PELICAN POINT PTY LTD

PELICAN POINT, BUNBURY

PUBLIC ENVIRONMENTAL REVIEW

VOLUME 1 OF 2

AUGUST 1991

LeProvost Environmental Consultants

INVITATION

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

The Public Environmental Review (PER) has been prepared in accordance with Western Australia Government procedures. The PER proposes the development of the Pelican Point, Bunbury. The report will be available for comment until 2 October 1991.

Following receipt of comments from government agencies and the public, the EPA will prepare an assessment report with recommendations to government, taking into account issues raised in public submissions.

Why write a submission ?

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

All submissions received by the EPA will be acknowledged. Submissions will be treated as public documents unless confidentiality is requested, and may be quoted either in full or in part in each report.

Why not join a group ?

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

Developing a submission

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

When making comments on specific proposals in the PER:

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

Points to keep in mind

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

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

Remember to include:

- your name,
- address,
- date.

The closing date for submission is: 2 October 1991.

Submissions should be addressed to:

The Chairman,
Environmental Protection Authority,
1 Mount Street,
PERTH WA 6000.

Attention: Mr Colin Murray

PELICAN POINT, BUNBURY

PUBLIC ENVIRONMENTAL REVIEW

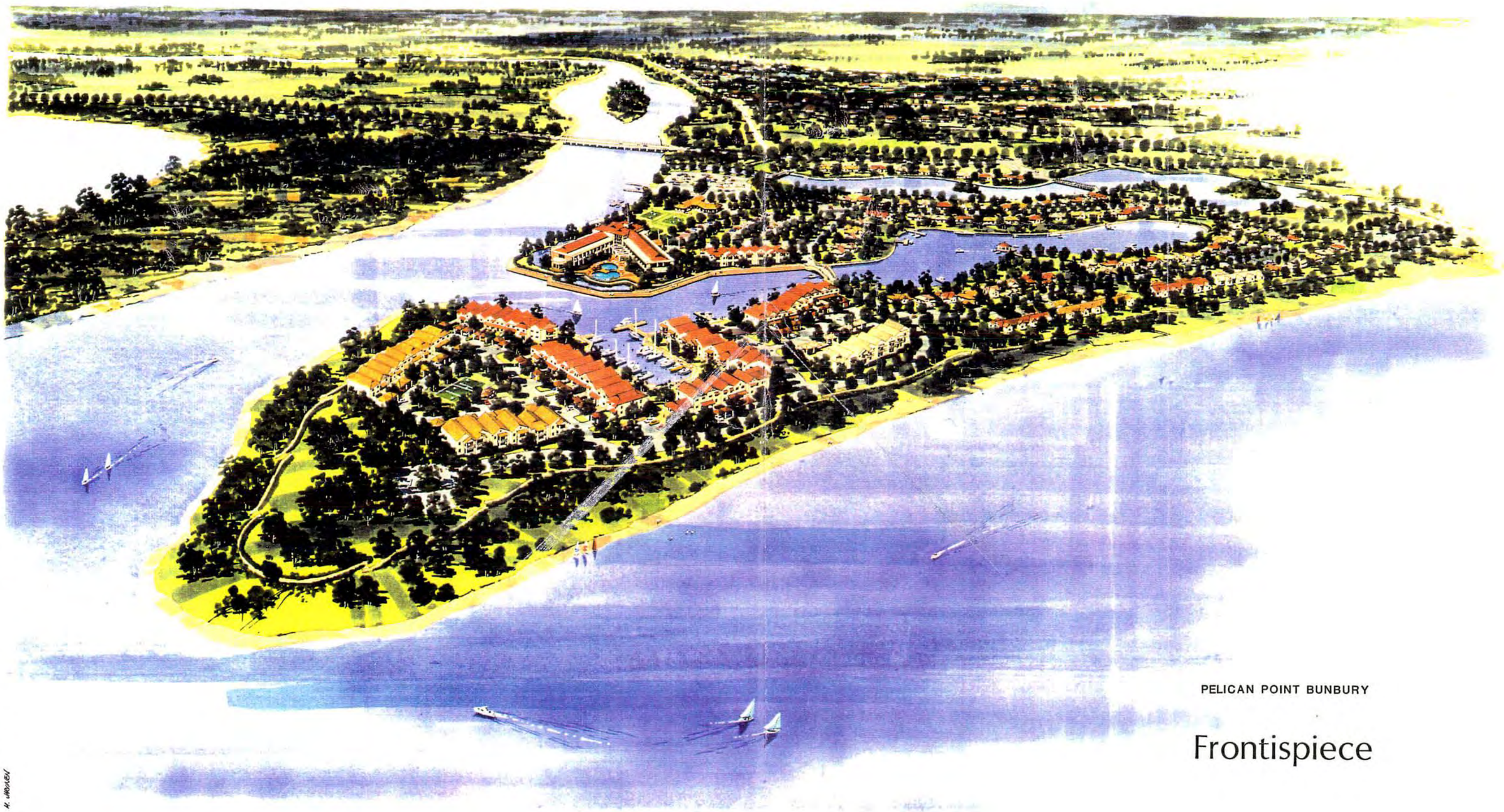
Report to: Pelican Point Pty Ltd,
442 Murray Street,
PERTH WA 6000.

by: LeProvost Environmental Consultants,
Suite 2, 1st Floor,
175 Labouchere Road,
COMO WA 6152.

1 August 1991

LEC Ref: J186

Report No. R320



PELICAN POINT BUNBURY

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PELICAN POINT, BUNBURY

PUBLIC ENVIRONMENTAL REVIEW

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SUMMARY

INTRODUCTION

This Document

This document is a Public Environmental Review (PER) of a proposal by Pelican Point Pty Ltd (the Proponent) to develop land located at Eaton near Bunbury, Western Australia. The purpose of this document is to seek environmental approval for the proposed project to proceed.

Proposed Project

The proposed project is located on the southern side of the Collie River on predominantly low-lying land which is separated into two parcels of land by the Old Coast Road. The land on the north side of the road (Lot 26) is owned largely by the Proponent and is known as Pelican Point. The land on the south side of the road (Lot 100) is owned by the Industrial Lands Development Authority (ILDA), but is under purchase agreement to the Proponent.

It is proposed to develop a golf course estate on the ILDA land and a mix of short-stay tourist accommodation, residential accommodation and resort facilities set around artificial wetlands, a canal and waterways on Pelican Point.

Proponent's Objective

The Proponent's objective is to construct and operate an environmentally compatible tourism and residential development. Specifically this has meant designing the project to satisfy existing planning guidelines, resolving environmental constraints on development, and providing for on-going future management of the site. By adopting this approach the Proponent has designed a development which is aimed at benefiting both the Proponent and the local community, while maintaining and enhancing the natural values of the environment upon which the project is dependent.

Relevant Planning Guidelines

The following planning and development guidelines apply specifically to the project site:

- City of Bunbury Town Planning Scheme No. 6;
- Bunbury Region Plan; and
- Leschenault Inlet Management Programme.

