivers,
- maximisation of public access and recreational opportunities along the foreshores of the abovementioned rivers in a manner which is sympathetic to the river landscape,
- conservation and protection of rare/or endangered species of flora and fauna within the study area,
- prevention of development or filling which inhibits flood flow,
- implementation of regional and local strategic town planning objectives,
- formulation of alternatives to the acquisition of land adjacent to the waterway within rural areas,
- protection and preservation of sites or buildings of heritage value,
- participation of local government and the community in the landscape planning and management process.

3.2 Waterways Protection Precinct

In order to achieve the preceding objectives, the concept of a "Waterways Protection Precinct" has been developed. A considerable proportion of the land abutting the waterways is in private ownership and is zoned for rural purposes. As the population grows there is increasing pressure to rezone this land. LIMA provides advice to decision making authorities about these changes after considering their likely impact on the waterway. The precinct focuses attention on areas where the protection of waterways and adjacent foreshore margins is of high priority.

Management techniques required to protect fringing vegetation are known, particularly in terms of erosion control. However, it is a function of the precinct to identify areas of waterway at risk from degradation and establish a bank and foreshore revegetation strategy to ameliorate the effects of conflicting land use.

THE WATERWAYS PROTECTION PRECINCT MAY BE DESCRIBED AS THE AREA OF CRITICAL IMPORTANCE IN PROTECTING THE WATERWAYS ECOSYSTEM.

The provision of public access to the foreshore is of major concern in waterways planning; as the population increases there will be a greater demand for foreshore access. To ensure that physical and visual alienation does not occur the precinct can be utilised to identify suitable recreational nodes, connected by linear access corridors (e.g. dual use paths).

Similarly, it will be employed to describe environmentally sensitive wetlands and areas of conservation significance so that public access can be appropriately managed. Accordingly, the **"Waterways Protection Precinct"** may be described as the area of critical importance in protecting the waterways ecosystem. This area includes the waterway and adjoining foreshore which form the waterway environment. The area is highly valued by the community for its aesthetic appeal and high conservation values, as well as for its attraction for tourism and leisure activities. Within the precinct Leschenault Inlet Management Authority will see to limit the extent and nature of environmental change and thus protect this valued asset. .

The limit of the precinct is illustrated by a line. The depth of the Waterways Protection Precinct varies as it is based on a number of factors including the extent and quality of the vegetation, the floodway, the floodfringe, erosion, topography and landscape aesthetics. It also incorporates planning considerations such as existing reserves, public access, recreation needs and miscellaneous constraints and the results of strategic planning reports. Figure 4 overleaf presents the area which is commonly included in the Waterways Protection Precinct.

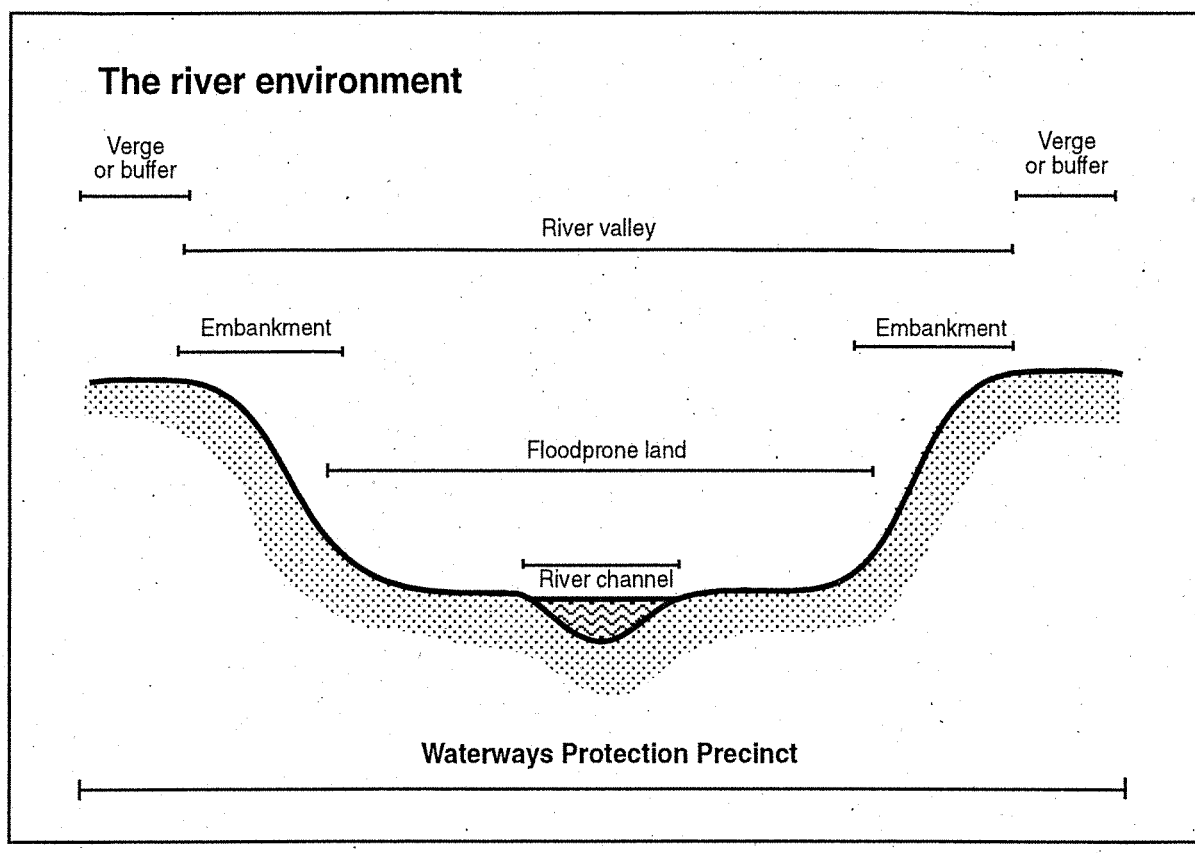
3.3 Determining the Precinct

The table overleaf outlines the various issues that were examined to identify the Waterways Protection Precinct. The table also provides the criteria that are used when determining the boundary of the precinct. In order to determine the exact position of the precinct line it was necessary to undertake specific studies and investigations. This research and justification for the Waterways Protection Precinct is provided in Chapter 4.

Plate 3 : Landscape amenity

The fringing vegetation imparts a unique landscape amenity to the river environment

FIG 4: Diagramatic representation of the Waterways Protection Precinct



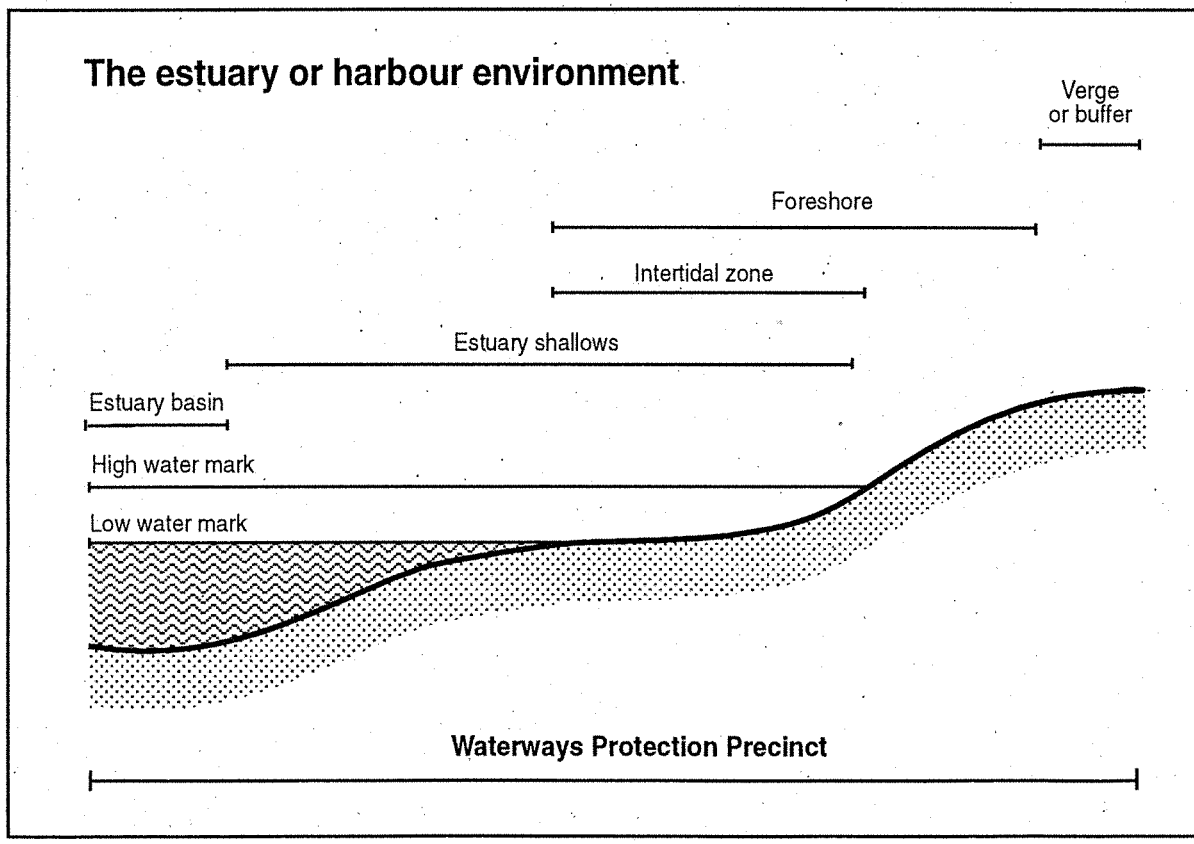


Table 2: Criteria and considerations for identifying a Waterways Protection Precinct

Issue	Importance to waterways functioning	Criteria and considerations for determining the Waterways Protection Precinct (WPP)
Vegetation	Foreshore vegetation is an important element of the waterways environment as it: •provides important food shelter and breeding habitats for wildlife. •filters drainage waters entering a waterway, trapping sediments and taking up nutrients, thus helping the water quality of the waterway. •provides support and stabilisation to the banks and acts to minimise erosion and impede floodwaters. •acts to dissipate the energy of flowing water. As water losses its kinetic energy, it loses its capacity to erode and carry sediment. Different types of vegetation which provide different functions in the waterways ecosystem include: •fringing vegetation containing native understorey are often relics of communities once present along all waterways. The understorey is of primary importance to songbirds, small mammals and reptiles. •salt marshes contribute to estuarine productivity by adding decaying matter to the food chain. •high sandy rise vegetation is significant in preventing mass wasting such as landslides and provides a landscape aesthetic function for the waterway. The mesh of roots and rhizomes of this vegetation tends to keep the river valley and channel securely in place. •woodland areas over pasture impart a unique landscape value and add character to the foreshore area. Aged stands of trees are highly valuable resources for egrets, ibis and kangaroos. In areas where clearing of foreshore vegetation has occurred the process of waterways functioning is disturbed. Regeneration of vegetation in these areas is important as it indicates the establishment of new growth and an ttempt by a waterways ecosystem to regain its previous balance. In many foreshore areas old growth trees are not replaced once they are cleared, succumb to disease or perish of old age. This results in a reduction in foreshore vegetation and a reduction in the diversity and numbers of wildlife which depend on that vegetation. Weed encroachment and the occurrence of frequent bushfires are problems that need to be considered when protecting or rehabilitating foreshore vegetation.	Native vegetation should be retained along a waterway. The WPP should therefore include and protect: •all existing intact remnant vegetation adjacent to waterways. •rare and endangered vegetation species and those vegetation communities which provide habitat for rare and endangered wildlife species. Every attempt should be made to reestablish degraded vegetation adjacent to waterways. The WPP should therefore include and work to reinforce and rehabilitate: •degraded vegetation adjacent to waterways with the potential for regeneration or revegetation. •areas of vegetation which are subject to weed encroachment. •stands of older trees which are not regenerating. In order to protect foreshore vegetation the WPP should also allow for access for weed and fire control.

Issue	Importance to waterways functioning	Criteria and considerations for determining the Waterways Protection Precinct (WPP)
Erosion	Erosion is often part of the natural process of waterways functioning, whereby a waterway changes its course or meander over a number of years. This process is however often accelerated by human activities. Erosion often looks unsightly and results in the undermining of important foreshore vegetation. It can also increase turbidity and result in increased nutrient export to the waterways. It is important to control accelerated erosion, especially in areas where the foreshore between the waterways and adjacent development if narrow. Erosion can be caused by: • natural river processes especially high river flow during times of flood • trampling of banks by livestock, • uncontrolled pedestrian access, • clearing of foreshore vegetation including destruction by fire , • wave action from boat wash, and • vehicle access in foreshore areas. • high water flow experienced during floods.	Waterway banks should be protected from accelerated erosion which may cause a reduction in foreshore area, result in the loss of foreshore vegetation or reduce the aesthetic appeal of the foreshore. The WPP should therefore include and work to protect and rehabilitate •waterway banks which are suffering from erosion •waterway banks which are of high erosion risk and therefore may erode in the future.
Wildlife	Waterways and the land which surrounds them provide important habitats for wildlife. Fringing vegetation in particular provides shelter and food sources for wildlife. The wildlife also contribute to the maintenance of the vegetation by undertaking functions such as pollinating flowering plants, transporting seeds and limiting the spread of competing species through browsing and consuming pests. Varied vegetation produced different habitats and a greater diversity of wildlife. The protection of wildlife corridors is also important. Wildlife corridors provide the following functions: •aid in preventing species in-breeding which results in genetic abnormalities and may result in the eventual demise of a population. •provide movement pathways to similar habitats in times of drought or bushfire without being exposed to predators Feral animals are often observed along the foreshores of waterways as they are attracted by the abundance of water, food and shelter. Many species of native wildlife have their populations severely reduced through predation and competition for food and other resources. Preservation of native habitats assists in protecting native fauna from feral predation. Feral animals such as the introduce cat (*Felis cattus*) can become more prominent in waterway ecosystems with the establishment of residential areas adjacent to waterways. Establishment of buffers on development may minimise this encroachment.	Wildlife habitats should be protected along waterways. Native vegetation along waterways provide these habitats. Wildlife corridors should also be protected. The WPP should therefore include and protect: •all native vegetation adjacent to waterways (Refer to criteria for vegetation). •wetland areas adjacent to waterways. •corridors of native vegetation which link waterways ecosystems with other similar habitats. •vegetation which support rare and endangered fauna species. Buffers should be maintained between wildlife habitats and adjacent development to reduce the invasion of feral animals The WPP should therefore include an area of land which separates foreshore vegetation from adjacent development. The wider this area the greater the level of protection.

Mosquitoes	Mosquitoes create considerable nuisance to visitors and residents in the vicinity of waterways. In addition, they are known to be the primary carrier (vector) of the Ross River virus. Generally there is a high correlation between the level of disturbance to a waterway and its associated foreshores and the intensity of mosquito breeding (Chester and Klemm 1990). Maintenance of the waterways ecosystem and in particular foreshore vegetation, in as near to natural state reduces the chances of increased mosquito breeding by: • maintaining habitat for fauna which prey on mosquitoes, and • screening and filtering adult mosquitoes from leaving their breeding sites	Vegetation should be retained along waterways to provide habitat for fauna which prey on mosquitoes and to screen and filter adult mosquitoes from leaving their breeding sites. The WPP should therefore include and protect all native vegetation adjacent to waterways (Refer to criteria for vegetation). To reduce the risk of mosquito nuisance there should be minimal disturbance to the waterway ecosystem.
Flood prone land	Low lying areas adjacent to waterways are often subject to flooding. Natural ecosystems which are adapted to the process of flooding exist in these areas. These ecosystems are valuable to the natural functioning of the waterways ecosystem. Flood prone land and the ecosystems which exist on it provides the following functions: • channel fast moving flood waters and provide a storage area for flood waters. • provide an interface between the aquatic and the terrestrial environments. • play a part in trapping nutrients and other pollutants coming from the catchment. • stabilise the waterway edges and provide important wildlife habitat. Changes to the natural landform of floodprone land by filling or through development can alter the natural process of flooding. Inundation of areas which do not usually experience flooding and consequent damage to proprety may result. Development of this land can also disrupt the natural ecosystem by clearing vegetation, loss of fauna habitat and increased pollution of waterways.	Floodprone land along waterways should be protected in order to maintain the natural process of flooding and the ecosystems which exist on it. Ideally the WPP should include and work to protect all flood prone land adjacent to waterways. In cases where the flood plains extend for many kilometres back from the waterway channel, consideration of the importance of this land to the maintenance of the waterways ecosystem must be taken into account. In some areas where floodprone land is already highly developed this will also need to be taken into account when locating the WPP.