Other planning guidelines apply to the project type and environmental setting, such as:

- the land use plan for Leschenault Coastal Park and Kemerton Community Park;
- Draft Environmental Protection (Swan Coastal Plain Wetlands) Policy 1991;
- Environmental Guidelines for Tourism Development in Western Australia.

Without exception, all regional land use plans recognise:

- the recreational and conservation attributes of Leschenault Inlet, Leschenault Peninsula and the Collie River;
- the need to provide for residential and recreational land use for a growing regional population;
- the potential of tourism as a major growth industry and the region's current lack of appropriate facilities;
- the need to provide adequate buffers between residential land and industrial land uses;
- the use of Pelican Point for resort and recreation purposes and the use of adjacent land for parks, recreation and drainage purposes;
- the need to provide for protection from river floods; and
- the desirability of increasing public access to, and use of, estuary foreshores.

The Draft Environmental Protection Policy identifies the environmental, social and economic values of wetlands on the Swan Coastal Plain and seeks to protect these values by regulating development of wetlands to ensure the maintenance or enhancement of existing wetland values.

The Environmental Guidelines for Tourism Development establish a code of ethics aimed at protecting the environment and enhancing community enjoyment of the environment.

All of the above planning guidelines have been incorporated into the design of the proposed project to achieve the Proponent's objective. Most of the land is appropriately zoned for the style of development proposed. However, rezoning is required for certain portions of the land to allow the construction of the residential and waterway components of the project.

A Planning Report which contains the required rezoning application has been endorsed for public review by the Department of Planning and Urban Development and is currently available for public comment.

Project History

There have been numerous previous attempts to develop the land on Pelican Point. One such proposal [LeProvost, Semeniuk & Chalmer (LSC), 1986] involved the development of a holiday resort and sporting complex set within landscaped grounds and incorporating a nine-hole golf course and a small boat haven. That proposal underwent public review (LSC, 1986) and was assessed by the Environmental Protection Authority (EPA) and LIMA [Department of Conservation & Environment (DCE) Bulletin No. 267], who concluded that the proposal was not inconsistent with the Leschenault Inlet Management Programme and that the proposal was environmentally acceptable subject to the following conditions:

- compliance with existing flood management requirements;
- provision of a 50 m wide foreshore reserve; and
- development of an environmentally acceptable golf course on the ILDA land to the south of Pelican Point, and retention of the wetland functions and values of both blocks of land.

The last recommendation effectively stopped the proposal from proceeding until access to the ILDA land was negotiated. Prior to reaching agreement to purchase the ILDA land, the Proponent first had to:

- obtain approval in principle from the Department of Planning and Urban Development for part of the land to be rezoned for residential purposes (necessary to pay for purchase, development and on-going management of land);
- obtain approval from ILDA for the location of the proposed residential units and local commercial centre (necessary to comply with Bunbury Region Plan requirements for buffer to port industry); and
- establish a source of water supply for golf course irrigation (necessary to reduce golf course management costs).

Conditional approval to purchase the land for its proposed use was granted to the Proponent by ILDA in May 1990.

Design Consultations

Once the likelihood of access to the ILDA land had been confirmed, the Proponent submitted the new design concept to the EPA for comment and re-initiation of the environmental approval process. In its response, the EPA stressed the importance of maintaining and enhancing existing wetland values of the site, identified a range of other issues which required resolution and advised the Proponent to consult with officers of the Waterways Commission prior to finalising design details.

Extensive and detailed discussions have since been held with all authorities involved in managing land use in the vicinity of the project to arrive at the proposed design concept. The design constraints and the means of their resolution are summarised later in the "Proposed Development" section of this document.

EXISTING ENVIRONMENT

Physical Characteristics

The salient physical characteristics of the project site are:

- It is located on a delta flood plain complex which abuts a hinterland of Spearwood dune. The land is for the most part low lying, but rises in the south-east to elevations of 18 m Australian Height Datum (AHD). The Collie River adjacent to the project site has depths between -1.6 m and -2.3 m AHD. Water depths in Leschenault Inlet adjacent to the project site are very shallow (-0.5 to -1 m AHD).

- The soil types of the site are variable. A basement of estuarine mud is commonly overlain by flood plain sand deposits, and locally interspersed with sand-filled river channels. This sequence is further veneered by either flood-derived silts and clays or wind-borne sands. The soils of the dunal ridge are comprised of medium to coarse-grained yellow sand.

- Groundwater salinity is high (12,000 mg/L total dissolved solids) over the low lying parts of the site. Fresh groundwater occurs beneath the dunal ridge and seeps out at its base during spring. During summer much of the project site is dry, groundwater levels occurring at about 1 m below the surface of the floodplain. In winter groundwater levels rise and form pools in low-lying areas.

- The waters of the Inlet and River adjacent to the site are tidal, but of small range (0.3 m) and for most of the year waters are clear and saline. During winter, river flows reduce water salinity and clarity and also elevate levels of nutrients. Flood waters discharge from the Inlet to Koombana Bay via an artificial opening, cut through Leschenault Peninsula at Turkey Point during the mid-1960s. 'The Cut' has improved flushing and water exchange in the

Inlet and transformed the lower reaches of the Collie River from being a fluvial-dominated system to a tidal-dominated system. Damming of the Collie River (Wellington Dam) has also markedly reduced winter flood flows.

- The geomorphic processes which operated to form the Collie Delta no longer operate as a result of both damming the River and opening 'The Cut'. Wind waves have supplanted flood flows as the dominant hydrodynamic force acting on the geomorphology of the Inlet. The shoreline of the project site, however, has remained relatively stable for a long period of time.

Biological Characteristics

The salient floral characteristics of the project site include some seven vegetation assemblages situated on the five major habitats of the project site. The major habitat units are:

- An upland terrestrial dune ridge which supports a *Eucalyptus* parkland assemblage comprising remnant Marri, Jarrah and Peppermint trees with a pasture understorey. This unit grades into a lowland terrestrial plain which supports grasses and remnant sedges.

- A lowland floodplain which supports mainly samphire beds with Paperbark trees and remnant sedges on the higher parts around the edge of the samphire.

- A delta complex of old river channels, ponds and sand plain deposits (Pelican Point) which supports a mosaic of vegetation assemblages including:

    - samphire and sedge wetlands in the depressions;
    - remnant paperbarks fringing the depressions;
    - *Eucalyptus* woodland on sandy floodplain;
    - *Jacksonia* shrubland and pasture grasses on the higher ridges of the sand floodplain deposits.

- The Leschenault Inlet foreshore is a gently sloping sandy beach partly lined by sedges which supports a grassland of couch, weeds and scattered shrubs above high tide level.

- The Collie River foreshore, which is a narrow cliffed and scalloped bank that supports clumps of rushes at the waters edge and *Casuarina*, Flooded Gum and paperbarks on the bank.

However, the whole project site is recognised as having become degraded due to previous human activity in the area.

No rare or endangered flora are known or expected to occur on the site.

The salient faunal characteristics of the project site and environs are:

- Leschenault Inlet is a locally important fish and crab nursery and waterfowl refuge.

- The project site has some value to local waterfowl populations.

- Use of the project site and immediate environs by waterfowl varies on a seasonal basis. During winter and spring, the samphire wetlands provide feeding grounds for relatively small numbers of ducks, swans and members of the heron, egret, spoonbill group of wading birds. In summer and autumn the samphire wetlands dry up and are little used. However, during this period the Inlet is used by trans-equatorial migratory shorebirds, some of which utilise the intertidal flats of Vittoria Bay.

- Eleven of the 32 species of shorebird recorded on the intertidal flats of Vittoria Bay are protected under international treaty. However, only one species (Great Egret) consistently utilises the samphire wetlands on the project site for feeding. The others either roost or loaf on the foreshore during high tide and feed on the intertidal flats during low tide.

- The samphire and sedge wetlands of the project site are locally important feeding grounds for the Great Egret and Yellow-billed Spoonbill. The drier terrestrial portions of the project site are infrequently used by waterbirds.

- No birds gazetted as "rare or otherwise in need of special protection" were recorded on the subject land.

- No rare and endangered species of other wildlife are known or expected to occur on the project site. The site is known to support rabbits and probably also supports rats, mice, foxes and feral cats. Populations of native animals are believed to be low in abundance.

Social Characteristics

The Bunbury region has a long record of environmental modification since the beginning of European settlement in 1841. Much of the land in the region has been cleared, drained and put to pasture. The Collie River has been dammed to provide water for irrigation, and the Collie River mouth has been dredged for navigation and flood mitigation purposes. 'The Cut' at Turkey Point was also undertaken as a flood mitigation measure. The Preston River was diverted to discharge into the southern end of Leschenault Inlet to allow for construction of the inner harbour in the mid-1970s, and there are proposals to divert it again in the future to allow for further expansion of the inner harbour. Harbour works have also reclaimed part of the original estuary and part of the southern end of Leschenault Inlet.

Present use of the area in the vicinity of the project site includes:

- residential and commercial (Eaton, Clifton Park);
- recreational and professional fishing on Leschenault Inlet and Collie River;
- grazing on ILDA land and land to the south; and
- industrial at Australind and near the Bunbury Inner Harbour.

Pelican Point itself is presently little used because access is difficult. The foreshores of Pelican Point are used by crabbing and fishing parties, horse trainers and off-road vehicle enthusiasts. The site is currently highly degraded as a result of past use and present unmanaged use. The Collie River foreshore in particular is highly degraded.

The wetlands on the project site have been identified as major mosquito breeding areas and allocated a high priority control rating by the Western Australian Health Department. The cut off river channel which runs parallel to the Old Coast Road on Pelican Point is also a source of severe odour problem to nearby residents in summer each year. Works to control the mosquito breeding and odour problems are awaiting the outcome of this proposal.

A number of minor archaeological sites containing evidence of previous Aboriginal use occur on the project land, but no ethnographic sites of Aboriginal significance have been recorded.

Future land use plans for the region have been previously outlined. All planning guidelines have recognised the recreational and tourism potential of the project site and the need for urban expansion in the region, while retaining the conservation and recreational values of the area. The need for adequate flood protection has also been emphasised.

PROPOSED DEVELOPMENT

Design Constraints

The proposed development has been designed to accommodate the planning guidelines for the site and environs and to resolve the environmental constraints which apply to the site.

The major design constraints were:

- the requirement to comply with the Collie River flood strategy;

- the requirement for a 50 m foreshore reserve and public access to that reserve;

- the need to maintain or enhance the existing wetland values of the site;
- the need to control mosquito breeding and odour problems in wetlands on the site;
- the need to fill much of the site to required construction levels;
- the need to establish an adequate water supply for irrigation requirements;
- the need to make the project economically viable in the long term; and
- the requirement for a buffer between residential and industrial land.

Project Components

The proposed development will contain the following components:

- an 18-hole golf course set in landscaped native parkland;
- permanent waterfowl and wildlife refuges established within the golf course;
- a golf resort;
- several areas of landscaped public open space within the development and adjacent the foreshores;
- public facilities such as parking areas, toilet and boat launching ramp;
- a resort hotel and function centre;
- a range of tourist and managed residential accommodation set around artificial wetlands and waterways;
- tourist accommodation adjacent to the Vittoria Bay foreshore and floodway wetland reserve;
- a residential golf estate; and
- a commercial centre to service the development.

Resolution of Design Constraints

The above design constraints have been resolved in the following manner.

Flood mitigation

All aspects of the Collie River flood strategy which apply to the site have been complied with. Specifically this means:

- the incorporation of a 250 m wide floodway through Pelican Point;
- no structures will be constructed on the Collie River foreshore within the "recommended limit of floodplain encroachment"; and
- floor levels of all buildings will be established at 2.76 m AHD at the eastern side of the project, dropping gradually to 2.53 m AHD at the western side. This height, which incorporates a 0.3 m buffer for potential sea level rise as a result of the 'Greenhouse Effect', is some 0.6 m above the anticipated 100 year average recurrence interval flood level for this site.

Foreshore reserve and public access

A 50 m foreshore reserve has been incorporated into the development plan. Additional setback from the tip of Pelican Point has also been incorporated to provide a public park and additional buffer between the development, and extensive intertidal flats which occur near the point and are used by waterfowl.

Public access to the foreshore has been provided for and public facilities such as parking and toilets will be established by the Proponent. Existing boat launching facilities on the Collie River will be upgraded.

Wetland function maintenance and mosquito and odour control

Recognised mosquito control methods include:

- filling in breeding sites;
- excavating breeding sites;
- improving drainage and water exchange of breeding sites;
- reducing tidal fluctuation in water levels; and
- application of insecticides.

Odour control involves some of the above options also.

Wetland function maintenance involves either:

- protection and management of existing wetlands; or
- modification of some wetlands and enhancement of others; or
- replacement of degraded wetlands with enhanced and managed wetlands of equal or greater value to waterfowl than existing wetlands.

A combination of all the above methods is proposed for the development. Specific design initiatives proposed for the site include the following:

(i) The preservation and enhancement of the wetland located within the floodway reserve on Pelican Point. This wetland will be connected to the Collie River by a non-navigable waterway to improve water exchange, thereby solving the current odour and mosquito problem.

(ii) The creation of numerous permanent saltwater and freshwater wetlands within the golf course proposed for the ILDA land. Dense stands of existing natural vegetation will be retained and incorporated into islands or natural edges to the wetlands. Islands have been incorporated to provide protection from foxes, dogs and cats, and permanent freshwater soaks will be provided near the southern boundary of the project site adjacent to a dense stand of Marri and Peppermint for drought use by waterfowl, bush birds and other wildlife.

(iii) The creation of a permanent freshwater lake and small island on Pelican Point.

(iv) All of the existing mosquito breeding areas will be modified in some way to minimise potential for breeding.

Fill requirements

All fill material required to raise ground levels will be obtained from within the project site. Some 145,000 m^3 will be obtained from the dunal ridge and lowlands of the ILDA land, 82,000 m^3 of which will be used on the ILDA land. Much of the fill required for development of Pelican Point will be obtained from the proposed wetland and waterway excavation. Some of this material is silty clay and is unsuitable for housing foundations. The silty material will be stockpiled and used for golf course landscaping and sealing of irrigation ponds.