Issue	Importance to waterways functioning	Criteria and considerations for determining the Waterways Protection Precinct (WPP)
Greenhouse Effect	Future climatic changes have been forecast as a result of the Greenhouse Effect. It is predicted that the average annual temperatures in southern Australia may be 4-5°C higher than at present and the south will probably have less rainfall. In terms of foreshore management, the implications for vegetation must be taken into consideration, with more salt tolerant varieties becoming predominant and possibly a movement toward more drought tolerant species. Furthermore, the foreshore should be wide enough to account for predicted sea level rises and higher rates of erosion from increased storm frequency. Sea level rises would not only reduce foreshore width by inundation but the associated rise in groundwater would affect drainage and effluent disposal by reducing the depth of the soil to filter nutrients and pathogens (WWC 1992).	The Greenhouse Effect should be taken into account when attempting to protect and maintain waterways ecosystems. The WPP should therefore include and protect additional foreshore areas and the ecosystems they support to provide for changes that may occur from the Greenhouse effect.
Water requirements	For a waterway to maintain its current level of ecosystem function it requires a minimum amount of water. The construction of dams and weirs alters the flow regime and accordingly may have an impact on the hydrological and biological characteristics of a waterway ecosystem. Although quite a number of dams have been established in Western Australia, insufficient research exists to provide any understanding of their effects downstream (Arrowsmith 1992).The issues involved in determining the impacts are complex. The main concerns involved include : • the proposed discharge regime, • the relative position of the next major tributary, • the climate, • the current extent of riverine vegetation and the extent of catchment clearing, • groundwater versus surface run-off,and Groundwater drawdown from excessive bore use is also a consideration for waterways ecosystem function. This may have an effect on the fringing vegetation adjacent to the waterways.	Changes to water regimes may impact on waterways ecosystem functioning. The WPP should therefore be based on current water regimes and requirements and be reviewed should there be changes to the hydrological system. Proposed changes to a hydrological system that may result in adverse impact on the WPP would not be favoured by the Waterways Commission or its Waterways management authorities. Proposals to construct new dams should be subject to environmental assessment in accordance with the Environmental Protection Act. This assessment should consider the need to provide a continued supply of water for ecological purposes.

Water quality	Maintenance of good water quality in a waterways environment is vital to the protection of the waterways ecosystem, especially for protecting flora and fauna, maintenance of aesthetic quality and recreation appeal. Similarly protecting components of the waterways ecosystem such as foreshore vegetation is also important in maintaining water quality. Well vegetated foreshores provide a filtering function for pollutants entering the waterways. Certain landuses adjacent to waterways have the potential to reduce water quality more than others. Upstream pollution sources are also a problem. There are a large range of pollutants which can enter waterway systems and impact on water quality. The main ways pollutants reach the waterways are outlined below: • stormwater runoff from residential and other urban areas. • groundwater flow carrying leachate from septic tanks and sanitary landfill sites. • direct discharge of effluent from industry. • surface and groundwater runoff from industrial areas. • surface and groundwater runoff from agricultural landuses. The level of water quality management required in any waterway will depend on the identified beneficial uses of that waterway. For example the water quality standards required for direct contact recreation are higher than those required for the maintenance of the waterways ecosystem.	The water quality of waterways should be maintained at the highest level possible. Foreshore vegetation plays an important role in reducing pollutants reaching waterways. The WPP should therefore include and protect a vegetation pollutant stripping buffer between waterways and adjacent landuses which could adversely affect water quality particularly housing, parks and recreation, industry and agriculture. When identifying the WPP the identified beneficial uses for the waterway need to be considered. If the beneficial uses require a high level of water quality the vegetation buffer may need to be increased.
Heritage and cultural sites	Heritage and cultural sites are an important component of the waterways environment. Waterways and their foreshores often provide an important link with the past as they were places where Aboriginals often visited to hunt for food and collect water. They were also the focus for European settlement. European archaeological and ethnographic sites are protected under the provisions of the Western Australian heritage Act 1972 -80. Aboriginal archaeological and ethnographic sites are protected under the Aboriginal heritage Act 1972-1980.	Heritage and cultural sites should be protected as part of the waterways environment. The WPP should therefore include and aid in the protection of :all Aboriginal sites and Europeann heritage sites which are located adjacent to a waterway

Issue	Importance to waterways functioning	Criteria and considerations for determining the Waterways Protection Precinct (WPP)
Landscape aesthetics	Waterway environments contain a variety of landscapes both natural and man made. These landscapes often provide a visually appealing backdrop to the waterway, contain places of scientific or historic interest or contain unique or unusual waterway ecosystems. The protection of special and significant views to and from the waterways are also important.	Landscape aesthetics is an important element of the waterways environment. The WWP should therefore include and protect: •special and significant views to and from the waterway •landscape features which are visually appealing •landscape features with historic or scientific significance
Surrounding landuse pressure	Along many waterways pressure exists for development of land,especially for residential purposes. The waterways environment is appealing to people who, in the Australian environment generally wish to live and recreate near water. The waterway environment must therefore be considered as an asset to the development it enhances. At present the major landuse pressure around waterways is for residential subdivision. Residential subdivision and the development which is associated with it can have the following impacts on the waterway environment: •reduce the area of natural vegetation near the waterways. •increased demand for public access to foreshore areas can destroy valuable foreshore vegetation and the wildlife it supports. •pollutants from stormwater runoff and septic tank leachate can reach the waterways and threaten water quality. •domestic animals and weed species can cause damage to flora and fauna communities. •increase the risk of fire. •lighting, noise, and rubbish are also problems.	The impact of surrounding landuses on the waterways environment should be minimised. The WPP should therefore include an adequate buffer between the waterway and adjacent landuse to allow the waterways ecosystem to cope with the added pressure of development. The current and possible future zoning of land adjacent to the waterways should therefore be taken into account when identifying the WPP. The WPP should not be compromised to allow for development to proceed. The WPP should also be regularly reviewed to account for changing landuse pressures.

Reserves	Areas of land adjacent to waterways are often already reserved in public ownership. These reserves can be for a variety of purposes including conservation, recreation and waterway protection. These areas have been reserve because of their importance to maintaining the waterways ecosystem and providing areas for public recreation and access.	Reserves along waterways should be maintained as they have previously been recognised as important to the waterways ecosystem. The WPP should therefore include and protect reserved areas which have already been recognised as important for the waterways ecosystem and the provision of public access and recreation.
Public recreation and access	Generally people want to have access to waterways and their associated foreshores for pleasure and recreation activities. Managing waterways therefore has to balance the community use of the waterway environment with the protection of the natural functioning of the ecosystem. To limit the impact of recreational/access activities on the waterways environment waterways planning and management should adequately cater for the location of nodes where these activities can be undertaken and where appropriate facilities and site development can occur.	Recreation and public access areas are an important element of the waterways environment. The WPP should therefore include provision for areas suitable for public recreation and access. The identification of the extent and location of these areas should take into account the current and proposed zoning of the area and the pressure for development.

4. Specific studies

This chapter details the research used to develop the Waterways Protection Precinct for the Collie and Brunswick Rivers. This information was obtained from a variety of sources :

(a) specific studies undertaken as part of the project

(b) existing reports

(c) on-site investigations

Chapter 5 depicts this information on maps, lists area specific planning considerations and makes recommendations for LIMA when planning, managing and advising on the area.

4.1 Vegetation

In 1992 a comprehensive vegetation survey of the study area was undertaken by Pen (1993). Pen's report describes six major categories of fringing estuarine vegetation. These include :

(1) Saltmarsh

(2) Fringing vegetation

(3) Estuarine vegetation forest

(4) Freshwater (riverine) fringing forest and sandy rise vegetation

(5) Sandy rise vegetation

(6) Other plant communities and vegetation types

These groups are further classified into their constituent complexes and ultimately the particular species in each are defined.

The Waterways Protection Precinct has been drawn to include the fringing vegetation within the study area ensuring that all components are included. For this study a simplified version of Pen's categories has been adopted. Five plant complexes are illustrated on the maps in Chapter 5 and listed below:

(1) Saltmarsh

(2) Fringing vegetation

(3) Fringing vegetation (including forest) with intact native understorey

(4) High sandy rise

(5) Woodlands

4.2 Tree regeneration

Tree regeneration is occurring within the study area and is detailed in Pen (1993). The most marked regrowth has been noted along the Brunswick River where seedlings and saplings have been observed. The species primarily recovering in numbers are *Melaleuca rhaphiophylla* (Swamp Paperbark) on boggy pasture and *Eucalyptus rudis* (Flooded Gums) within the floodplain. The latter is displaying considerable regeneration where large numbers of seedlings have established dense stands of young trees (Pen 1993).

4.3 Erosion

The Waterways Protection Precinct has been drawn to account for these areas, which are illustrated in Figure 5. Sites of severe erosion within the study area are to be found between Point Latour and Snake Island, where four wheel drive vehicles, trailbikes, human trampling and frequent fires have thinned out the vegetation (Pen 1993). The steep slopes combined with the location on the power curve of the river have resulted in considerable loss of soil along the foreshore.

Another site is located 500 metres west of the Australind Bypass on the Collie River where extensive clearing and the use of the waterway as a de facto cattle fence has resulted in the degradation of the fringing vegetation and the trampling of the banks by livestock. Undermining of the remaining trees by the fast flowing waters in the power curve of the river has eroded and undercut the exposed foreshore (Pen 1993).

The Waterways Protection Precinct has been drawn to allow for natural erosion processes. Recommendations for erosion control are included in Chapter 5.

4.4 Revegetation

Revegetation is critical in restoring waterway buffers on areas previously cleared for farming. A guide outlining suitable species for replanting is contained within (Pen 1993).

Particular care should be taken when revegetating the floodway to avoid replanting with small trees and shrubs. Dense undergrowth would inhibit the fast flowing floodwaters of the floodway in much the same manner as artificial structures do. Establishing trees of a minimum height of 3 metres would negate such problems.

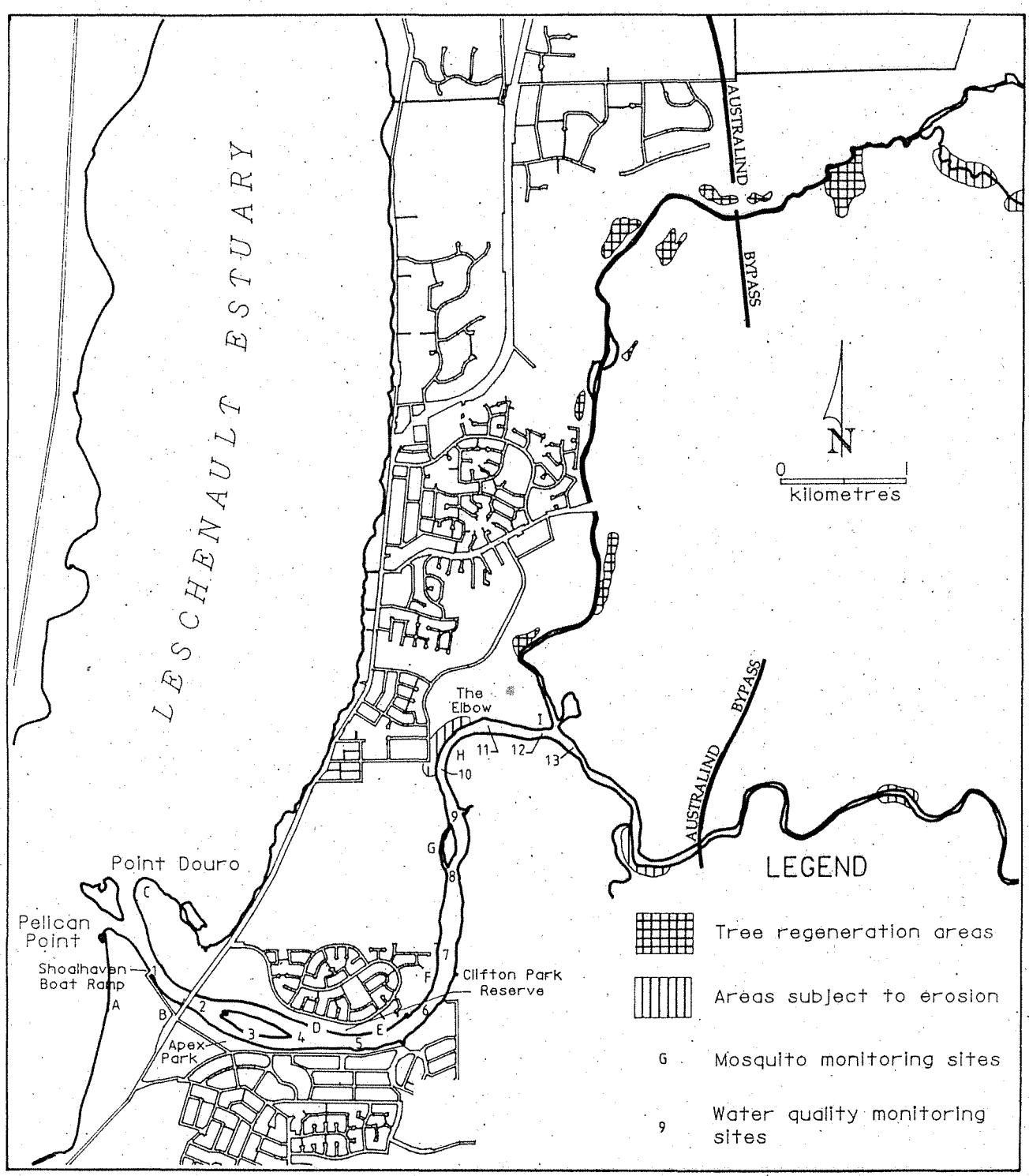


FIG. 5: Monitoring Map

The Waterways Protection Precinct recognises that cosiderable revegetation of the foreshore is required at particular sites, therefore the WPP line has been drawn to allow for future enrichment planting of foreshore reserves.

4.5 Fauna

There have been no recognised fauna surveys of the study area. In order to achieve some understanding of the species which may be present and consequently attribute a conservation value to the foreshore habitat based on its significance to the existing fauna, a comparison has been made with the Kemerton area.

A number of fauna surveys of the Kemerton region were made for the environmental assessment of the proposed industrial development. This study compared the vegetation complexes at Kemerton and within the Collie and Brunswick Rivers study area to determine the types of species possibly found along the foreshore and in the associated wetlands.

4.5.1 Birds

In 1985, Ninox Wildlife Consultants undertook a vertebrate fauna survey of Kemerton. Of the six quadrats observed, the site most similar to that of the Collie and Brunswick River environments was FQ 6. The site, classified as a drainage line, contained open woodland of *Eucalyptus rudis* to dense low forest of *Melaleuca priessiana* (Moonah Paperbark) and *Acacia saligna* (Coojong).

As a result FQ 6 supports a preponderance of species adapted to deeper water including *Pelicanus conspicillatus* (Australian Pelican), *Phalacrocorax sulcirostris* (Little Black Cormorant), *P. varius* (Pied Cormorant) and *Biziura lobata* (Musk Duck). *Anhinga melanogaster* (Darter) and *Cygnus atratus* (Black Swan) were observed breeding (Ninox Wildlife Consulting 1985).

A. melanogaster are commonly associated with estuaries and rivers where they mainly feed on fish such as yellow-eyed mullet, whiting and cobbler. They are known to utilise the lower reaches of the Collie and Preston Rivers for foraging (Bamford & Watkins 1983).

Melaleuca swamp is known to provide roosting sites for *Threskiornis aethiopicus* (Sacred Ibis) and *T. spinicollis* (Straw-necked Ibis). A number of such swamps are located adjacent to the Collie and Brunswick Rivers. These species tend to feed on moist grasslands (damplands) such as paddocks and on flooded areas including floodplains (Bamford & Watkins 1983).

Similarly, *Nycticorax caledonicus* (Rufous Night Heron), a nocturnal bird, forages on the edge of the swamps and favours roosting in trees lining the banks of rivers (Bamford & Watkins 1983).

Of the above species , none are gazetted as "rare, or otherwise in need of special protection" (Ninox 1985). However, bird populations that nest in a limited number of colonies such as the *A. melanogaster* (Darter), *Threskiornis* spp. (Ibis) and *Egretta alba* (Egret) are those most susceptible to changes in land use. The *Melaleuca* and *Eucalyptus* lined banks of the Collie, Brunswick and Wellesley Rivers provide breeding habitat for a limited variety of waterbirds such as tree nesting ducks and Herons (Bamford & Watkins 1983).

The maintenance of the current variety of habitats is therefore essential to prevent significant changes in the bird populations that are reliant on the Collie and Brunswick rivers.

The Waterways Protection Precinct has been drawn to protect the habitats of the above birds, particularly to prevent the loss of *Melaleuca priessiana* and *Eucalyptus rudis* communities.

4.5.2 Amphibians and reptiles

Amphibians are often good indicators of an ecosystem's health. They exist partly on land and partly in water and therefore are very susceptible to changes in their environment. Again, there have been no direct studies undertaken along the Collie and Brunswick Rivers and therefore inference has to be made from the relevant Kemerton surveys.

Seven species of frogs were identified in the Kemerton region. The two tree fogs (*Littoria*) are the most aquatic species present, *L. adelaidensis* usually occurring in reeds growing in water. *L. moorei* is more common in the reeds and grasses of the swamp regions, such as the wetland areas adjacent to the Collie and Brunswick Rivers (Bamford & Watkins 1983).

All seven species identified are widely distributed on the coastal plain except *Ranidella glauerti* which favours dense grass areas with scattered clumps of reeds and no trees (Bamford &Watkins 1983).

Sixteen species of reptiles were recorded by the Bamford and Watkins (1983) at Kemerton. The skinks (family Scincidae), *Egernia luctuosa* and *Ctenotus labillardieri* were significant as examples of species commonly associated with the Darling Scarp of which populations exist on the coastal plain, probably as a relict of a wetter climatic period. Such populations are scattered and may be associated with Collie and Brunswick river system.

It is the intention of the Waterways Protection Precinct to highlight and conserve these habitats, to maintain species diversity and preserve the amphibians' and reptiles' ecological niches in the wetland ecosystem.

4.5.3 Mammals

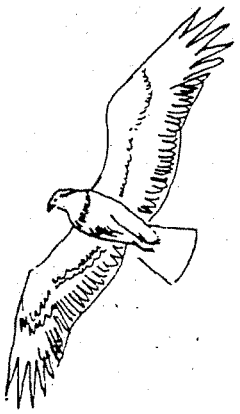
The majority of the mammals identified at the Kemerton site are commonly found along the coastal plain such as *Trichosurus vulpecula* (Brush Tail Possum) and *Isoodon obesulus* (Quenda). However, a number of species of bat have been observed which have a particular association with wetlands and river systems.

Five bat species were described by Bamford & Watkins (1983). These include :

Chalinolobus gouldii	Gould's Wattled Bat
Eptesicus regulus	King River Eptesicus
Nyctophilus geoffroyi	Lesser Long - eared Bat
N. major	Greater Long - eared Bat
Pipestrellis tasmaniensis	Great Pipestrelle

All of the above shelter in tree hollows in species such as *Melaleuca priessiana* and*Eucalyptus rudis*. These readily are common along the fringes of the Collie and Brunswick Rivers and may support populations of the above bat species. The Waterways Protection Precinct identifies these habitats and recommends rehabilitation if they are in a degraded condition.

Bat species of the genus *Nyctophilus* may be considered rare, but not enough is known to determine how rare particular species of the genus are (Nichols 1980).



4.5.4 Mosquitoes

In 1984 the Mosquito Control Review Committee was established by the Waterways Commission to respond to nuisance and potential health problems caused by mosquitoes (Chester & Klemm 1990). A survey of mosquitoes in the Bunbury region was undertaken by Wright (1986) which detailed larval breeding and adult biting activities in the Leschenault area. The report concluded that the mosquito nuisance problem in the Bunbury region is mainly caused by *Aedes camptorhynchus* and *Aedes vigilax* which are both carriers of the Ross River Virus. The study identified the saltmarsh habitats such as those found at the Collie River mouth as the most significant breeding sites for these species (Wright 1986).

An epidemic of polyarthritis (Ross River Virus) was experienced in the summer of 1988-89 leading to a considerable injection of funds into the research programme to control mosquito breeding in the Peel and Leschenault regions. The results are described in the Draft Integrated Mosquito Control Strategy for the Leschenault Estuary Region, Western Australia (Chester & Klemm 1990). For the purposes of this study the major breeding sites have been identified and are illustrated in Figure 5. They are listed with their associated breeding intensity rank and prescribed control options in Table 2.

Table 3. Mosquito Monitoring Sites

Wetland Name	Breeding Intensity Rank	Current and /or proposed mosquito control options
Point Douro	High	Spinner channels
Pelican Point	High	Modify tidal flushing. To be viewed as part of development . Current aerial larviciding
West of the Collie Bridge	High	Formalise outlet to Collie River
Clifton Park Collie River	Low	Chemicals as required
East of WAWA pipe	Limited	Low priority
West of Harding St	Low	Investigate top dressing while preserving *Melaleuca* spp. stand.
SCM Backwater	Medium	Limited to backpack spraying
West of Collie/ Brunswick Rivers Confluence	Limited	Low priority

(Chester & Klemm, 1990)

In conclusion, the research suggests that public access to the saltmarshes should be restricted. These wetlands are easily degraded by human interference, which would exacerbate the mosquito problem. The saltmarsh's high conservation value would therefore be more appropriately served by reserving the area for conservation purposes.

The Waterways Protection Precinct was drawn to maximise buffer vegetation to screen adult mosquitoes and to provide a habitat for their predators. It also aims to separate development from known high intensity mosquito breeding areas in an effort to reduce the incidence of mosquito nuisance.

The remainder of breeding sites along the Collie River assigned a low breeding rank do not have many implications for the planning aspects of this study, but the sites must retain their environmental integrity as degradation of the ecosystem may increase mosquito breeding. The Waterways Protection Precinct would limit environmental change, particularly any modification of the areas hydrological regime, to control mosquito breeding

4.6 Water quality

The nutrient condition of the Collie River is considered to be between mesotrophic and eutrophic (Hosja 1992). The Leschenault Inlet Management Authority has monitored a number of moderate to intense phytoplankton blooms in the Collie River. These have been observed during the summer-autumn period. The monitoring sites are illustrated in Figure 5 (WWC 1990).

The peak in biomass of the phytoplankton is commonly associated with the strong stratification of the water column which develops as river flow decreases and the salt wedge moves upstream. The leading edge of a salt wedge is often oxygen deficient resulting in anaerobic conditions on the river bottom. This causes the release of nutrients from the sediments to the water column which in turn feeds phytoplankton blooms.

The cell concentrations are commonly a reddish brown colour which indicates the presence of dinoflagellates. The pattern and intensity are similar to those blooms experienced in the Swan and Murray Rivers (WWC 1990).

Water quality data highlight the need for adequate, well vegetated foreshore reserves to filter nutrients from the system before they enter the river. Furthermore, deterioration in water quality often has an adverse effect on recreation. The Department of Conservation and Environment Bulletin 103 (1981) contains water quality criteria for marine and estuarine recreation. Before swimming, people should ensure that the water quality is adequate. A secchi disc should be visible to a depth of 2 metres; which in terms of the

Collie River generally means that the bottom should be seen. Also the water should be free from materials which will produce odour, colour or turbidity.

ADEQUATE, WELL VEGETATED FORESHORE RESERVES FILTER NUTRIENTS BEFORE THEY ENTER THE SYSTEM.

In conclusion, the Collie River is quite suitable for direct contact recreation except in the presence of phytoplankton blooms. Correct catchment management practice and adequate, well vegetated foreshore reserves would ensure that suitable water quality is maintained, consequently the ecosystem would remain in balance and the associated recreational and conservation value of the river would not decline.

The Waterways Protection Precinct was drawn to conserve the buffer vegetation as a filter system for nutrients and sediments. It also emphasises an area where any proposed changes to the hydrological regime must undergo special consideration.

(Plate 4 : Land use pressure)

Privately owned rural land commonly abuts the river.

4.7 Existing reserves

A number of foreshore reserves currently exist along the Collie and Brunswick Rivers. Most of these are vested in the local authorities for recreation purposes. The remainder (except 8118) are unvested. Currently, no reserves are vested for conservation purposes. Table 3 outlines the existing reserves, their purpose and vesting.

Table 4. Existing Reserves, Purpose and Vesting

RESERVE	PURPOSE	VESTING
26858	recreation	Harvey
32868	recreation	N.V.
24359	recreation	Dardanup
25417	recreation	Dardanup
31576	recreation	Harvey
31166	-	-
33247	recreation	N.V.
32214	recreation	N.V.
32213	-	-
8025	recreation	Harvey
8118	stopping place	Harvey
39922	recreation	Harvey
40020	recreation	Harvey
39864	recreation	Harvey

(WWC 1988)

Vacant Crown land also exists along the foreshore and is illustrated on the relevant maps.

4.8 Foreshore reserve demarcation

The line of demarcation between reserves and freehold land should be clearly defined to avoid confusion over the location of property boundaries and the extent of management responsibilities. This is most effectively achieved through the appropriate positioning of a minor road and/or by the construction of a dual use path abutting the reserve.

The imposition of a road and/or a dual use path along the reserve boundary assists in :

(a) facilitating public access where it is considered suitable,

(b) precluding boundary disputes,

(c) deterring unauthorised clearing of foreshore reserves,

(c) preventing the establishment of structures and boat launching areas on public land, and

(d) clearly defining the limit of government and landowners' management responsibilities.

The Waterways Protection Precinct therefore includes sufficient room for such a demarcation.

4.9 Existing recreational nodes

The Collie and Brunswick Rivers and their associated foreshores form an integral part of the recreational and tourist resources of the Bunbury region. This importance is reflected in a study by Thurlow (1990) which identifies uses of the area and their recreational pursuits, and outlines the public's attitudes towards current and future management.

The major recreation nodes relevant to this document:

(1) Shoalhaven Boat Ramp

(2) Apex Park (24359) and

(3) The Elbow (Eastwell St Boat Ramp) (33247)

The position of the above sites is illustrated in Figure 5. Other sites which are currently under increasing recreational pressure are the Clifton Park foreshore (Reserve 31576) and Reserve 25417, off Pratt Road.

A management plan has been produced for the Clifton Park Foreshore Reserve, the recommendations from which are detailed in Appendix 2 (WWC 1989).

Apex Park and Shoalhaven Boat Ramp appear to be the most popular recreational nodes. Both contain a toilet block, barbecues and a launching ramp. Apex Park contains further facilities , including a swimming jetty and formalised car and trailer parking. Access to the Collie River bridge can also be gained from Apex Park allowing for crabbing and fishing from the platform beneath the structure (Thurlow 1990).

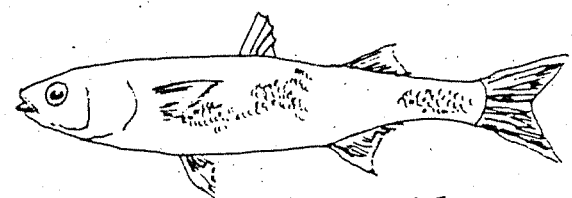
The Elbow has a launching ramp, toilets, barbecues and formalised parking, yet the secluded nature of the reserve means that it is primarily utilised by local residents. Clifton Park is also principally used by the surrounding residents (Thurlow 1990).

The existing recreational nodes may be considered adequate in terms of their respective area. However, considerable concern has been expressed by visitors regarding the provision of further facilities. Comments and observations suggest that upgrading of the boat ramps may be required as well as installation of more barbecues, picnic facilities and formalised car and trailer parking (Thurlow 1990).

Most of these issues have been addressed in the Pelican Point Public Environmental Review which proposes to replace Shoalhaven Boat Ramp with a new ramp, considerably improved parking and changerooms. This is presently only defined in terms of a concept plan, yet if the project were to proceed then the appropriate location of public access and facilities would be formalised by a foreshore management plan for the reserves to be developed and implemented by the proponent (LeProvost Env. Con. 1990).

The Leschenault Inlet Management Authority's vision of an ideal recreation node would be similar to that presently found at The Elbow. The launching ramp and parking facilities would be proportional to the projected use but the reserve would remain aesthetically pleasing. However, additional improvements would include an increased capacity for picnicking and a jetty for mooring and fishing where considered appropriate.

The Waterways Protection Precinct as drawn addresses the need for future recreational nodes by defining adequate space on foreshore land that has limited conservation significance and is adjacent to areas designated by DPUD as urban deferred.



4.10 Heritage and cultural sites

4.10.1 Aboriginal, archaeological and ethnolographic sites

An archaeological and ethnographic site survey was commissioned by LeProvost Environmental Consultants for the Pelican Point, Bunbury Public Environmental Review. It concluded that there were six archaeological sites located within the area but each was considered to be of minor archaeological importance (LeProvost Env. Con. 1990). Other surface artefact scatters have been located in the region of the Collie River defined in the study area but these also are of minor significance (LeProvost Env. Con.1990).

The major archaeological and ethnological sites identified along the Collie River are found above the Wellington Dam and have no direct relevance to this study (Bodney, O'Connor and Quartermaine 1989). However, if a site is discovered, then all development must comply with the provisions of the Western Australian Heritage Act 1972-80.

The Waterways Protection Precinct line is based on current sites but could be expanded to cover new listings as information becomes available.

4.10.2 European historic sites

There are no historic sites within the study area listed or registered with the National Trust (Macey 1992).

4.11 Floodplain

The Water Authority of Western Australia has developed maps which delineate the extent of the floodplain. Data exists for the Brunswick River from the Australind Bypass to its confluence with the Collie River. Similarly maps exist for the Collie River from its confluence with the Brunswick to its mouth at the Leschenault Estuary (George 1992). The floodplain, floodway and floodfringe are described in section 3.3.7.1.

The Waterways Protection Precinct accounts for the floodfringe as lands consistently subject to inundation tend to have high water tables even in terms of normal river flow, which increases the risk of on-site sewerage system failure. Development in many instances removes vegetation cover and increases the rate of stormwater discharge leading to accelerated erosion (Gilpin 1990). The floodplain and its associated vegetation are also used extensively as fauna corridors between similar habitats, particularly in times of drought and bushfires. Foreshore areas subject to inundation contain the most productive ecosystems (see sections 4.1, 4.2 and 4.5).

4.12 Ecosystem water requirements

It is important that some understanding be developed in relation to the processes involved in maintaining an adequate water supply to support natural ecosystems. Insufficient research exists to provide any understanding of the effects of dams on downstream ecosystems and their water requirements (Arrowsmith 1992).

The factors involved in determining the impacts are complexand include :

- the proposed discharge regime,
- the relative position of the next major tributary,
- the climate,
- the current extent of riverine vegetation,
- groundwater versus surface runoff and
- the extent of catchment clearing.

The Waterways Protection Precinct is based on current water regimes and requirements. Any proposal to dam a river should provide evidence that it will not adversely affect the hydrological regime of the ecosystems located downstream of the development.

4.13 Bunbury - Wellington Regional Planning Study

The Department of Planning and Urban Development (DPUD) is undertaking a major planning study to prepare a regional plan for the Bunbury-Wellington region (DPUD 1992).

The aim of the study is to develop a regional plan that provides a framework for land use and social and economic development

consistent with responsible environmental management.

The Bunbury Region Plan was adopted as a Policy Statement in 1987. The Bunbury -Wellington plan includes the City of Bunbury and the Shires of Harvey, Collie, Dardanup, Donnybrook/Balingup and Capel. The Bunbury Region Plan (1987) will be reviewed as part of the Bunbury - Wellington Study.

The main objectives of the study are:

- To provide a comprehensive, general plan for social and economic development and conservation in the Bunbury region.
- To review the Bunbury Region Plan.
- To guide local authority town planning schemes, rural strategies and other local planning and development matters.
- To provide a planning framework within which all local authorities, government agencies and private sector organisations operating in the region may formulate co-ordinated, complementary and co-operative action programmes.
- To provide a rational basis for decision-making, especially on land use matters, and to clarify decision-making processes.
- To address current issues and avoid future problems such as:
    - The growing demand for urban land and housing to accommodate a rapidly growing resident population.
    - Potential conflicts between regional and local transportation needs.
    - Competition for land between agricultural, rural living, industry, forestry, mining, conservation and other uses.
    - Environmental degradation including pressures on sensitive wetlands and the coast.
    - Growing demands for tourist and recreational facilities.
    - The need to provide for new education and employment opportunities.
    - Shortages of community and health facilities in some areas.
    - High costs of public utilities and infrastructure; requiring the allocation of priorities and more efficient use. (DPUD 1992)

The Waterways Protection Precinct reflects the findings of the DPUD report and the line drawn generally conforms to the areas of Regional Open Space depicted in the Bunbury - Wellington Planning Study. Specifically, it is consistent with the extent of the Possible Reserves zone and Rural Landscape Amenity Area designated in the DPUD study.

The Waterways Protection Precinct also plans for urban expansion and its associated problems of increased public usage of local resources. The WPP line has been drawn to account for the needs of an increased population and associated infrastructure such as bridge/utility crossings, drainage and public open space for community recreation rather than conservation purposes (see Appendices 3 and 4)

(Plate 5 : Floodplain)

A considerable amount of land adjacent to the Collie and Brunswick Rivers lies within the floodplain.