Water supply

Hydrogeological investigations conducted by the Proponent have proved the availability of adequate deep (Leederville Formation) groundwater supplies for the golf course. Additional supplies required for landscaping are available from the main supply or may be obtained from the superficial aquifer located beneath the dune ridge on the ILDA land. The Water Authority of Western Australia (WAWA) has confirmed the availability of all sources of supply.

Project viability

The economic viability of the project is dependent on the ability to sell some of the project site for residential purposes. The sale of land is necessary to not only purchase the ILDA land, but also to compensate the Proponent for the establishment of the foreshore reserves, public open space, public facilities and floodway wetland reserve. However, equally important is the need to provide a differential rate catchment from which funds can be obtained to finance the on-going management of the foreshores, public facilities and golf course.

Industry buffer

The location of the residential golf course estate on the ILDA land was dictated by the ILDA requirement for such development to be placed in northern parts of the property in compliance with the industrial buffer zone requirements defined in the Bunbury Region Plan. Much of the land in this area is recognised mosquito breeding ground which will be filled to provide foundations for the estate. The proposed location and size of the estate have been approved by ILDA.

Construction Staging

The development will take a number of years to complete. Bulk earthworks will be undertaken in two separate phases. Phase One will mainly be undertaken on the ILDA land and will involve the construction of:

- all artificial wetlands on the golf course;
- the golf course residential estate and commercial centre; and
- nine holes of the golf course.

Phase One will also involve undertaking sufficient earthworks on Pelican Point to:

- resolve the mosquito and odour problem in the cut-off river channel by connecting it to the Collie River;
- lower parts of the wetland reserve for floodway purposes; and
- modify the shores of the floodway wetland reserve to improve drainage for mosquito control.

Phase Two will be undertaken between one and three years after Phase One depending on the demand for residential units within the golf estate. It will involve the modification of Pelican Point by the construction of artificial wetlands, non-navigable waterways, the canal and the placement of fill to raise levels to the required building height.

The staging of the bulk earthworks is a management initiative aimed at minimising disturbance of the wetland values of Pelican Point until the replacement wetlands created on the ILDA land have developed sufficiently to provide alternative feeding habitat for the range and number of waterfowl which presently use the Pelican Point wetlands.

Completion of Phase Two bulk earthworks will then enable staging of services and further construction as follows.

Stage Two: The lake estate, incorporating a mix of housing styles and types set around an artificial freshwater lake on the southern end of Pelican Point.

Stage Three: The non-navigable waterway estate, incorporating landscaping of the floodway wetland reserve with native species, provision of public boat launching and parking facilities and toilets on the Collie River foreshore.

Stage Four: The canal residential estate.

Stage Five: Pelican Point tourist accommodation plus small private marina complex.

Stage Six: The resort hotel and function centre.

Stage Seven: The second nine golf holes on the southern portion of the ILDA land plus the construction of the golf resort.

Services

The proposed development will be fully deep sewered.

Domestic water supply is readily available. Irrigation water supply is also available.

Stormwater will be disposed of on site into localised soakage pits to the maximum extent possible. Surface flow will be diverted to the artificial lakes within the golf course and residential areas. Initially the flow will be to the sealed freshwater lakes from which the water will then be recycled through the irrigation system, and will subsequently drain to the saltwater lakes which will act as soakage basins.

In the event of more extreme storm events the overflow will overtop the lake system and drain to the estuary.

Construction Methods

Bulk earthworks will be undertaken in the dry using conventional earthmoving equipment such as scrapers, dozers, backhoes and trucks. Construction works will be undertaken during summer. It is unlikely that dewatering will be required for the Phase One construction programme since much of the fill required will be obtained from the dunal ridge.

Dewatering will be required during the Phase Two construction programme which is anticipated to take five months to complete. Extracted groundwater will be discharged into the Collie River after a settlement period in a stilling basin to remove silts if required.

Prior to initiating bulk earthworks, a detailed Landscape Master Plan will be produced to guide landform modification. All mature trees and foreshore vegetation will be maintained wherever possible to preserve existing landscape aesthetics. Topsoil will be stockpiled for later use in landscaping of public open spaces and the golf course.

ENVIRONMENTAL EFFECTS

A range of actual and potential effects of the proposed development on the natural environment and local community have been recognised and assessed in the PER. They are identified below for both the construction phase and the subsequent operation phase of the project. Further detail on potentially significant effects and management requirements to minimise scale of effect is provided later.

Construction Effects

Physical

(i) Landform modifications resulting from excavation of wetlands and waterways and placement of fill to raise levels to design height.

(ii) Temporary and localised effects of groundwater drawdown during dewatering operations.

(iii) Temporary and localised effects on water turbidity in the Collie River during dewatering and final dredging works in the canal.

(iv) Temporary destabilisation of soil surfaces during the bulk earthworks programme.

Biological

(i) Habitat alienation and wetland replacement and enhancement.

(ii) Modification of some wildlife and waterfowl distribution patterns.

Social

(i) Temporary effects of construction activity, traffic and noise on the local community.

(ii) Reduced public access to Pelican Point during construction works.

(iii) Loss or modification of minor archaeological sites.

(iv) Modification of landscape aesthetics from degraded wilderness and grazing fields to a built and managed environment.

Operation Effects

Physical

(i) Groundwater consumption. Minimal long-term drawdown effects are anticipated and no other users of the resource are likely to be disadvantaged.

(ii) Natural drainage patterns will be modified by construction of waterways. When possible, stormwater runoff will be contained on site. Potential for nutrient accumulation will require management.

(iii) Potential effects on the water quality of the Collie River and Leschenault Estuary as a result of nutrient input from both runoff and groundwater infiltration. A nutrient management programme for the golf course and public open spaces will be required to manage this potential impact.

The navigable and non-navigable waterways will flush adequately and no adverse effects on regional water quality are anticipated.

(iv) Potential effects of increased public access and use on shoreline stability. These can be minimised via appropriate foreshore design and management of public access.

Biological

(i) While use of Pelican Point by wildlife and waterfowl is likely to reduce as a result of disturbance caused by human pressure and domestic pets, a substantial increase in the diversity and abundance of wildlife and waterfowl is anticipated in the golf course as a result of the provision of drought and predator refuges. The provision of these refuges is seen as a major positive effect of the development.

It is also likely that the trans-equatorial shorebirds which have utilised Pelican Point for loafing at times will no longer do so. However these birds will continue to feed on the intertidal habitat offshore and will roost elsewhere. The carrying capacity of the estuary for these birds is therefore unlikely to change as a result of the development proceeding.

(ii) Increased fishing pressure on marine biota is inevitable as the local and regional population expands. The construction of the canal and non-navigable waterway will provide a small increase in fish nursery habitat within the estuary.

(iii) The proposed development will markedly reduce the number of mosquito breeding areas in the locality.

Social

(i) Both the regional and local communities will benefit substantially from the proposed development as a result of:

- achievement of regional planning objectives;
- provision of high quality public recreation facilities;
- stimulus for local tourism industry;
- provision of short and long-term employment opportunities;
- improved access to the estuary and river foreshores;
- control of mosquito and odour problems;
- provision of residential land; and
- provision of tourist facilities.