5. Waterways Protection Precinct Maps

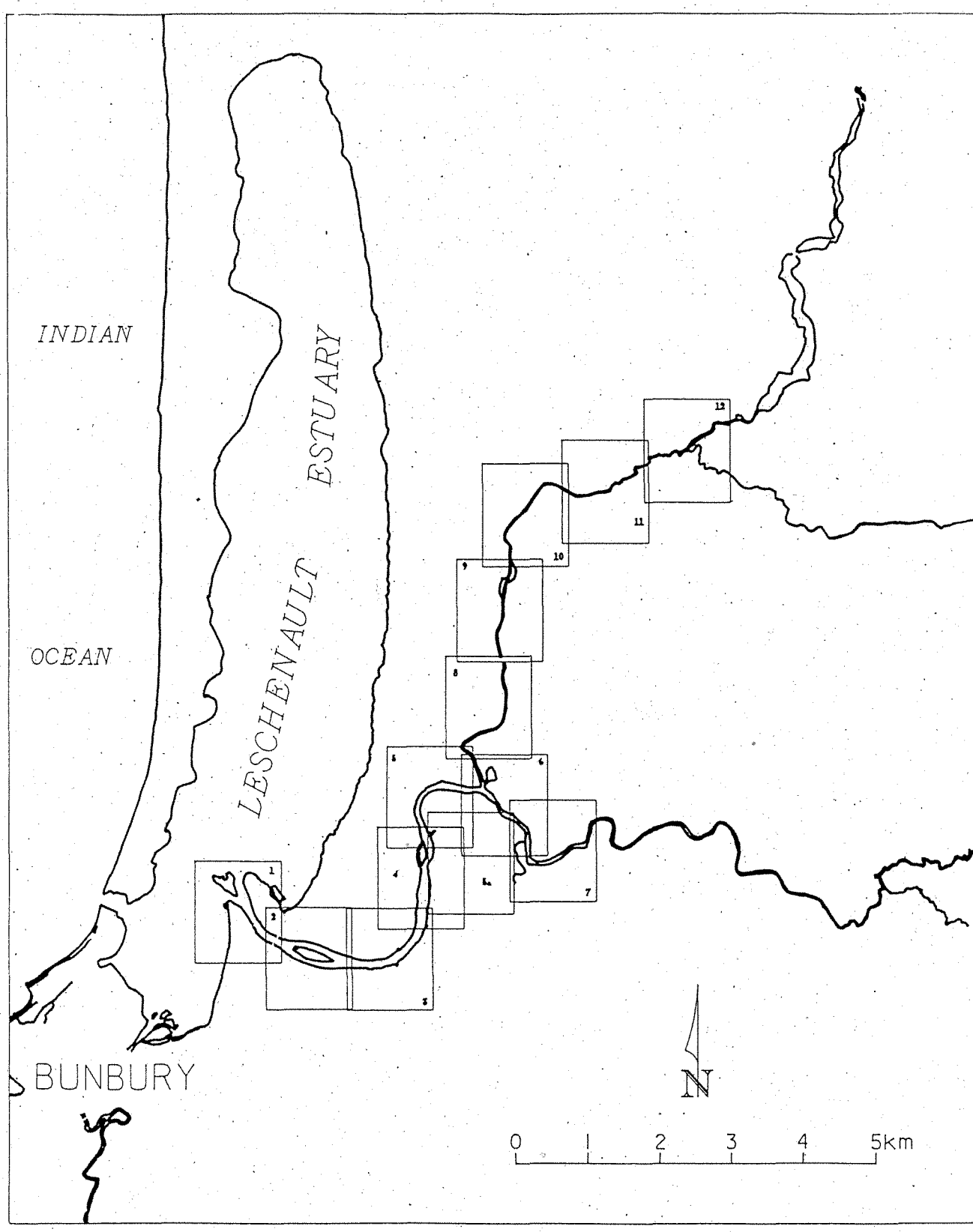


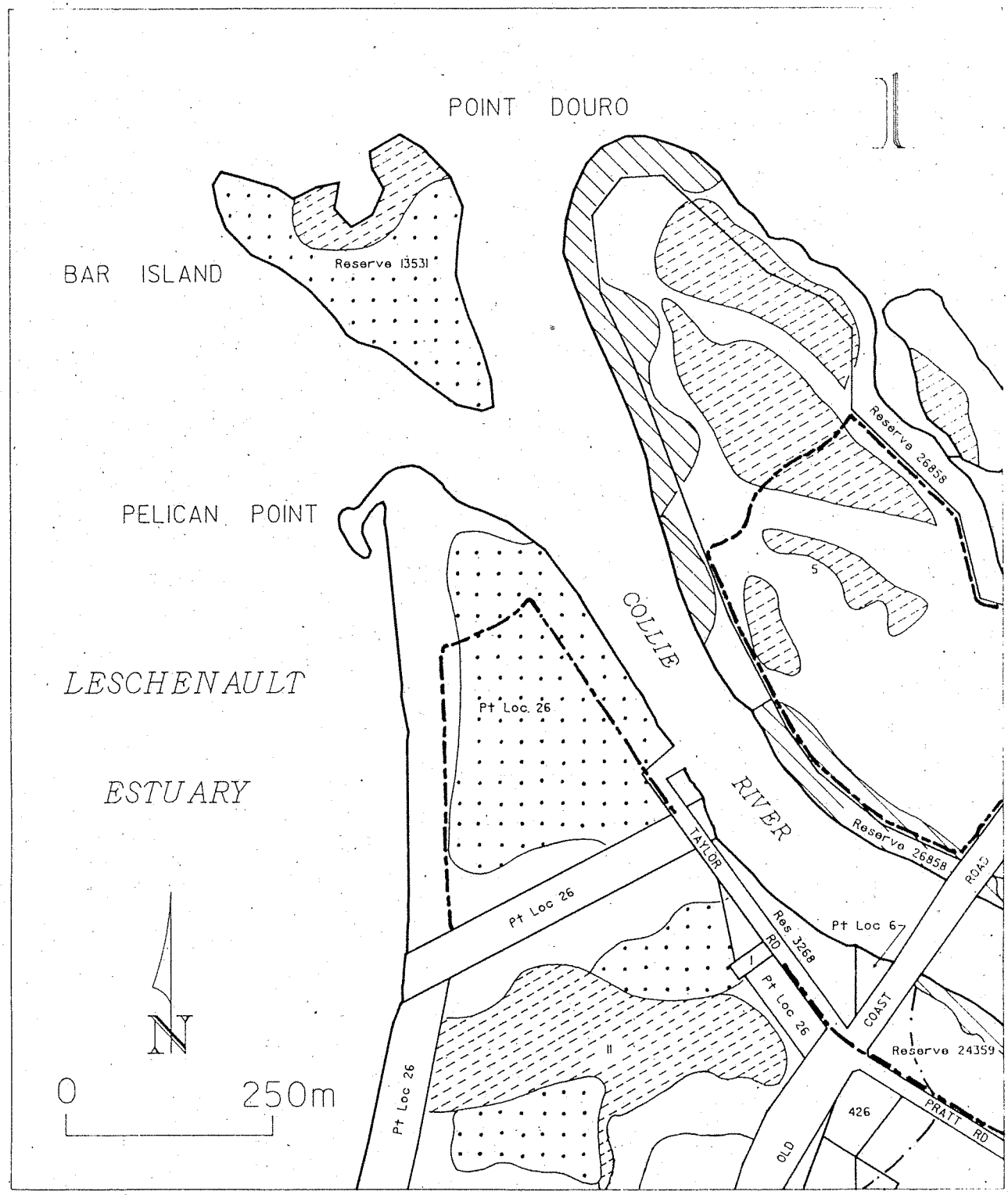
FIG. 6: Index Map

Planning considerations for Map 1

- the Waterways Protection Precinct at Point Douro is in accordance with the development plan approved by the Minister for the Environment, dated 14 September 1989. The illustrated line is subject to the adherence of the developer to the stated Ministerial conditions pursuant to the provisions of the Environmental Protection Act 1986 and the implementation of the Point Douro Management Plan.
- the Waterways Protection Precinct at Pelican Point is in accordance with the development plan approved by the Minister for the Environment, dated 8 September 1992. The illustrated line is subject to the adherence of the developer to the stated Ministerial conditions pursuant to the provisions of the Environmental Protection Act 1986 and the preparation and implementation of a Pelican Point Management Plan.
- saltmarsh
- floodway / floodplain
- reserve 32868 and 26858
- high recreational potential of the area
- valuable conservation area for waterbirds and associated wetland habitat.

Recommedations

1. Support the continued implementation of the Integrated Mosquito Control Strategy for Point Douro and Pelican Point.
2. Create additional public access and recreation areas at Pelican Point, if an alternative development is proposed.

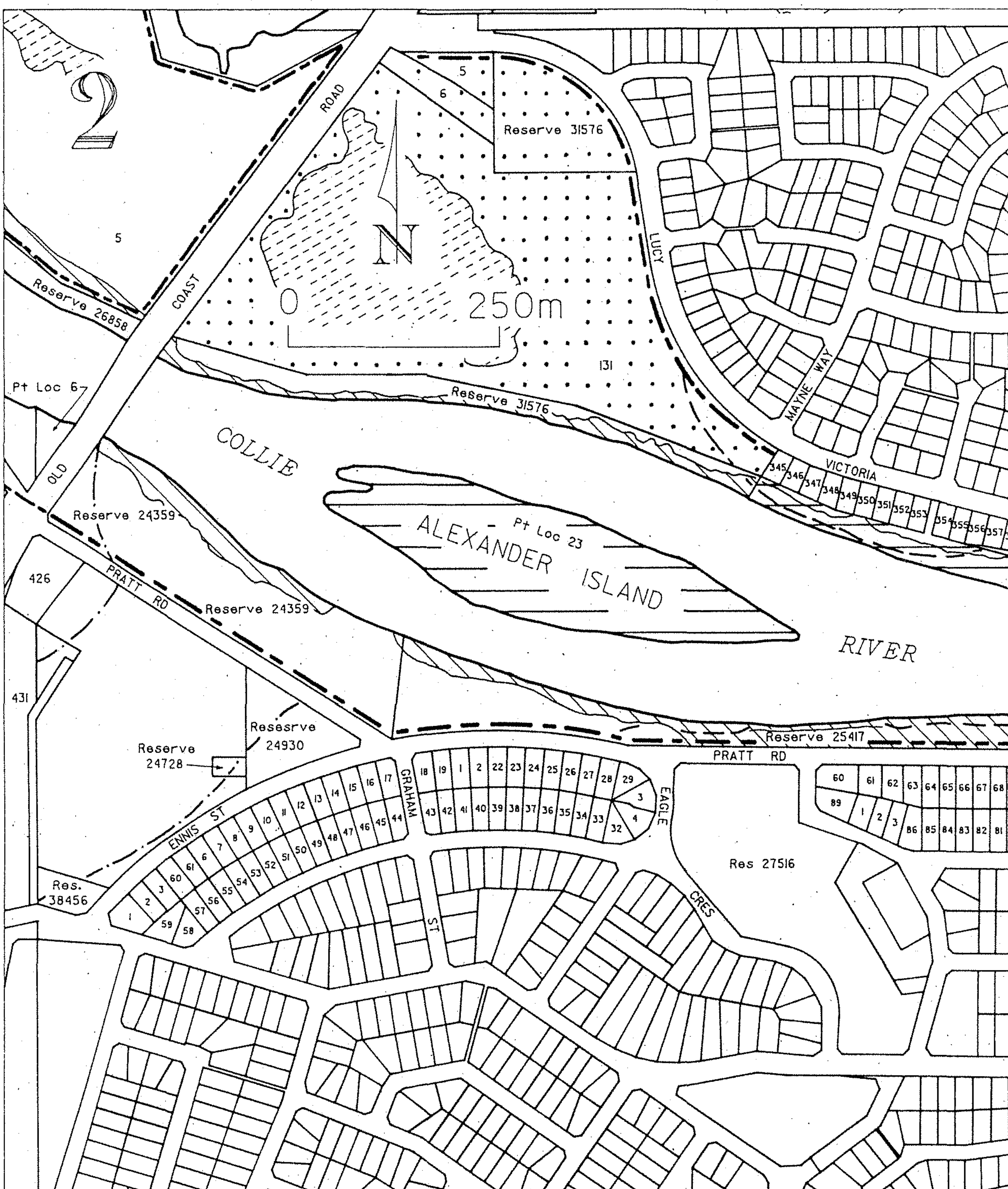

POINT DOURO
BAR ISLAND
Reserve 13531
PELICAN POINT
LESCHENAULT
ESTUARY
COLLIE
RIVER
Reserve 26858
5
Pt Loc 26
Pt Loc 26
TAYLOR
Res 3268
RD
Pt Loc 6
ROAD
Pt Loc 26
COAST
Reserve 24359
Pt Loc 26
426
PRATT RD
OLD
N
0
250m

Planning considerations for Map 2

- existing reserves
- floodway / floodplain
- steep slopes
- peripheral vegetation (incl. forest) with intact understorey
- Clifton Park Reserve as a high use recreation area
- Apex Park as a high impact recreation area and boat launching site
- landscape amenity provided by the combination of the gorge, river and overhanging vegetation

Recommendations

3. Continue implementation of the Clifton Park Management Plan.
4. Endorse appropriation of lot 131 by the South West Development Authority and the establishment of the relevant Joint Management Committee.
5. Rehabilitate wetland on lot 131 as a waterbird habitat and recognise the conservation importance of the area through the development of interpretation facilities and the formalisation of limited public access.

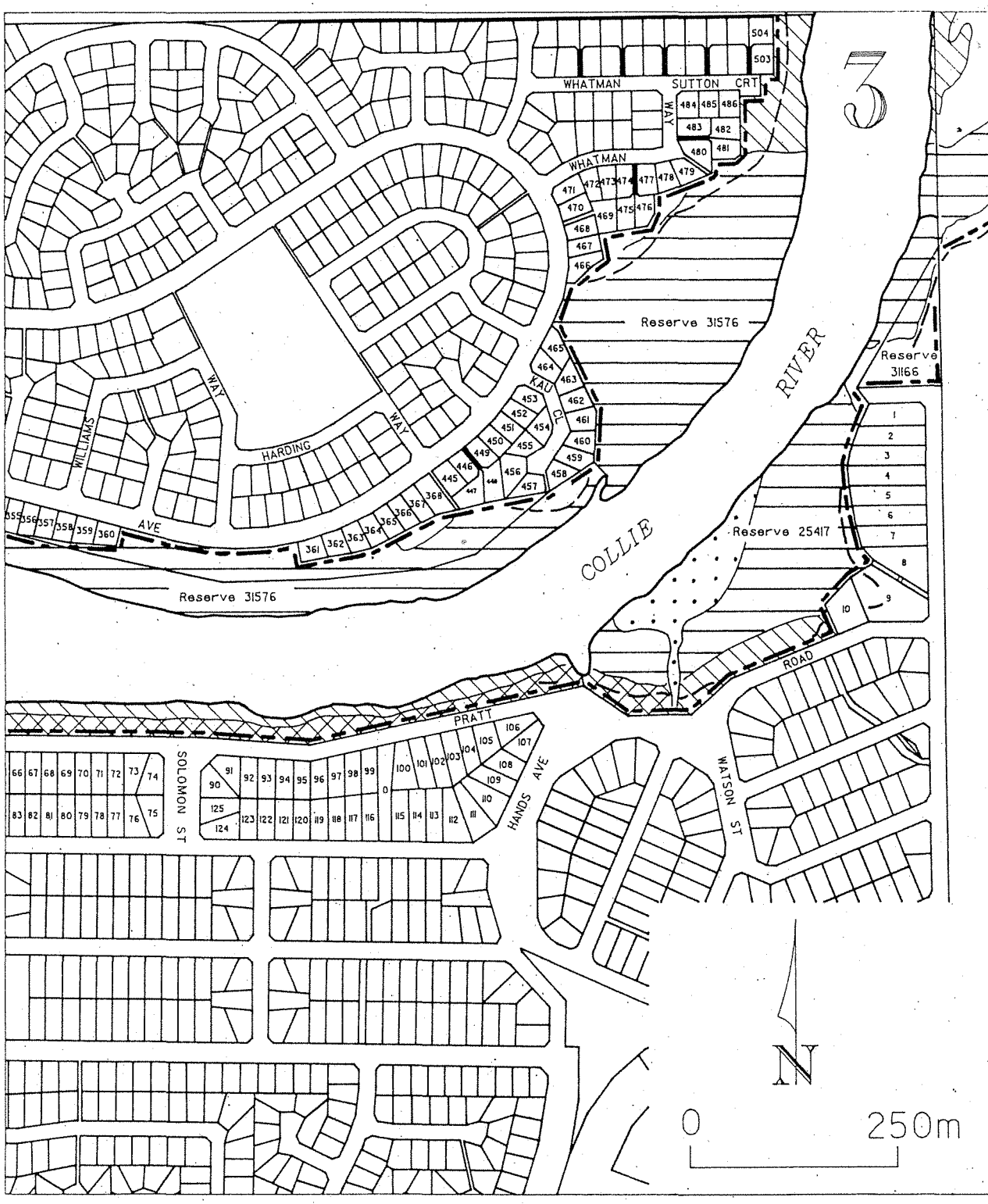

2
5
Reserve 31576
OLD COAST ROAD
N
0 250m
131
Reserve 26858
Pt Loc 6
Reserve 31576
COLLIE
RIVER
Pt Loc 23
ALEXANDER ISLAND
LUCY
MAYNE WAY
VICTORIA
Reserve 24359
Reserve 24359
PRATT RD
426
431
Resesrve 24930
Reserve 24728
Reserve 25417
PRATT RD
ENNIS ST
GRAHAM ST
EAGLE CRES
Res 27516
Res. 38456

Planning considerations for Map 3

- wildlife corridors
- existing reserves
- floodway / floodplain
- steep slopes
- peripheral vegetation (incl. forest) with intact understorey
- Clifton Park Reserve as a high use recreation area
- landscape amenity provided by the combination of the gorge, river and overhanging vegetation

Recommendation

6. Develop a management plan for Pratt Road Reserve (reserve 25417) to formalise the recreational potential of the woodland area whilst recognising the conservation significance of the peripheral vegetation.

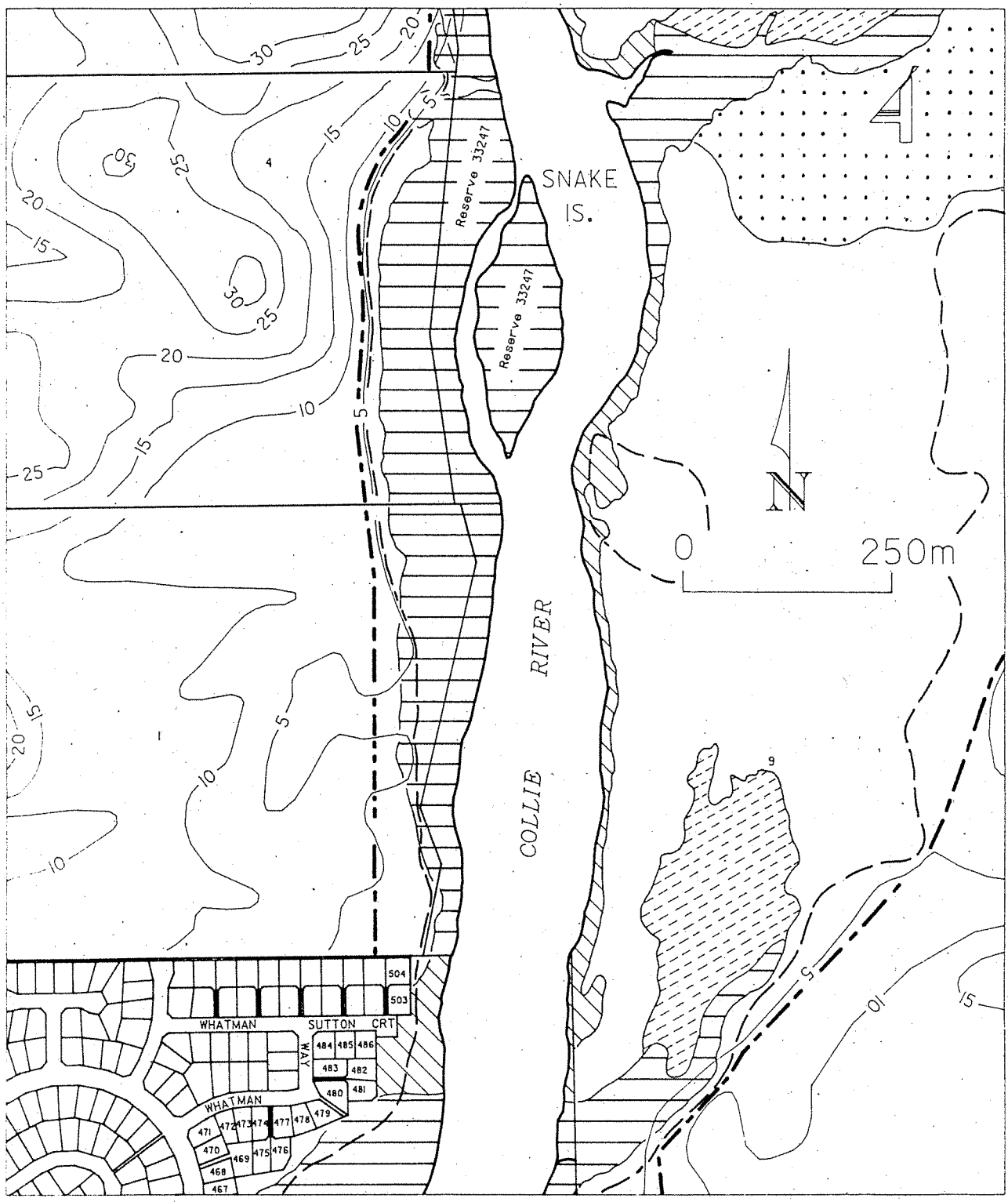

3
WHATMAN WAY
SUTTON CRT
WHATMAN WAY
Reserve 31576
RIVER
COLLIE
Reserve 31166
Reserve 25417
KAU PL
HARDING WAY
WILLIAMS WAY
AVE
Reserve 31576
PRATT
ROAD
SOLOMON ST
HANDS AVE
WATSON ST
N
0
250m

Planning considerations for Map 4

- medium intensity mosquito breeding
- reserve 33247
- 5 metre contour
- a buffer on fringing vegetation on the west bank
- associated wetlands
- a buffer on associated wetland on the east bank
- Eaton Structure Plan
- floodplain
- steep slopes
- peripheral vegetation (incl. forest) with intact understorey
- Clifton Park Reserve as a high use recreation area
- wildlife corridors
- landscape amenity provided by the combination of the gorge, river and overhanging vegetation

Recommendations

7. Rehabilitate and enhance fringing vegetation and associated wetlands.
8. Develop a management plan to control the demand for public access, created by the expansion of the Eaton urban area. Area suitable for low impact recreation and conservation of associated wetlands.
9. Support the continued implementation of the Integrated Mosquito Control Strategy.


SNAKE
IS.
Reserve 33247
Reserve 33247
COLLIE
RIVER
N
0
250m
WHATMAN
SUTTON
CRT
WAY
WHATMAN
504
503
484
485
486
483
482
481
480
479
478
477
476
475
474
473
472
471
470
469
468
467
30
25
20
15
10
5
9

Planning considerations for Map 5

- The Elbow as an important local recreation area
- reserve 33247
- 5 metre / 10 metre contour
- a buffer on fringing vegetation on the west bank
- associated wetlands
- Eaton Structure Plan
- floodplain
- steep slopes
- peripheral vegetation (incl. forest) with intact understorey
- feeding and roosting area for waterbirds
- landscape amenity provided by the combination of the gorge, river and overhanging vegetation
- wildlife corridors
- eastern foreshore requires enrichment planting
- the western bank of the Elbow is suffering from severe erosion

Recommendations

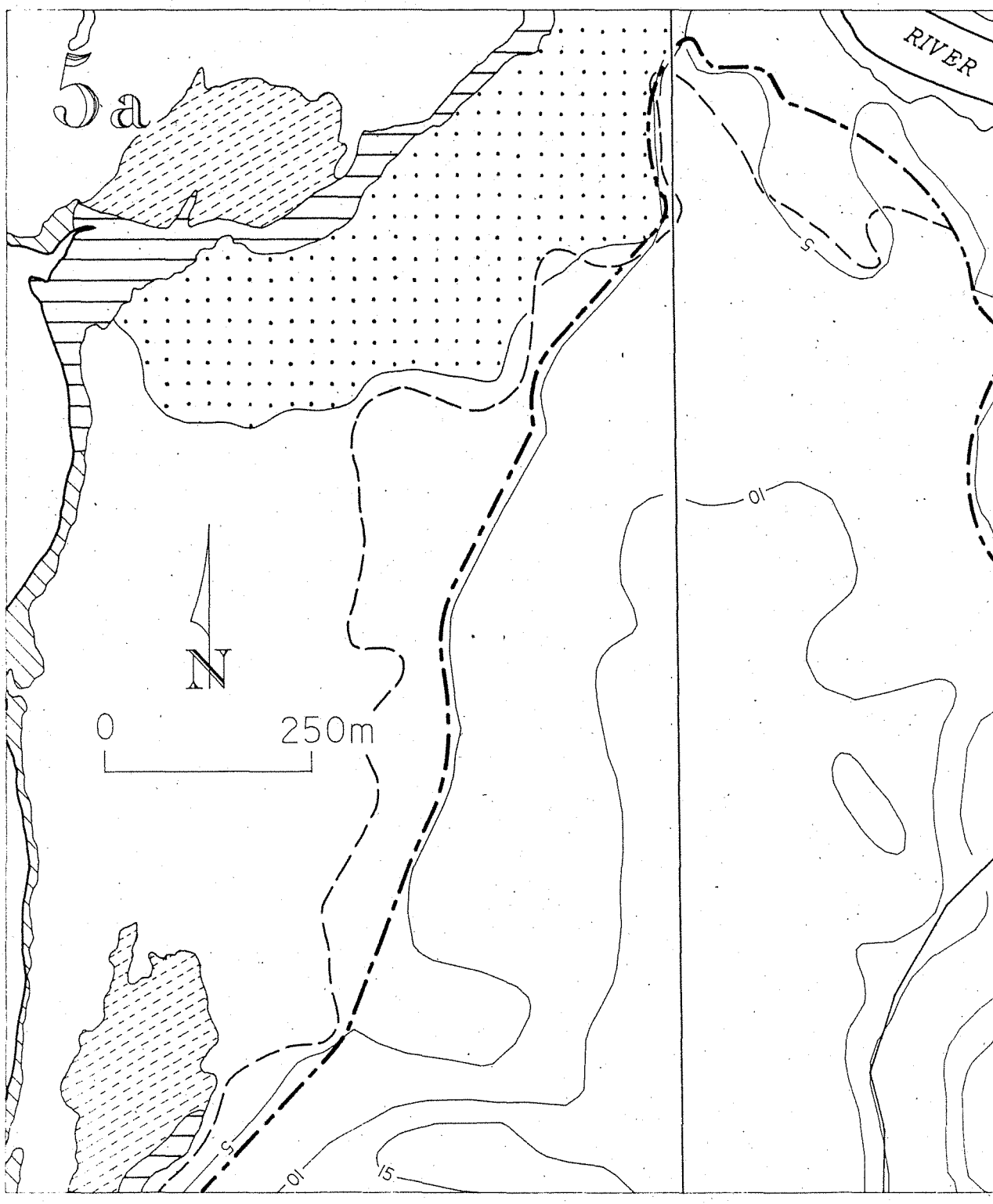
10. Undertake remedial works to control erosion along the Collie River.
11. Rehabilitate and enhance fringing vegetation and associated wetlands.
12. Develop a management plan to control the demand for public access, created by the expansion of the Eaton urban area. Area suitable for low impact recreation and conservation of associated wetlands.
13. Limit foreshore access to within the Elbow recreational reserve to minimise erosion of the surrounding steep western slopes.

Planning considerations for Map 5a

- a buffer on associated wetlands
- feeding and roosting area for waterbirds
- extensive woodlands
- associated wetlands
- Eaton Structure Plan
- lack of public access
- floodplain
- 5 metre contour
- wildlife corridors
- peripheral vegetation (incl. forest) with intact understorey

Recommendation

14. Preserve and enhance wildlife corridors through the development of continuous linear reserves and via strategic enrichment planting.

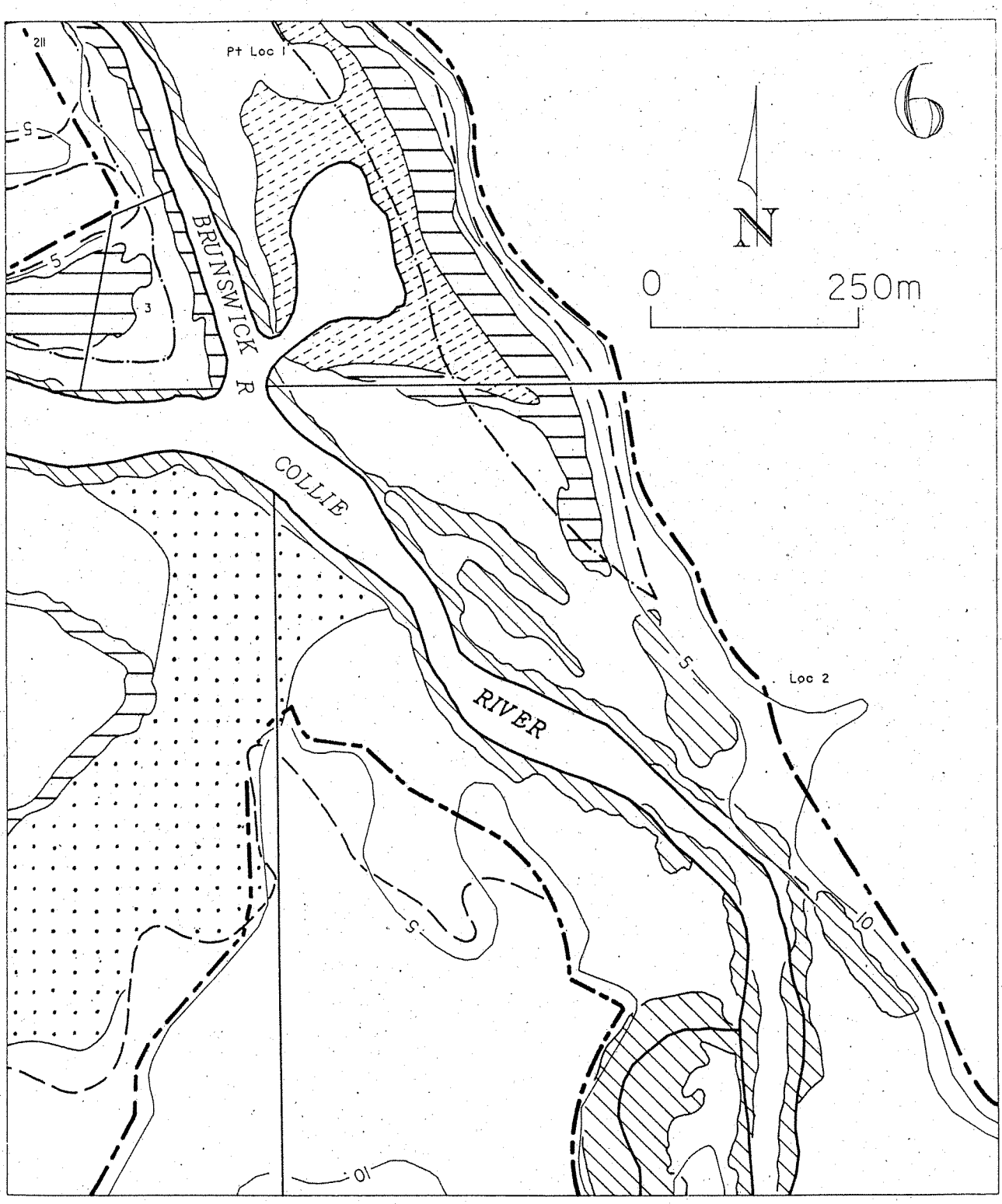

5a
RIVER
5
10
N
0
250m
5
10
15

Planning considerations for Map 6

- a buffer on peripheral vegetation
- feeding and roosting area for waterbirds
- extensive woodlands
- associated wetlands
- Eaton Structure Plan
- floodplain / floodway
- 5 metre / 10 metre contour
- peripheral vegetation (incl. forest) with intact understorey
- confluence of the Brunswick and Collie Rivers
- wildlife corridors
- stream entering Collie River from the south

Recommendations

15. Develop a management plan to control the demand for public access, created by the expansion of the Eaton urban area. Area suitable for low impact recreation and conservation of associated wetlands.
16. Recognise the importance of the foreshore surrounding the confluence of the Collie and Brunswick Rivers as a high quality conservation area.