(ii) Regional conservation and recreation values will not be adversely affected by the proposed development, which is ideally located to enhance the community's enjoyment of these values.

(iii) Existing community services and facilities will not be adversely affected and road systems will be modified to cater for the increased traffic resulting from the development.

DETAILED ASSESSMENT OF HABITAT MODIFICATIONS

The land use and public amenity value of the project site will be substantially improved as a result of the proposed development. However, to achieve this improvement, substantial modification of natural habitats and landform will be required. It is recognised that some of the wetland habitats to be modified have local conservation value as seasonal feeding areas for limited numbers of waterfowl species, particularly those belonging to the heron/egret/spoonbill group of wading birds. It is also recognised that the scale of development proposed for the land north of Old Coast Road may inhibit use of the floodway wetland reserve and the artificial freshwater lake by shy wading birds, although many other less sensitive species of waterfowl (such as ducks, swans, cormorants, pelicans and ibis) are likely to be attracted to these wetlands. To compensate for this loss, wetlands have been incorporated into the golf course design specifically to provide habitat of value to the more reclusive species of birds such as the spoonbills and egrets.

In recognition of the importance attached to maintenance and enhancement of wetland function by the EPA, the PER contains a separate appendix which concentrates solely on evaluating pre- and post-development wetland values. The assessment is based on the numerical classification system described in EPA Bulletin No. 374. This system seeks to determine a score for various wetland attributes which, when totalled for each wetland, enables its classification into one of the following categories:

- H: High conservation
- C: Conservation
- O: Conservation and recreation
- R: Resource enhancement
- M: Multiple use

For the purpose of this assessment, the project site was divided into five land units which are distinguishable on the basis of both natural characteristics and the type and scale of land use proposed for each unit. The five units correspond to the major habitats described earlier, i.e.:

- upland/lowland terrestrial unit;
- lowland wetland unit;
- delta complex (Pelican Point);
- Leschenault Inlet foreshore; and
- Collie River foreshore.

For each unit, its present use, condition and habitat value is described and assessed where applicable using the numerical evaluation system to derive a value classification. Subsequently its modified use, condition and habitat value is described and also assessed to derive its likely post-development value classification.

The results of this assessment are summarised as follows.

LAND UNIT	CLASSIFICATION	
	Pre-development	**Post-development**
Upland/lowland terrestrial	No existing wetlands	R
Lowland wetland	M	O
Delta complex	M	R
Leschenault Inlet foreshore	H	H
Collie River foreshore	Not applicable	Not applicable (no change)

The above results indicate that both natural attributes and human use of the five land units will improve due to the proposed development proceeding. This result is largely due to the fact that existing wetlands are largely degraded and under-utilised, are seasonal in availability and are recognised problem areas for mosquito breeding and odour. The proposed development will replace these wetlands with permanent bodies of shallow water and islands of natural vegetation which will not only provide food all year round, but will also provide drought and predator refuge. The increased diversity of habitat type and its permanence will more than compensate for the loss or modification of the existing wetlands.

The proposed landscaping of the golf course and protection of existing dense tree stands will also have a beneficial effect on native wildlife and bush bird populations.

ENVIRONMENTAL MANAGEMENT PROGRAMME

The proposed development is a complex project which has the potential to provide a wide range of benefits to the local and regional community. However, it is situated adjacent to Leschenault Inlet, a natural environment of high conservation and recreation value and hence will require substantial management to minimise its impact on that environment during both the construction phase of the development and its subsequent operation phase.

Virtually all of the potentially adverse effects identified in the preceding Environmental Effects section can be substantially mitigated through either appropriate design or sensible management practices. The range of management actions proposed for each of the recognised environmental effects is outlined in Summary Tables 1 and 2 for the construction and operation phase, respectively.

These management actions will be incorporated into distinct management plans for various components of the proposed development. The management plans will also include monitoring programmes aimed at providing feedback on the effectiveness of management actions. The following plans are proposed:

- a Construction Management Plan;

- a Nutrient and Irrigation Management Plan;
- an Artificial Wetlands and Wildlife Conservation Management Plan;
- a Waterway Management Plan; and
- a Foreshore Reserve Management Plan.

The main components of each of the above management plans are outlined below.

Construction Management Plan

Aim: To minimise construction effects on local environment and community.

Tasks: (i) Preserve existing vegetation wherever possible, but especially on the river foreshore, in public open space and in the golf course.

(ii) Undertake bulk earthworks in two major phases to allow development of artificial wetland refuges on ILDA land before alienation of Pelican Point wetlands.

(iii) Minimise dewatering requirements by undertaking major bulk earthworks in the late summer-autumn period.

(iv) Release dewatering fluids and impounded waters to the Collie River under conditions specified by the Leschenault Inlet Management Authority (LIMA).

(v) Stabilise all disturbed soil surfaces by wetting and revegetation.

(vi) Preclude public access during construction works.

(vii) Comply with Section 18 of the *Aboriginal Heritage Act.*

(viii) Monitor workforce compliance.

Responsible authorities: Liaison and reporting will be maintained with Bunbury City Council, LIMA and the Western Australian Museum.

Nutrient and Irrigation Management Plan

Aim: To minimise the potential for additional nutrient contamination of the river and estuary.

Tasks: (i) Minimise application of fertiliser by:

- soil analysis to determine minimum nutrient requirements;

- monitoring soil and foliar nutrient levels to determine appropriate rates of nutrient application;
- use of slow release fertilisers;
- soil modification to enhance retention of nutrients;
- minimise grassed areas in the golf course and landscaped open spaces;
- use local species of grass wherever possible;
- encourage residents to minimise fertiliser application and plant native species.

(ii) Minimise groundwater use by:

- reducing the golf course grassed areas to minimum required;
- irrigation of grassed areas only. Intervening areas will be allowed to dry in summer;
- adoption of appropriate water conservation measures such as seasonal modifications to irrigation programme and dawn/dusk irrigation;
- use of stormwater runoff;
- monitoring of soil moisture levels to determine appropriate irrigation requirements;
- planting of native drought-tolerant species throughout landscaped parts of the development.

(iii) Monitor groundwater levels, abstraction rates, salinity and nutrient concentrations to provide feedback for management plan.

Responsible authorities: Monitoring results will be reported to LIMA, the Bunbury City Council, WAWA and the EPA.

Artificial Wetlands and Waterfowl Conservation Management Plan

Aim: To maximise the conservation potential of wetlands and minimise the potential for water quality problems and mosquito breeding.

Tasks: (i) Produce a Landscape Master Plan providing details of the wetland topography, areas of existing native vegetation to be retained, and

plantings. Design of wetlands will be aimed at maximising diversity of habitat, providing predator refuges and shelter belts of native vegetation, and providing wetland nutrient traps.

(ii) Monitor water quality, particularly nutrients and oxygen concentrations.

(iii) Monitor the development of invertebrate biota, including mosquitoes, and amphibians.

(iv) Monitor the use of wetlands by waterfowl.

(v) Implement a fox control programme.

(vi) Enforce the strict control of dogs and cats in the development by signage and public education.