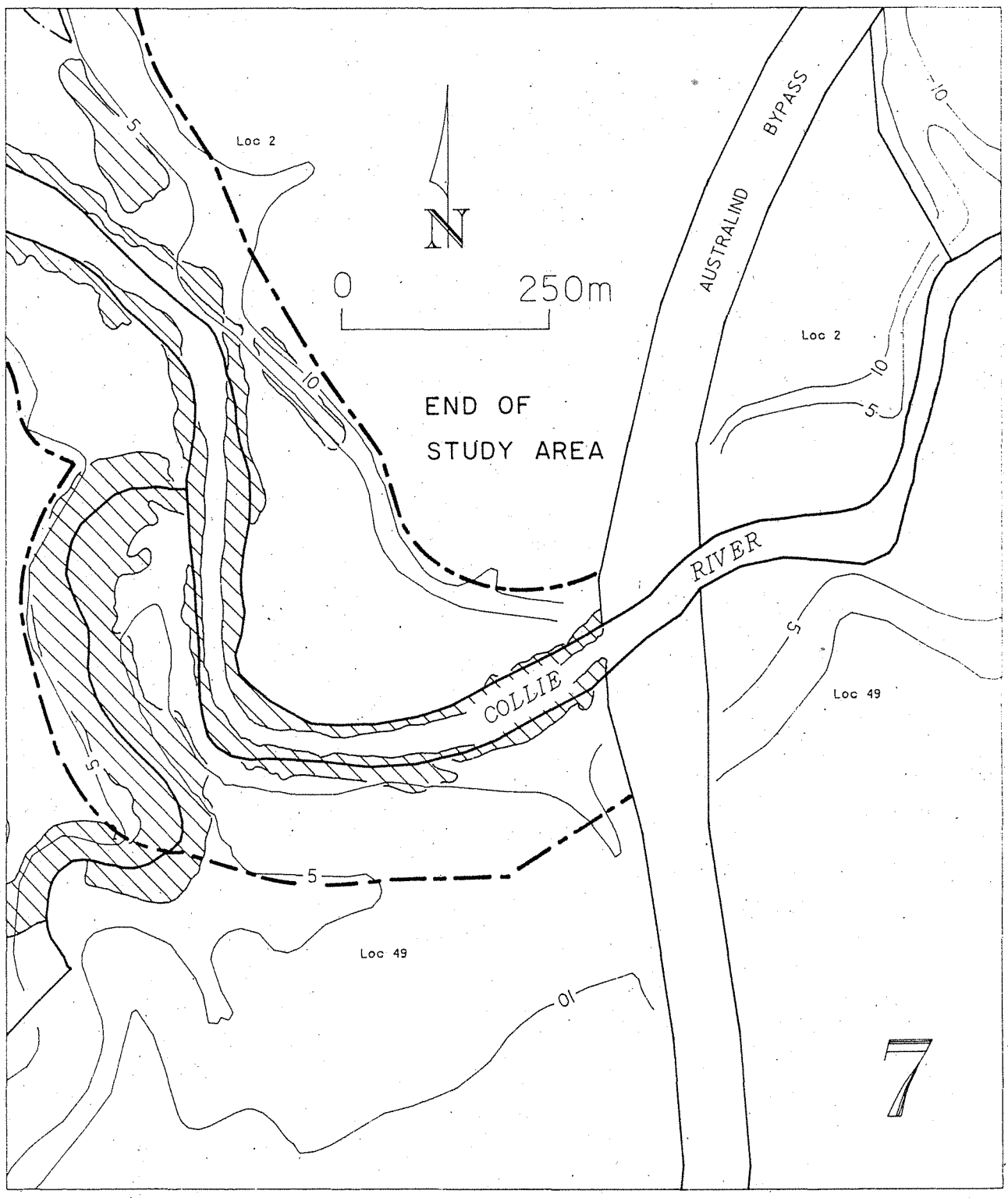

6
N
0
250m
Pt Loc 1
BRUNSWICK R
COLLIE
RIVER
Loc 2
211
5
3
10

Planning considerations for Map 7

- a buffer on peripheral vegetation
- feeding and roosting area for waterbirds
- associated wetlands
- Eaton Structure Plan
- floodplain / floodway
- 5 metre / 10 metre contour
- Australind Bypass
- confluence of the Brunswick and Collie Rivers
- wildlife corridors
- stream entering Collie River from the south
- the southern bank of the Collie River is suffering from severe erosion

Recommendation

17. Preserve stream vegetation as a valued wildlife corridor through the development of linear public open space.

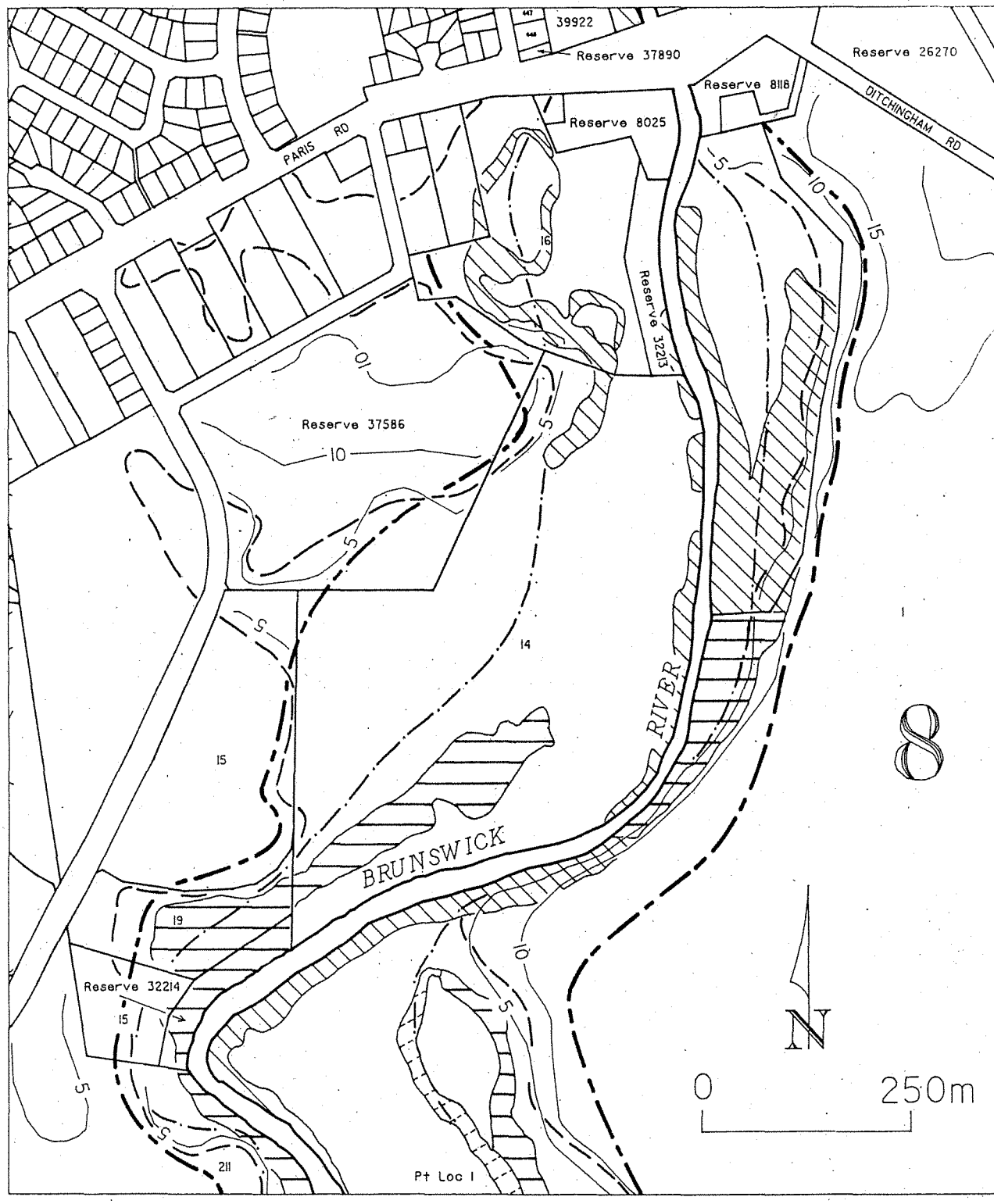

N
0
250m
END OF
STUDY AREA
AUSTRALIND BYPASS
COLLIE RIVER
Loc 2
Loc 2
Loc 49
Loc 49
5
10
5
10
5
5
5
10
7

Planning considerations for Map 8

- area exhibiting tree regeneration
- narrowness of the river
- peripheral vegetation (incl. forest) with intact understorey
- East Australind Structure Plan Stage 2
- Paris Road Bridge
- reserves 32214, 32213, 8118 and 8025
- a buffer on peripheral vegetation
- feeding and roosting area for waterbirds
- associated wetlands
- floodplain / floodway
- 5 metre / 10 metre contour

Recommendations

18. Encourage landowners to restrict stock access to areas exhibiting tree regeneration.
19. Rehabilitate and enhance fringing vegetation and associated wetlands.
20. Develop a management plan to control the demand for public access, created by the establishment of the East Australind urban area. Area suitable for low impact recreation and conservation of associated wetlands.
21. Preserve and enhance wildlife corridors through the development of continuous linear reserves and via strategic enrichment planting.

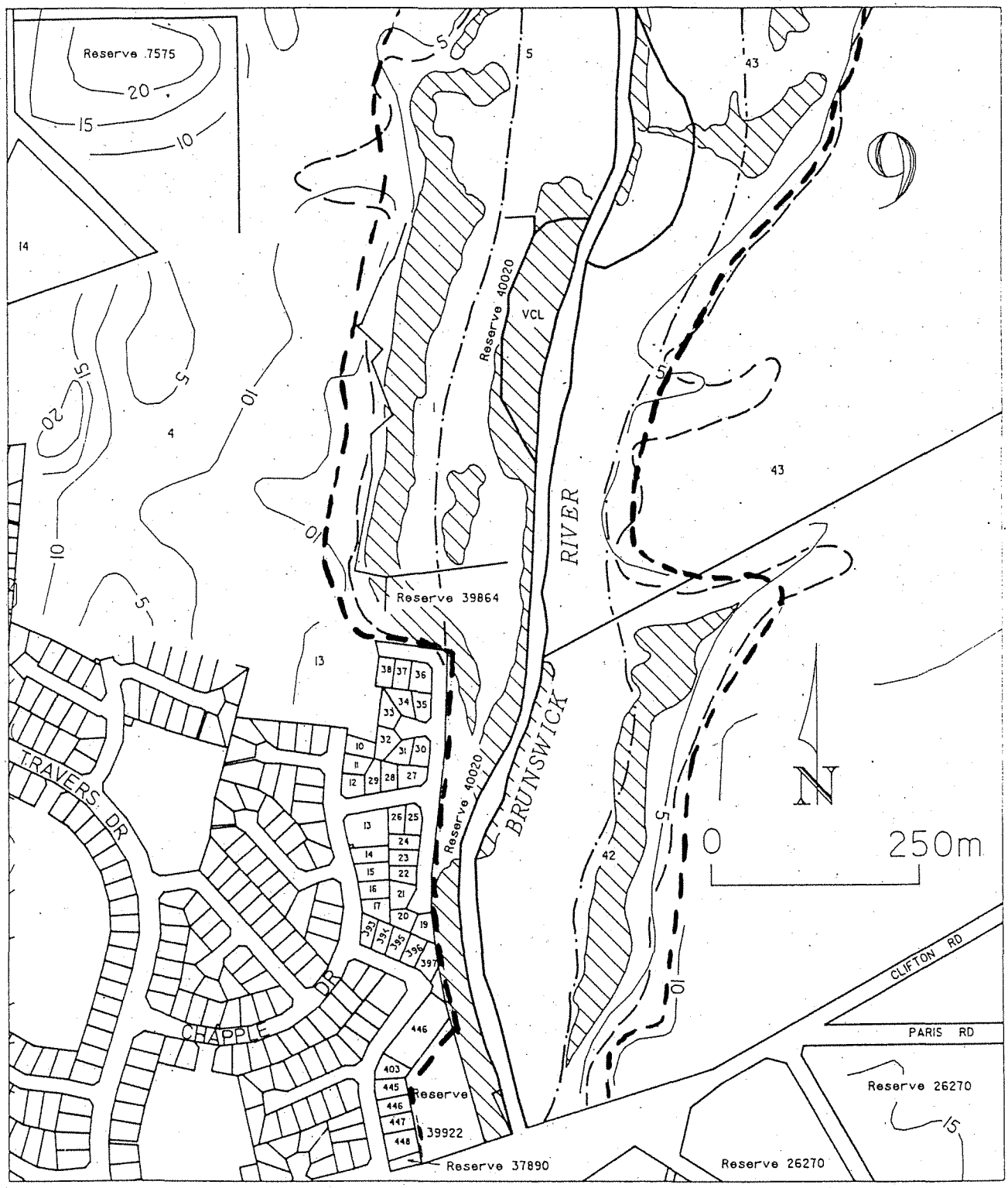

39922
Reserve 37890
Reserve 26270
Reserve 8118
DITCHINGHAM RD
PARIS RD
Reserve 8025
Reserve 32213
Reserve 37586
RIVER
BRUNSWICK
Reserve 32214
Pt Loc 1
N
0
250m
8

Planning considerations for Map 9

- area exhibiting tree regeneration
- narrowness of the river
- peripheral vegetation (incl. forest) with intact understorey
- East Australind Structure Plan Stage 1
- currently predominant rural land use with special rural/ residential pressure
- Paris Road Bridge
- reserves 39922, 40020, 39864 and vacant Crown land
- a buffer on peripheral vegetation
- landscape amenity provided by the combination of the river, woodland over pasture and riverine vegetation
- wildlife corridors
- eastern foreshore requires enrichment planting
- feeding and roosting area for waterbirds
- associated wetlands
- floodplain / floodway
- 5 metre / 10 metre contour

Recommendations

22. Rehabilitate and enhance fringing vegetation and associated wetlands.
23. Develop a management plan to control the demand for public access, created by the establishment of the East Australind urban area. Area suitable as a low impact recreational node incorporating the conservation of the associated wetlands.
24. Preserve and enhance wildlife corridors through the development of continuous linear reserves and via strategic enrichment planting.
25. Encourage landowners to restrict stock access to areas exhibiting tree regeneration. Western foreshore suitable for conservation puposes.



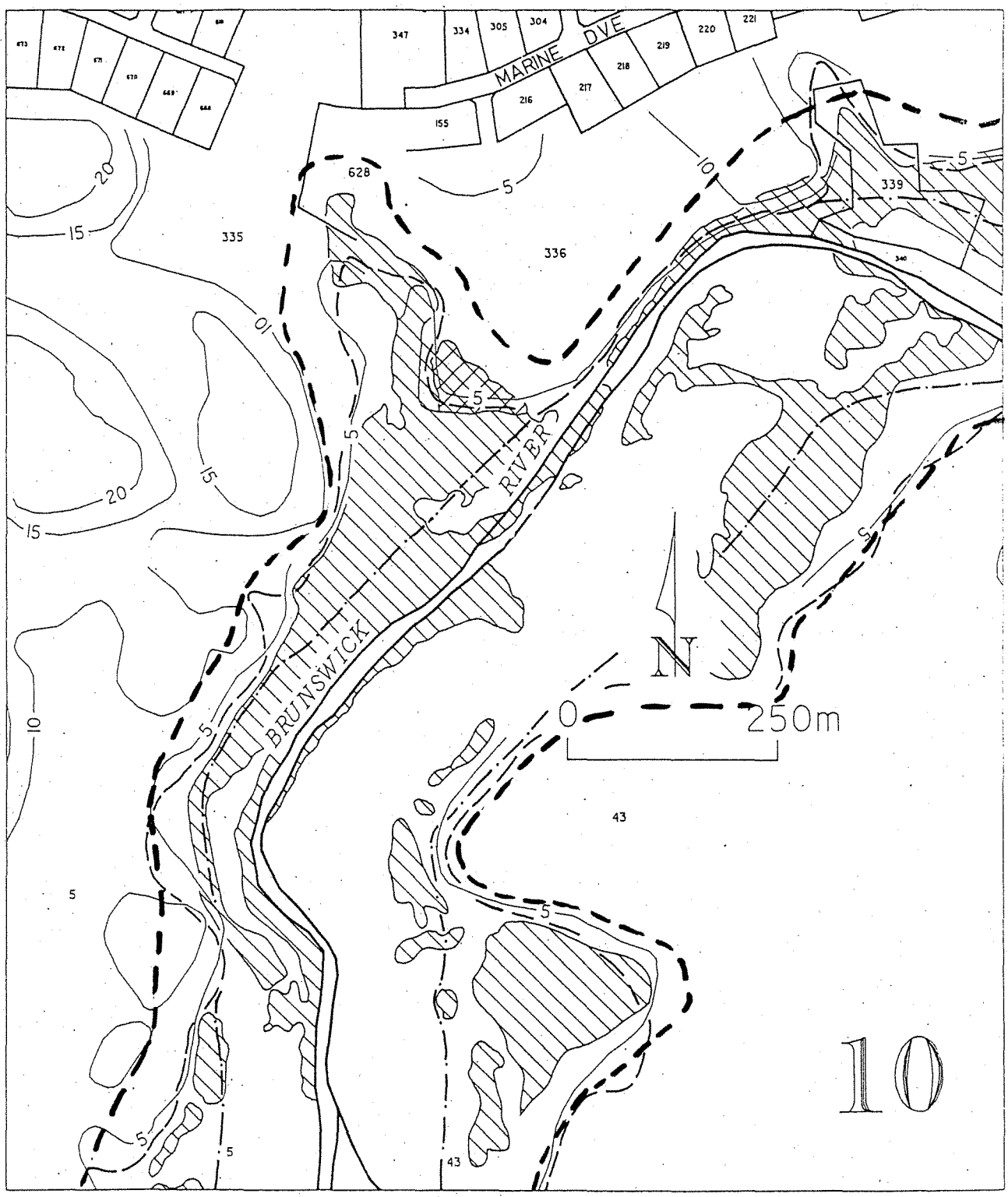
e:\water\collie\cabross.dgn Oct. 5, 1992 16:37:18

Planning considerations for Map 10

- area exhibiting major tree regeneration
- narrowness of the river
- East Australind Structure Plan Stage 1
- currently predominant rural land use with special rural/ residential pressure
- no existing foreshore reserves
- lack of public access
- a buffer on peripheral vegetation
- landscape amenity provided by the combination of the river, woodland over pasture and riverine vegetation
- wildlife corridors
- eastern foreshore requires enrichment planting
- feeding and roosting area for waterbirds
- associated wetlands
- floodplain / floodway
- 5 metre / 10 metre contour

Recommendations

26. Rehablitate and enhance fringing vegetation and associated wetlands.
27. Develop a management plan to control the demand for public access, created by the establishment of the East Australind urban area. Area suitable as a low impact recreational node incorporating the conservation of the associated wetlands.
28. Preserve and enhance wildlife corridors through the development of continuous linear reserves and via strategic enrichment planting.
29. Encourage landowners to restrict stock access to areas exhibiting tree regeneration. Western foreshore suitable for conservation puposes.