(vii) Plant a range of native flowering shrubs within the golf course and public open space to attract bush birds to the area.

Responsible authorities: Liaison with and reporting to the Department of Conservation and Land Management, LIMA and EPA.

Waterway Management Plan

Aim: To ensure the serviceability and integrity of all public infrastructure and to maintain acceptable water quality within waterways and the adjacent river.

Tasks: (i) Minimise the potential for water quality problems by:

- banning sewage discharge from boats;
- minimising the discharge of stormwater and constructing silt and grease traps at all drainage points to the waterways.

(ii) Monitor water quality, especially nutrients and chlorophyll 'A'.

(iii) Monitor sediment quality, especially nutrients, and metals.

(iv) Monitor the condition of wall structures, sedimentation rate and navigable depth.

(v) Establish contingency plans.

Responsible authorities: Liaison and reporting to LIMA, EPA, Bunbury City Council and the Department of Marine & Harbours.

Foreshore Management Plan

Aim: To protect the conservation value of intertidal flats for shorebirds while enhancing the value of foreshores for passive recreation.

Tasks: (i) Minimise disturbance to waterfowl by:

- public education;
- strict control of dogs;
- set paths back from the waters edge; and
- additional plantings of appropriate trees.

(ii) Control public access via appropriate location of:

- car parks;
- toilets;
- picnic areas; and
- boat ramps.

(iii) Monitor the success of management actions.

(iv) Monitor the use of intertidal flats by shorebirds.

Responsible authorities: Liaison and reporting to the Bunbury City Council and LIMA.

LEGAL AGREEMENT

The commitments outlined in the above management plans, plus any conditions subsequently imposed on the project by the EPA, LIMA and other affected government authorities will be incorporated into a Legal Agreement between the Proponent and the Bunbury City Council. It is envisaged that an appropriate mix of tourist, managed residential and conventional residential development will be negotiated with LIMA and the City of Bunbury, and resulting ownership and management commitments will be incorporated into the Legal Agreement. The need for short-stay tourist and holiday accommodation adjacent to the foreshores and floodway wetland reserve is acknowledged, and appropriate commitments to this effect will also be incorporated into the Legal Agreement.

Approval of the rezoning application by the Minister for Planning is conditional on prior finalisation and acceptance by the Proponent and City of Bunbury of the commitments contained in the Legal Agreement.

CONCLUSION

The proposed development has been researched by the Proponent since 1986. It has been designed to accommodate planning guidelines for the site and the region and to overcome environmental constraints applicable to the area. The Proponent has addressed recommendations made by the EPA and LIMA in DCE Bulletin No. 267 and in subsequent correspondence, in the design of the proposed development. Extensive consultations have been held with all appropriate land and water use regulating authorities.

The local conservation value of some of the wetlands on the site have been recognised and compensation for their modification has been incorporated into the golf course design. The conservation and recreational values of Leschenault Inlet will be protected via a combination of appropriate design and sensible management practices.

The major permanent effect of the development will be the change of landscape aesthetics from a vista of degraded wilderness and open grazing fields to one of a landscaped and built environment. While some may see this as an adverse effect, others will see it as an improvement.

The proposed development will provide substantial benefits to the local and regional community, including:

- community access to and managed use of the estuary and river foreshores in perpetuity;
- provision of short and long-term employment opportunities;
- control of mosquito breeding and odour problems;
- provision of tourist facilities and stimulus of the local tourism industry;
- provision of a diverse range of residential units between Bunbury and Australind adjacent to Eaton townsite;
- provision of public recreation facilities to benefit both the existing and proposed community;
- provision of waterfowl and wildlife refuges.

It is therefore considered that the Proponent has adopted an environmentally responsible approach to the development of a project which will benefit the community. As such it is submitted that the project is environmentally acceptable and the Proponent seeks approval to proceed with the proposed development subject to the design and management commitments made being formally incorporated into the project agreement.

SUMMARY TABLE 1

SUMMARY OF POTENTIAL ADVERSE IMPACTS PREDICTED AND MANAGEMENT PROGRAMME PROPOSED FOR THE CONSTRUCTION PHASE OF THE PELICAN POINT, BUNBURY DEVELOPMENT

PREDICTED IMPACT	MANAGEMENT COMMITMENTS
Alienation of terrestrial habitat, including wetlands, fringing vegetation, pasture and parkland.	Creation of a range of artificial wetland habitats. Retention of mature trees on golf course land and along the foreshores. Landscaping throughout the development.
Localised, short-term increase in turbidity of estuary waters on release of impounded waters and excavation of the canal and non-navigable floodway lake entrance channels to the Collie River.	Dewatering fluids will be impounded on site to allow settlement of suspended particulates before discharge to the Collie River. Timing of discharge of dewatering fluids and breaching of the canal and lake connections to the estuary will take place to the satisfaction of the EPA and LIMA.
The landform of the development site will be modified with excavation of the artificial waterways and filling of the site.	The development will be designed to minimise the impact on landform. Filling of the site will only occur to the required level for engineering purposes (2.4 m AHD). Retention of mature trees and rehabilitation of the site will minimise the impact on landform.
Impact of construction earthworks on soil stability.	Exposed soil surfaces and stockpiled spoil and topsoil will be stabilised. Following construction, lawns and trees will be planted.
Dust impact on local residents.	Dust will be suppressed by watering.
Traffic, noise and vibration impacts on local residents.	Distance to the nearest residents should minimise impacts. Transport routes and hours of operation will be subject to approvals by the City of Bunbury. Liaison with the City of Bunbury throughout the construction phase.
Public access to the site will be prohibited during construction to ensure public safety.	The construction site will be fenced and signs erected at access points to enforce access restrictions.
Disturbance of Aboriginal artefact sites, assessed as being of low archaeological significance, identified on the subject land.	The proponent will comply with the requirements of Section 18 of the *Aboriginal Heritage Act*.
The landscape of the area will be altered by construction of the development.	The development has been designed to blend with the existing landscape as much as possible. Buildings will be confined to two development levels. A comprehensive landscape master plan will be prepared by the proponent. Public open space will be developed and maintained by the proponent for three years following practical completion.