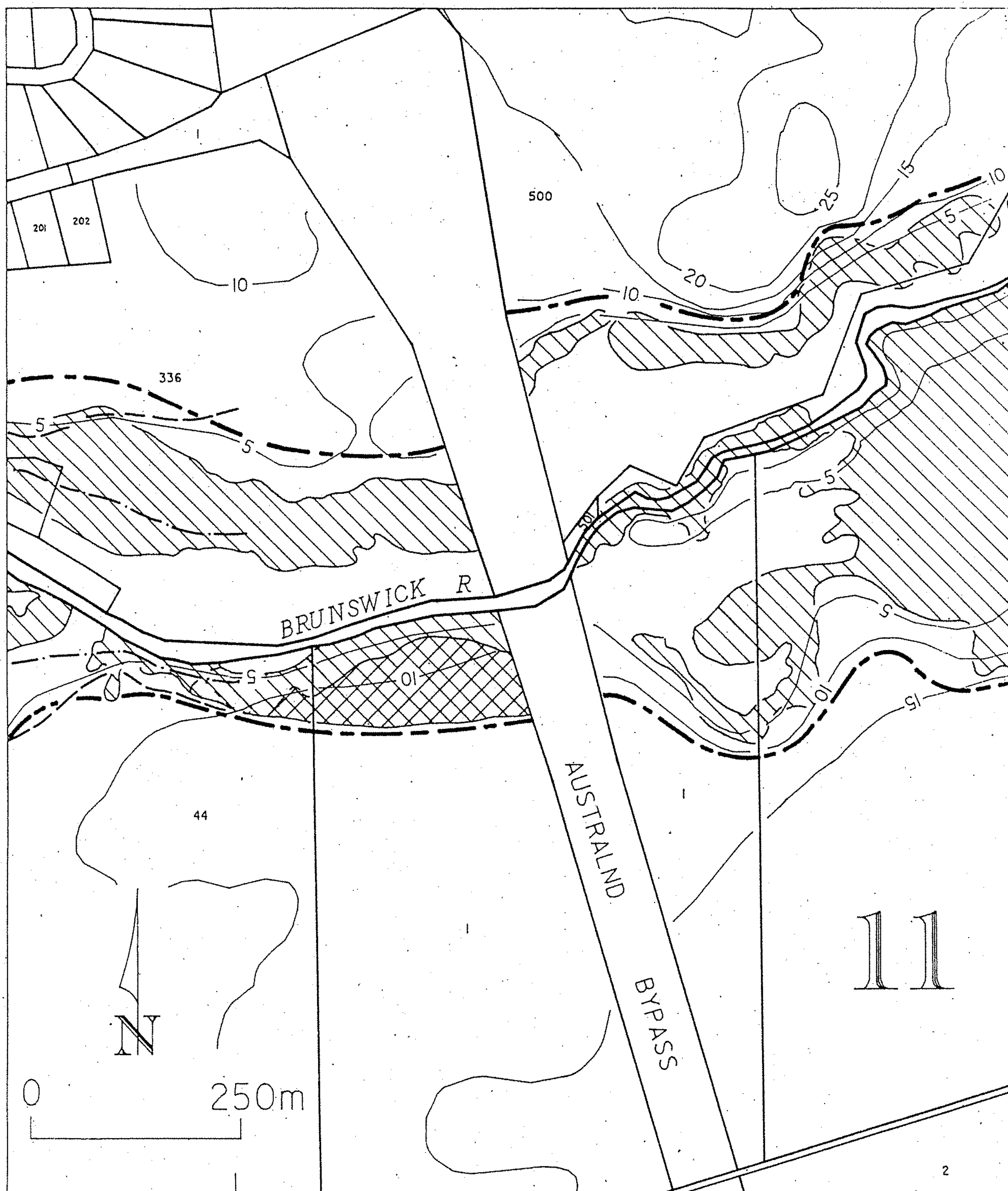

e:\water\collie\cabross.dgn Oct. 5, 1992 16:29:30
MARINE DVE
BRUNSWICK RIVER
N
0
250m
10
347
334
305
304
221
220
219
218
217
216
155
628
339
335
336
43
5
10
15
20

Planning considerations for Map 11

- area exhibiting major tree regeneration
- narrowness of the river
- East Australind Structure Plan Stage 1
- currently predominant rural land use with special rural/ residential pressure
- Australind Bypass
- no existing foreshore reserves
- lack of public access
- a buffer on peripheral vegetation
- steep banks
- high sandy rise vegetation preventing erosion
- associated wetlands
- floodplain
- 5 metre / 10 metre contour

Recommendations

30. Rehabilitate and enhance fringing vegetation and associated wetlands.
31. Develop a management plan to control the demand for public access, created by the establishment of the East Australind urban area. Area important as a wildlife corridor, for its value in minimising erosion and its associated aesthetic qualities. Direct public use to surrounding areas.
32. Preserve and enhance wildlife corridors through the development of continuous linear reserves and via strategic enrichment planting.
33. Encourage landowners to restrict stock access to areas exhibiting tree regeneration. Northern foreshore suitable for conservation puposes.

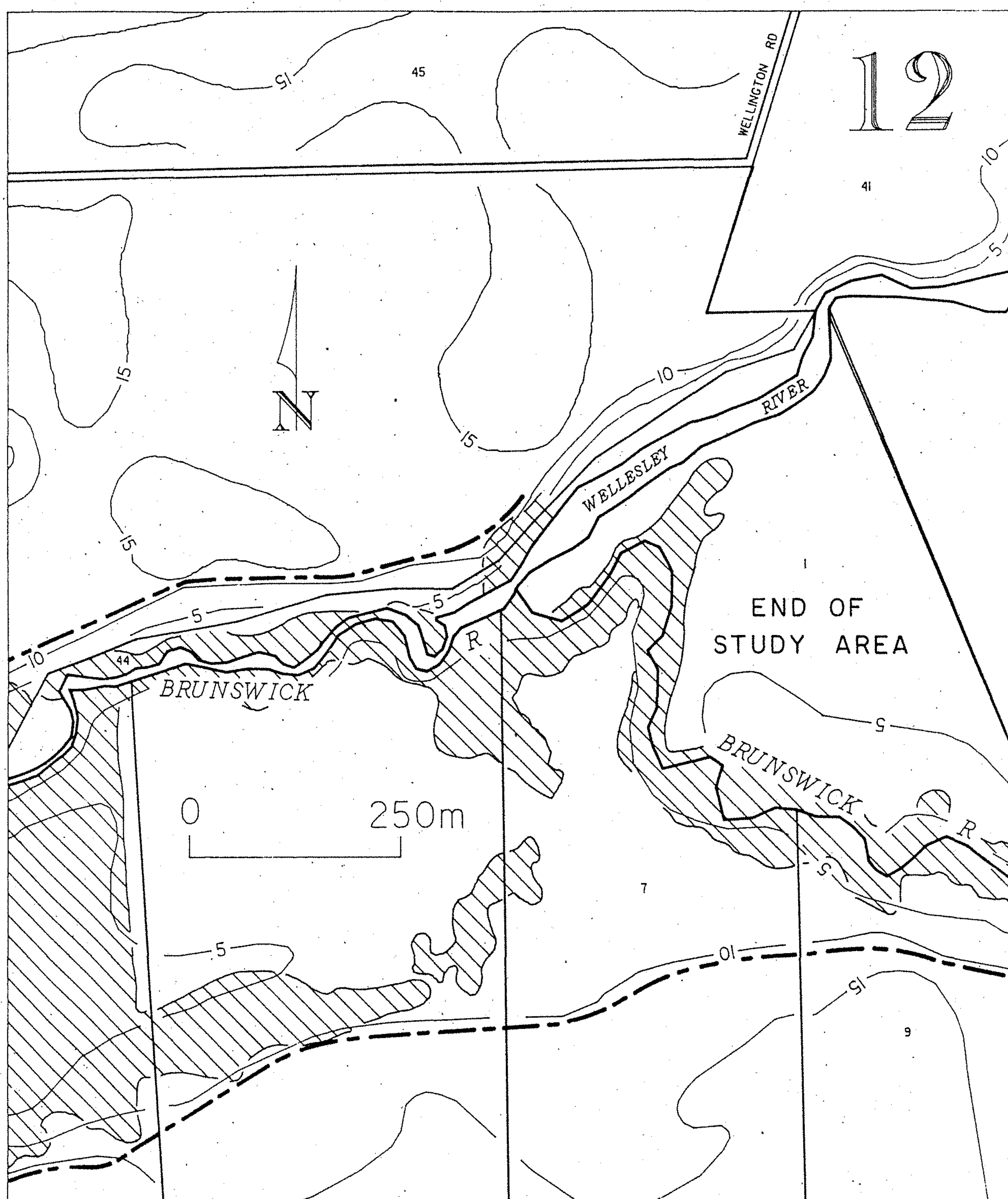

1
201
202
500
10
20
25
15
5
336
BRUNSWICK R
10
44
AUSTRALND BYPASS
N
0 250m
11
2

Planning considerations for Map 12

- area exhibiting major tree regeneration
- a buffer on peripheral vegetation
- landscape amenity provided by the combination of the meandering river and overhanging vegetation
- wildlife corridors
- associated wetlands
- consistency with map 11
- 5 metre / 10 metre contour
- feeding and roosting area for waterbirds
- confluence of the Wellesley and Brunswick Rivers
- Brunswick River becomes very narrow

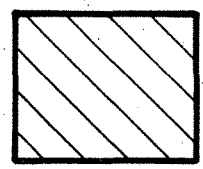
Recommendations

34. Encourage landowners to restrict stock access to areas exhibiting tree regeneration. Northern foreshore suitable for conservation puposes.
35. Recognise the importance of the foreshore surrounding the confluence of the Brunswick and Wellesley Rivers as a high quality conservation area.
36. Rehabilitate and enhance fringing vegetation and associated wetlands.
37. Preserve and enhance wildlife corridors through the development of continuous linear reserves and via strategic enrichment planting.

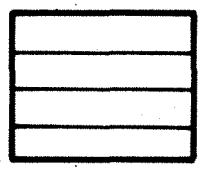

12
WELLINGTON RD
45
41
N
WELLESLEY RIVER
BRUNSWICK R
44
END OF STUDY AREA
BRUNSWICK R
0 250m
1
7
9
5
10
15

LEGEND

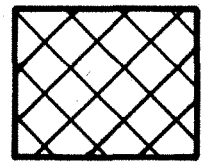
VEGETATION CLASSIFICATIONS



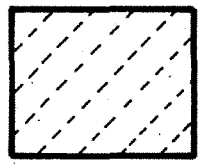
Fringing vegetation



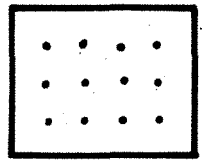
Fringing vegetation (incl. forest) with intact native understorey



High sandy rise vegetation



Saltmarsh



Woodlands

100 year floodline

W.A.W.A. limit of floodway

Waterways Protection Precinct

6. Implementation

The Waterways Protection Precinct (WPP) describes the zone of critical importance in protecting the waterways ecosystem. This area includes the waterway and adjoining foreshore land. The precinct is the area in which waterways management authorities are most active.

The Leschenault Inlet Management Authority will identify the Waterways Protection Precinct within its gazetted waterways management area. Within this area the authority will play a direct management role in conserving and rehabilitating the waterways ecosystem. A Waterways Protection Precinct may include Crown reserves, vacant Crown land and private property. As LIMA does not necessarily control the land within the precinct, it would seek to influence the type and extent of environmental change within that zone. In addition LIMA seeks to work with other agencies and landowners to enhance the waterway environment within this precinct. Mechanisms that may be utilised to appropriately manage the land within the precinct are outlined below:

(a) the ceding of a foreshore reserve to the Crown free of cost and encumbrance in accordance with section 20A of the Town Planning and Development Act 1928,

(b) a separate lot being subdivided off as a foreshore reserve as a condition of subdivision. The subject lot to be acquired by the Crown at its market value when funds become available,

(c) a portion of the WPP being ceded to the Crown as a foreshore reserve. The remaining land contained within WPP being developed as larger lots in accordance with tight land use controls which could be implemented through the LGA's Town Planning Scheme,

(d) incorporation of a fee into the price of residential blocks to finance the acquisition of foreshore land, and

(e) developing management agreements with landowners where reservation is not possible or appropriate.

The first process depends primarily upon a landowner subdividing. This presents problems for the management of foreshore areas in commercially viable rural areas, particularly in respect to controlling river bank erosion, undertaking enrichment planting and maintaining wildlife corridors. It also argued that it is not the responsibility of subdividers to meet regional open space requirements. Whilst there is some merit in that argument, it is often possible to meet the regional open space requirements as suggested by the WPP and outlined in the Bunbury Wellington Regional Planning Study by augmenting a nominal foreshore reserve with the mandatory public open space and potential drainage infrastructure requirements.

The second option is presently difficult to implement as the funds are frequently not available to purchase freehold title for public purposes. A partial solution has been established in the Perth metropolitan area through the formation of a Metropolitan Region Scheme Improvement Fund which contains money for the appropriation of reserves for public purposes. The Improvement Fund may be an option in the future for the Bunbury Wellington Region. Meanwhile, the creation of separate lots for foreshore reserve purposes may facilitate the expedition of this particular acquisition mechanism.

The third option has been investigated in the Cathedral Avenue Study area adjacent to the Leschenault Estuary. It is considered that a Town Planning Scheme is the most appropriate vehicle for land use control.

The fourth option refers to Scheme 3, previously implemented by the Shire of Harvey to fund the acquisition of foreshore land for public open space.

The final option principally applies to the areas alluded to earlier, which remain commercially viable as rural properties. The Waterways Commission or a Management Authority may enter into agreements with the owner, lessee or licensee of any area of land (including land from time to time or at all times covered by water) for the control or management of that land under the provisions of the Waterways Conservation Act.

7. Glossary of terms and abbreviations

CALM	Department of Conservation and Land Management
community	a natural group of organisms of different species that live together and interact as a relatively self-contained unit.
Crown	Local, State or Commonwealth Government
DCE	Department of Conservation and Environment
development	(a) the erection, construction , demolition, alteration or carrying out of any building excavation, or other works in, on, over or under land or waters (b) a material change in the use of land or waters; and (c) any other act or activity in relation to land or waters declared by regulation to constitute development.
DOLA	Department of Land Administration
DOT	Department of Transport
DPUD	Department of Planning and Urban Development
ecosystem	an ecological system that includes all living things and the environment in which they naturally occur.
EPA	Environmental Protection Authority
estuary	the tidal mouth of a river, or partially enclosed body of water having variable salinity due to its connection with river(s) and sea.
eutrophic	having a very high nutrient content.
eutrophication	nutrient enrichment usually due to accumulation of nutrients from agricultural lands. May bring about rapid growth of algae, causing unpleasant odours and death of aquatic life.
floodfringe	the remainder of the floodplain outside the floodway.
floodway	the channel and the lands immediately adjacent which carry the fast moving flood waters.
LIMA	Leschenault Inlet Management Authority
low impact recreation	forms of recreation that have minimal impact on the environment - e.g. walking, birdwatching.
MRS	Metropolitan Region Scheme
nutrient	material taken in by living things for growth and maintenance.
phytoplankton	plant plankton or single-celled algae in water.
saltmarsh	a coastal marsh, inundated by only the high tides.
substrate	the object or material on which or within which an organism lives.
Waterways Protection Precinct (WPP)	a guide to limit the impact of environmental change.
WWC	Waterways Commission

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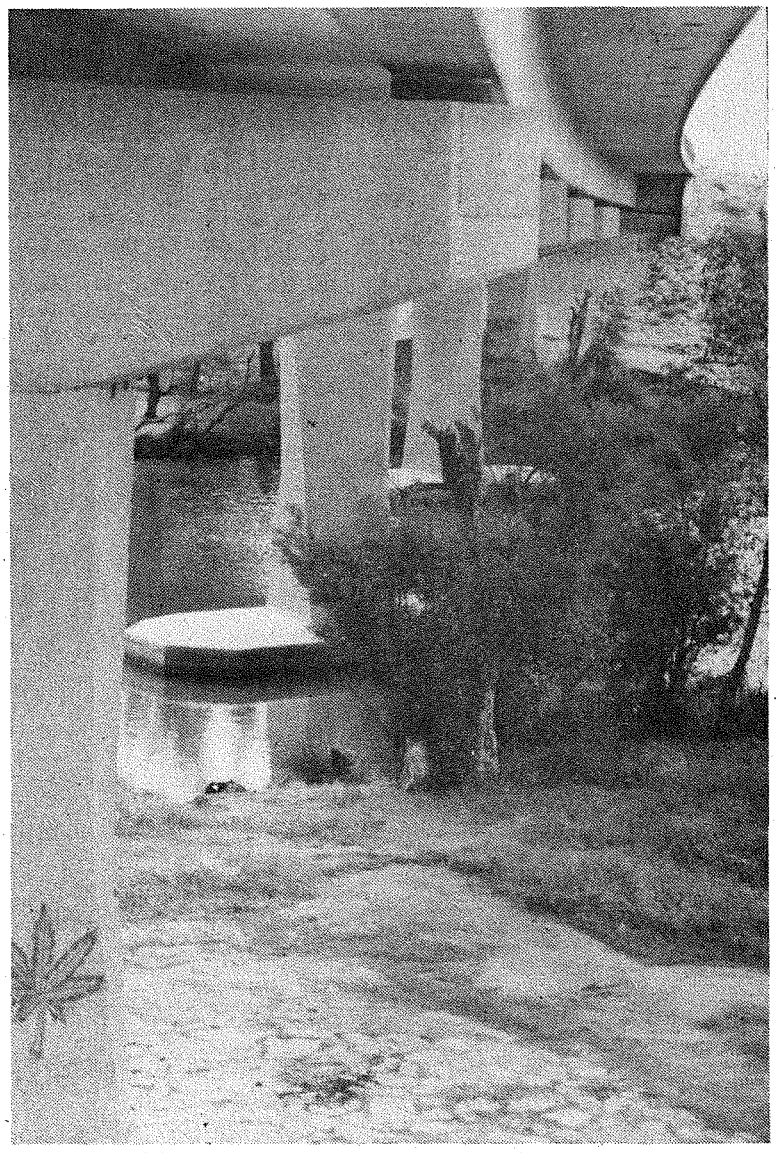
WWC (1992a) Leschenault Waterways Management Programme 1992. Waterways Commission, Perth, WA.

WWC (1992b) Peel Inlet Management Programme 1992. Waterways Commission, Perth, WA.



(Plate 6 : Collie River bridge)

Foreshore land adjacent to bridges is often under utilised and left in a degraded condition.

Appendix 1 : Public Submissions

Number and theme of submissions

Seven public submissions were received. These are outlined as follows:

1)	J&H Coote, V&B Bevan and J&E Bracey prepared by Thompson Taylor and Burrell	(Individuals)
2)	Peet & Co. and Marist Brothers Community Inc. prepared by Thompson Taylor and Burrell	(Commercial)
3)	Southwest Environment Centre	(Community organisation)
4)	Emily Hill	(Individual)
5)	Shire of Harvey	(Local Government)
6)	M W Smith	(Individual)
7)	Kintyre Holdings Pty Ltd	(Commercial)

The comments received were critical of certain elements of the document, but were generally supportive of the Draft Collie and Brunswick Rivers Foreshore Reserves Study as a whole. A positive response was received regarding the document's aim of developing a proactive approach to foreshore management.

A significant proportion of the submissions highlighted typographical errors and miscellaneous technical observations. These have been accounted for under the relevant chapter headings. The content of the remaining submissions focused on the philosophy of the study and accordingly have been addressed as such.

Submission analysis and methodology

Submissions received were analysed by the staff of the Waterways Commission, consulting with relevant persons and agencies as necessary. A list of criteria was used for determining amendments to the draft. These are as follows :

- Change in government policy or philosophy.
- The supply of additional information.
- Identified lack of clarity in the draft.
- Need to change the status of recommendations where recommendations have already been implemented.
- Identified changes to the implementation of recommendations.

The majority of the comments received pertained to the second and third criteria.

Amendments to Chapter 1

It was suggested that the Regional Map (Fig.1.) delineate the LIMA management area. Unfortunately the scale of the map is not conducive to the illustration of the relevant management area. Additionally, the intent of the map is simply to identify the major geographical features to orientate readers that are not familiar with Western Australia.

A submission noted that the WPP should reflect how much land is contained within LIMA's management area. LIMA' management area is not a component of the criteria used to determine the WPP and accordingly it has little relevance to the concept.

It was requested that the third sentence of Chapter 1.3 be deleted. It was interpreted that the comment assumes that if plans do not comply with the Leschenault Inlet Management Authority's requirements then delays in the planning approval process can be expected. However, as this document is purely a working paper designed to assist developers and planners in refining their proposal, it has only the potential to expedite applications within the planning process through increased communication.

Mention was made that the Shire of Harvey consistently expressed concern about foreshore acquisition. Accordingly, this has been included in Table 1.

Amendments to Chapter 3

A submission stated that the Australind By-pass should be named on Figure 3 as it is described on Figure 4 (now Figure 5). This has been amended to reflect the comment.

It was suggested that in Section 3.1 the statement "prevention of development or filling which inhibits flood flow " be replaced with "development to be in accordance with the Water Authority's Flood Study". The replacement is not considered appropriate as the former point accurately reflects the intent of the statement whilst the latter is purely prescriptive and is in effect a planning mechanism used to achieve the former.

As a result of comments made about the criteria for determining the Waterways Protection Precinct and further consideration of the concept by the Waterways Commission Section 3.3 has been totally revised. Criteria are now given in a table form which clearly describes what should be considered when determining a Waterways Protection Precinct.

Amendments to Chapter 4

The term "derive" has been deleted from section 4.5.

The term "quadrats" in 4.5.1 is correct.

The mosquito breeding site described as "West of Harding Street" in the Chester & Klemm reference, is illustrated as site E in Figure 5 (previously Figure 4).

Mention of Scheme 3 in Section 4.14 "Alternatives to Foreshore Acquisition" was not the result of a misunderstanding. It has been confirmed by the Shire of Harvey that this technique was previously used by that Council to acquire foreshore reserves.

Amendments to Chapter 5

A number of the maps have been modified to represent a greater proportion of street names for easier reference.

The concept of a buffer on areas that require environmental protection was adopted from a draft paper publish by CALM on the protection of wetlands. The approach is subject to debate and is currently being refined by the Commission in its implementation of the Waterways Protection Precinct. Guidelines No 3 is currently being prepared to define a Waterways Protection Precinct and will be published shortly.

Amendments to the philosophy of the study

The primary criticisms of the Waterways Protection Precinct were that :

1) It does not acknowledge all existing zoning boundaries.

2) Does not recognise existing structure plans.

3) Landscape amenity requires a landscape analysis to justify its inclusion as a planning consideration.

4) Does not detail the mechanisms for implementation of the WPP.

5) Vesting and management of reserves is not addressed.

The Waterways Protection Precinct does not recognise all current zoning boundaries as the delineation of the line is primarily based on existing physical features. The fact that development has not yet occurred on the subject properties, does not preclude LIMA from defining the area of critical importance to waterway ecosystem functioning. Similarly as structure plans are adaptable to the needs of the market and the community, the authority will work to ensure that the functioning of the ecosystem is not threatened by land use changes, development or other potential environmental impacts.

The Commission recognises that landscape analysis is a valued tool in environmental planning. Nevertheless, even without the relevant study, landscape amenity remains a consideration. It should be noted that this view is clearly reflected within the real estate industry. The market accepts that property adjacent to the river is comparatively more expensive yet similarly it does not need a landscape analysis to justify that value.

It should be noted that not all the Waterways Protection Precinct has to be reserved. The appropriate management of the land is the principle aim of the WPP and reservation is one of the mechanisms through which that can be achieved. The options that may be pursued have been expanded within the document and are now detailed in Section 6 under Implementation.

The Commission is willing to accept vesting of foreshore reserves solely for conservation purposes if other relevant authorities are not willing to accept vesting. However, the maintenance costs of the regional open space is not within the brief of this document and should be addressed at an inter governmental level. In respect to management plans for reserves, the Commission endorses the view that developers should be responsible for preparing management plans for foreshore reserves created as a condition of subdivision. Additionally, LIMA will endeavour to publish management plans for the waterways, to provide a framework for its three year operational plans.

Appendix 2 : Clifton Park Recommendations

The recommendations were divided up into two categories, General Recommendations and Area Recommendations. The following are the General Recommendations :

1) Maintain vegetation to protect landscape views from the river. Consider the views of residents in the landscaping of the area. No existing vegetation to be removed to enhance residents' views.

2) Keep grassed and parkland areas informal to minimise on-going maintenance costs.

3) Monitor erosion of the bank to determine need for future works.

4) Provide for hand launching of dinghies, sailboards and canoes in Areas A, B and D.

5) Ensure that any proposals for filling the area are in accordance with Water Authority recommendations on floodways and floodplains.

6) Ensure that drainage from lots, car parks and roadways does not alter the hydrology of the area.

7) Ensure catch traps are placed on road and car park sinks.

8) Establish bollards or post and rail fencing at strategic locations to delineate the reserve and restrict vehicle and bike access.

9) Monitor problems of vandalism and determine a joint strategy between Council and LIMA for controlling such problems.

10) Ensure that fertilising of grassed areas occurs during spring and minimal applications are used.

11) Control mosquito problem in accordance with the established mosquito strategy.

12) Construct a walk trail along the reserve, following the present firebreak. The walk trail to connect to access points at Sutton Court, Lucy Victoria Avenue adjacent Area C conservation area, the access way opposite Duigan Place, the swimming area opposite Mayne Way, and the Old Coast Road at the Collie River Bridge.

    A raised boardwalk to be developed in the vicinity of the Area C to minimise hydrological changes to the conservation area.

13) The need for a dual use path to be reviewed and reassessed after 3 to 5 years.

14) Maintain a firebreak along the existing alignment. When the walk trial is constructed, this should act as the firebreak.

15) Establish a fire management programme according to the established policy of Council and LIMA. Provide vehicle access for emergencies and maintenance along firebreaks. Inform local residents of the programme and encourage resident participation in fire control measures.

16) Develop a joint funding programme between Council and LIMA.

17) Implement the plan over 5 years.

Most of the above recommendations have already been implemented but are included as a useful guide to the preparation of management plans by highlighting a number of key issues. For further reference, the area recommendations are detailed in the Clifton Park Foreshore Reserve Management Plan (WWC 1989).

Appendix 3 : Guidelines for the establishment of bridges over waterways

The establishment of bridges over waterways can alter the hydrological characteristics of a river and affect the natural ecosystems if they are not designed and constructed carefully. Potential changes in flooding patterns, vegetation loss, weed invasion, silting and lack of foreshore access are issues which must be considered when assessing linear developments over waterways.

The following guidelines may be used by decision making authorities and the Leschenault Inlet Management Authority when assessing such proposals.

Siting

1) Bridges should be located to avoid :

   (a) quality riverine vegetation (particularly with intact native understorey)

   (b) associated wetlands

   (c) banks of streams and larger waterways with remnant native vegetation.

2) Bridges should be located and designed to minimise the need to fill the floodplain.

3) Positioning of the bridge should account for areas of archaeological and ethnographic significance. If sites are discovered during construction the developer should comply with the provisions of the Western Australian Heritage Act 1972-80.

4) Streamlining of crossing points for utilities and other facilities to be encouraged.

Timing

5) Construction and maintenance activities should be timed to minimise their effect on migratory bird colonies and breeding times of waterfowl. Proponents should liaise with the Department of Conservation and Land Management (CALM) and the Royal Australasian Ornithologists Union (RAOU).

Hydrology

6) Proponents should liaise with Water Authority of Western Australia before designing any bridge. Bridge design should conform to WAWA's criteria in regard to flooding. Structures placed within the floodway may alter the flooding patterns.

7) During construction, water flow should be maintained to support ecosystem function. Water flow can be critical to the survival of fish and freshwater crustaceans (eg. yabbies).

Erosion

8) Damage to river banks should be minimised by limiting the size of the construction site and ensuring that all activity is limited to that site. Vegetation should not be removed.

9) All batters and slopes should be stabilised as rapidly as possible. Direct seeding with indigenous species and the use of original topsoil is recommended.

Preservation of Vegetation and Fauna

The floodplain may contain productive ecosystems. Secondly, the vegetation along the foreshore functions to minimise erosion and trap nutrients before they enter the waterway. These properties combined with the aesthetic value of foreshore environments clearly suggest that all intrusion into the floodplain should be kept to a minimum. Guidelines to ensure that the establishment of bridges conform to such criteria are outlined below :

10) Filling of the floodplain should be discouraged and effectively minimised. Floodplain vegetation minimises erosion by binding soil and slowing runoff. It provides a diverse habitat for fauna and a productive nutrient source for estuarine food chains. Floodplains are frequently utilised as fauna corridors which enable animals to move to and from various habitats in times of drought or bushfire and the corridors ensure genetic diversity through interbreeding populations. Furthermore, the vegetation acts as a nutrient trap and fulfills a landscape aesthetic function.

11) Clearing of vegetation to be kept to a minimum. Existing cleared areas to be utilised where possible. The topsoil should be stockpiled from areas that require clearing to facilitate bridge construction. When construction is completed, cleared areas should be ripped and the topsoil replaced as soon as possible.

12) All noxious weeds should be sprayed and removed prior to construction. Liaise with the Waterways Commission on appropriate chemical treatments and physical removal methods.

13) Lighting fires to be discouraged on-site. Prefer removal of waste from area for appropriate disposal as the risk to riverine vegetation is considerable from wind driven embers which may ignite the undergrowth. Frequent fires alter the composition of the complexes toward exotic annuals. If it is necessary to incinerate the waste on-site, obtain a permit from the Fire Brigade to ensure that neighbouring properties are not threatened.

14) All litter to be removed from site and disposed of appropriately.

15) Parking areas should be clearly defined to minimise the area disturbed and should be located away from the river bank. Existing cleared areas should be utilised where possible.

16) The proponent should consult with the Department of Conservation and Land Management regarding dieback control measures.

17) Monitoring of weed invasion from fill and disturbance to be undertaken after 12 months and treated accordingly.

Construction Impacts

18) All drainage to be contained on-site. Construction activity should not cause river waters to become muddy. Suspended solids reduce light penetration and affect aquatic vegetation and fish.

19) Dust and noise should be minimised during development, to the satisfaction of the local authority.

20) All fill should be clean and free of pollutants.

21) The disposal of oil and building rubble should be organised to ensure that they are disposed of appropriately.

22) Construction site toilets should be self-contained and not discharge waste into the environment.

Revegetation/Aesthetics

23) Replanting of the construction site should occur in accordance with a plan approved by the Leschenault Inlet Management Authority.

24) Enrichment planting of the foreshore and rehabilitation of the riverbed with native species should be undertaken to the satisfaction of the Leschenault Inlet Management Authority.

25) Bridge to be designed and constructed to minimise landscape intrusion. Advice from a landscape consultant should be sought on this subject.

Public Access

26) Fishing platforms, pedestrians and cycle paths are to be incorporated into the bridge's design where practicable.

27) Provision for public access along the foreshore beneath the bridge should be created and maintained.

Design Standards

28) The design of the bridge should be approved by the Manager Engineer, Department of Transport, and the Commissioner for Main Roads.

29) The specifications of the bridge's span should minimise the necessary fill required and accordingly reduce the vegetation disturbance as well as maximising fauna corridors.

30) The structure should not interfere with boating activities on the waterway.

Appendix 4 : Draft Guidelines for Stormwater Use

The traditional method of urban stormwater management has been through the direction of the flow via feeder drains to a trunk channel which continues on into the nearest river. This technique is now considered unacceptable, as the nature of the stormwater results in the degradation of the receiving natural watercourse. Consequently, the use of compensating basins has been employed to check the velocity of the flow and to provide a limited pollution control function. It is the purpose of these guidelines to progress the idea of stormwater disposal, by presenting the concept of stormwater use, by which the water can be utilised to establish wetlands. Within these constructed wetlands, pollutants can be stripped and a wetland ecology sustained for the benefit of the urban area and the surrounding natural environment.

The key concept in stormwater use is to view the water as a resource rather than a waste product that requires disposal. There has been an estimated 80 per cent loss of wetlands within the Perth Metropolitan Area through infill and drainage from the expansion of the urban area. The loss of such valuable and productive habitats can be compensated to some extent by establishing artificial wetlands that can fulfill an urban stormwater management function, create a natural habitat for flora and fauna and an asset for urban recreational areas.

Please note that the guidelines have not been compiled at this stage as it has been resolved that further preparation is required before they can be adopted as Waterways Commission policy. This will involve considerable consultation with WAWA, Health Department and the Environmental Protection Authority to refine the design specifications.

If you require more information on retention basins please do not hesitate to contact the Waterways Commission.