SUMMARY TABLE 2

SUMMARY OF THE POTENTIAL ADVERSE IMPACTS PREDICTED AND MANAGEMENT PROGRAMME PROPOSED FOR THE POST-CONSTRUCTION PHASE

PREDICTED IMPACT AND TIMING	MANAGEMENT COMMITMENTS
PHYSICAL ENVIRONMENT	
Groundwater abstraction will lead to drawdown within the Leederville Formation. Potential impact of abstraction on the long-term sustainability of the groundwater resource and the saline interface within the Leederville Formation.	Monitoring of groundwater drawdown, quality and levels within the Leederville Formation to confirm predictions of availability.
Impact of the proposed drainage system on estuary water quality - on-going potential impact.	Stormwater runoff will be contained on site where possible. Silt, grease and other contaminants will be trapped before stormwater drainage is discharged to the waterways.
Potential impact of nutrient infiltration from on-going management of areas of public open space and the golf course on estuary water quality.	Use of slow-release fertilisers, native vegetation planting and turf management will minimise nutrient input from the golf course and landscaped areas. Nutrient monitoring programme.
Occasional fuel/oil spills within the canal and marina - on-going risk.	An Oil Spill Contingency Plan will be prepared for the development.
Occasional accumulation of weed, rubbish and debris within the artificial waterways.	Weed/debris will be removed by the Waterways Manager as necessary.
Nutrient and metal accumulation in canal sediments in the medium to long term.	Discharge from boat holding tanks will be strictly prohibited.
Siltation of canal and entrance channels in the long term.	Monitoring of canal depth will indicate the need for maintenance dredging, to be carried out by the Proponent as required.
Potential impact of the development on shoreline stability in the long term.	Reservation of foreshores and building setback. The shoreline adjacent to the entrance channels of the canal and lake to the Collie River and boat launching ramp will be stabilised in accordance with approvals to be sought from LIMA.
BIOLOGICAL ENVIRONMENT	
Potential on-going impact of increased urban/human/domestic and feral animal pressures on the use of artificial wetlands and the foreshore by waterfowl.	Creation of islands; planting of shelter belts; setting paths back from the water's edge; development of a public education programme; strict control of dogs; formulation of a fox and feral cat reduction programme if required; direction of light away from water; enforcement of speed limits within the development.
Increased human use of the estuary may lead to a local decline in fish populations of Leschenault Inlet in the medium to long term.	Co-operation with the Fisheries Department in educating recreational fishing enthusiasts on minimum catchable fish sizes and bag limits by appropriate signage within the marina and at the public boat ramp.

SUMMARY TABLE 2

SUMMARY OF THE POTENTIAL ADVERSE IMPACTS PREDICTED AND MANAGEMENT PROGRAMME PROPOSED FOR THE POST-CONSTRUCTION PHASE

PREDICTED IMPACT AND TIMING	MANAGEMENT COMMITMENTS
HUMAN ENVIRONMENT	
Increased recreational boating activities within estuary waters resulting from the development may impact upon present users.	Navigation aids will be constructed to the satisfaction of DMH.
Potential reduction in the conservation value of the adjacent System 6 areas and the subject land resulting from the development.	The Proponent's commitments with regard to provision of waterfowl habitat, rehabilitation and an integrated management programme is expected to enhance the value of the area for conservation and passive recreation.
ENVIRONMENTAL CONSTRAINTS	
Impact of the proposed industrial site west of the Preston River diversion on the tourist/recreational uses of the development land.	Tourist/residential uses of the site have been planned external to the buffer zone (Rigden Lines) proposed for industry in the area. Tree belts will be planted between the industrial zone and housing on the site.
On-going mosquito nuisance.	Mosquito controls formulated by the Mosquito Control Review Committee have been implemented on adjacent land and removal of mosquito breeding areas on Pelican Point should further reduce mosquito nuisance.
Flood risk in the event of the 1:100 year flood.	The development incorporates the floodways recommended to maintain the flood compensation characteristics of the site. Building levels will be set above the predicted 1:100 year flood level.
Greenhouse Effect.	Minimum fill levels for the development have included the accepted 30 cm allowance for potential sea level rise resulting from the Greenhouse Effect.

NOTE: ALL LEVELS ARE TO AHD

PELICAN POINT MASTER PLAN

TRACT CONSULTANTS
LANDSCAPE ARCHITECTS & URBAN DESIGNERS
RUSSELL TAYLOR & WILLIAM BURRELL
TOWN PLANNERS & CIVIC DESIGNERS
JULY 1991

NORTH

LEGEND

PUBLIC ROADS

SEMI PRIVATE ROADS

PRIVATE ROADS

OPEN SPACES

HIGH GROUND (Golf courses)

RIPARIAN VEGETATION

FORESHORE

PELICAN POINT, BUNBURY

PUBLIC ENVIRONMENTAL REVIEW

1 INTRODUCTION

1.1 THE PROPONENT

The Proponent for the proposed development is Pelican Point Pty Ltd, a private company registered in Australia. The address of the Proponent is 442 Murray Street, Perth, Western Australia.

1.2 THIS DOCUMENT

This document is a Public Environmental Review (PER) which has been prepared by LeProvost Environmental Consultants (LEC) on behalf of Pelican Point Pty Ltd for the Pelican Point development. The level of assessment was determined by the Environmental Protection Authority (EPA) under the provisions of the *Environmental Protection Act 1986*.

This document contains a description of the existing environment at both local and regional scales, a description of the proposed development, identification and assessment of the impacts predicted to be associated with the project and the constraints which the environment will impose on the development, and a management programme which outlines actions required to minimise the potential adverse impacts of the project on the environment.

1.3 PROPONENT'S OBJECTIVE

The Proponent proposes the construction of a range of tourist and residential accommodation and resort facilities, including an 18 hole golf course, on land at Pelican Point in Bunbury, Western Australia (Fig. 1).

The Proponent's objective is to construct and operate an environmentally compatible tourism development [as defined by the State Government's Guidelines for Tourism Development in Western Australia (1989)]. Specifically, this has meant designing the project to satisfy existing planning guidelines, resolving environmental constraints on development, and providing for on-going future management of the site. By adopting this approach the Proponent has designed a development which is aimed at benefiting both the Proponent and the local community, while maintaining and enhancing the natural values of the environment upon which the project is dependent.

1.4 PROJECT OUTLINE AND TIMING

The proposed development will be constructed on land encompassing Lot 11 and Part Location 26 (Pelican Point) and Lot 100 [Industrial Lands Development Authority (ILDA) land], as shown on Figure 2. The Pelican Point development concept is shown on Figure 3.

The proposed project will provide the following facilities:

- an 18 hole golf course and Golf Resort;
- a public boat launching ramp with car and trailer parking;
- several areas of landscaped public open space with car parking and toilet facilities adjacent to the estuary foreshores;
- permanent waterfowl refuges;
- a resort hotel and function centre;
- a range of tourist and residential accommodation within a waterway setting;
- a residential canal estate and small private marina; and
- a residential Golf Estate and local shopping centre.

It is proposed to construct the development in seven stages (Fig. 4). In an agreement negotiated with the City of Bunbury, the proponent is committed to begin construction of Stage One within 18 months of receiving approvals to proceed. Construction of subsequent stages will follow sequentially with completion of Stage Seven expected within five years.

1.5 RESPONSIBLE AUTHORITIES

Authorities responsible for management of the Pelican Point development include:

(i) The Proponent - construction management, management of the residential waterways and lakes in perpetuity, management of the resort development and golf course, and management of foreshores and public open space for a period of three years, at which time management responsibility will be handed over to the City of Bunbury.

(ii) The City of Bunbury - Waterways Manager and foreshore management.

(iii) Leschenault Inlet Management Authority (LIMA) - management of the Leschenault Inlet and estuarine reaches of the Collie River.

(iii) The Water Authority of Western Australia (WAWA) - domestic water supply and licensing of groundwater abstraction for reticulation purposes.

(iv) The Department of Marine and Harbours (DMH) - jetty licensing, navigation aids.

1.6 RELEVANT STATUTORY REQUIREMENTS - APPROVAL PROCEDURE

Approvals for the total proposal (Stages One to Seven, as outlined in Section 4.4) are sought from the State Government and the City of Bunbury following advice from relevant authorities.

The statutory procedures which must be followed to develop and operate the project are:

(i) submission of the PER to the EPA and LIMA for an eight week period of public review and comment;

(ii) EPA consideration of the PER, together with public submissions and advice from other relevant authorities;

(iii) EPA recommendation to Government (through the Minister for the Environment) that the project may proceed on environmental grounds, and Government acceptance of this recommendation; and

(iv) Department of Planning and Urban Development (DPUD) consideration of the project, involving advice from other authorities in specialised areas.

1.7 STUDIES CONDUCTED

The following consulting groups have provided input to the project:

- LeProvost Environmental Consultants - botanical survey, environmental assessment, design of management programmes, design and production of the PER;
- Russell Taylor and William Burrell, Consultants in Town Planning and Civic Design (Taylor & Burrell) - project planning and design, land use study;
- Gutteridge Haskins and Davey Pty Ltd - project engineering aspects;
- Riedel and Byrne Consulting Engineers Pty Ltd (Riedel & Byrne) - geometric aspects of the canal and non-navigable waterway, flushing and exchange characteristics, and details of wall structures;
- Groundwater Resource Consultants - groundwater resource investigations, nutrient and irrigation management;
- Ninox Wildlife Consulting - waterbird survey and avifaunal conservation status of the project area, and recommendations for artificial wetland habitats;
- R. O'Connor, G. Quartermaine and C. Bodney - archaeological and ethnographic surveys;

- Zuideveld Bennett - site survey;
- Tract Consultants - landscape planning; and
- White Dundas - architectural design.

1.8 ACKNOWLEDGMENTS

The assistance of officers from the following Government departments who provided information used in the production of this report is gratefully acknowledged:

- Aboriginal Sites Department, Western Australian Museum;
- City of Bunbury;
- Department of Conservation and Land Management;
- Environmental Protection Authority;
- Leschenault Inlet Management Authority; and
- Waterways Commission.

2 PROJECT JUSTIFICATION

2.1 PRESENT ZONING AND DEVELOPMENT OPPORTUNITIES

2.1.1 Introduction

Development of the Pelican Point site is subject to consideration of the zoning and planning policies and guidelines which have evolved for the Bunbury Region in general, and Pelican Point in particular. Planning documents relevant to the development of the site include the City of Bunbury Town Planning Scheme (TPS) No. 6, the Bunbury Region Plan, and the Leschenault Inlet Management Plan.

2.1.2 City of Bunbury Town Planning Scheme No. 6

In the City of Bunbury Town Planning Scheme No. 6, the land to the north of Old Coast Road, which includes Pelican Point, is zoned "Special Use" (Resort Development), while the land to the south of Old Coast Road, which includes Lot 100, was zoned "Rural" pending the outcome of the Bunbury Region Plan (Fig. 5). Town Planning Scheme No. 6 also makes general policy statements about the Pelican Point locality, which may be summarised as follows:

- limited resort development should be allowed after due recognition of the site's constraints;
- the foreshores of both the Collie River and Leschenault Inlet should be set aside for non-urban uses; and
- relevant proposals for floodways in the Regional Flood Study should be executed.

2.1.3 Bunbury Region Plan

The Bunbury Region Plan (SPC, 1987) is a land use policy for the City of Bunbury and adjacent parts of the Shires of Harvey, Dardanup and Capel. The area covered by the plan is nominally defined as land within 20 km of the Bunbury Town Centre, an area of approximately 650 km^2. An extract from the Plan which covers the central part of this area, including the proposed development site, is presented in Figure 6.

The Region Plan report also identified the need to make provision for the floodways of the lower Preston and Collie Rivers, and acknowledged the recreational and potential resort values of the Pelican Point area.

In addition, the report recommended the adoption of industrial buffer zones based on the minimum distance that a particular class of industry should be from existing or proposed

residential zones. The boundaries of such buffers have come to be referred to as "Rigden Lines" (Fig. 7).

The residential boundary adopted under the Rigden Line concept allows for the rounding out of the Eaton townsite and the development of Pelican Point as shown in the two district zoning schemes (Dardanup and Bunbury respectively). As a result of the adoption of this boundary, the northern part of Lot 100 (ILDA land) is included in the existing and future residential precinct, while the southern part is included in a light industry buffer zone (Fig. 6).

Pelican Point appears in the Bunbury Region Plan as two distinct "urban expansion" areas separated by the proposed Collie River floodway and fringed by land to be set aside for "parks, recreation and drainage".

There are no suggestions as to the range of acceptable uses, or the appropriate intensity of use, apart from the policy statements and planning guidelines such as the Rigden Lines.

From discussions with Government agencies involved in the preparation of the Bunbury Region Plan and its subsequent approval and administration, it is clear that Lot 100 was set aside for an indeterminable use at the time, however some form of recreation was, and still is, expected in any detailed development proposal. Clearly the "parks, recreation and drainage" designation was adopted as an appropriate holding device ensuring an adequate buffer between industry located around the port and the residential areas of Pelican Point and Eaton.

The policy statements made in the Bunbury Region Plan which have a bearing on the future development of the subject land (SPC, 1987) are as follows:

Policy Area 4 - Eaton

Precinct A (which includes the southern part of Lot 100): Open Space and recreation as well as the future Preston River Diversion.

Policy Area 10 - Leschenault Conservation Area

Precinct B: Provision should be made for the floodways of the lower Preston and Collie Rivers within the management plans of the southern or Vittoria Bay end of the Inlet.

Precinct C: The northern end of the Inlet should be retained for passive recreation and natural environment uses, while the southern end including the foreshore at Australind, Samphire Bay and Pelican Point should be used for more active recreation and resort facilities.

2.1.4 Leschenault Inlet Management Programme

The proposed development occurs within the area of the Leschenault estuarine system, which is defined as the Leschenault Inlet Management Area. A land use management

programme for this area has been produced by the Waterways Commission (Kinnaird Hill deRohan & Young Pty Ltd, 1983). The implementation of the management programme is the responsibility of the Leschenault Inlet Management Authority (LIMA). The management programme for Leschenault Inlet is intended to promote a desirable state of development of the Inlet by providing guidelines for public usage and development.

The general recommendations of the management programme which apply to this development are as follows:

- development to be in nodes, constrained to the east and south of the Inlet and excluded from the north and west;
- all new developments to be deep sewered;
- restricted development on flood plains;
- environmental margins to be preserved;
- a large section to the north and west of the estuary to become flora and fauna reserves;
- maximise use with due respect for the environment;
- uses to embrace catamaran yachting, power boating and manually-powered boats;
- public ramps and jetties to be developed;
- recreation settlements, camping areas and walking trails to be developed;
- fishing, crabbing and prawning should remain a recreation activity;
- waterways should be in public ownership;
- foreshore reserves should be a minimum of 50 m wide in the estuary and lower reaches of rivers; and
- aesthetic qualities to be protected (landscape).

On the subject of recreation settlements and chalets, the management programme makes the following recommendations:

(i) Maximise public use and limit permanent residential development in prime recreational areas.

(ii) Where proposals impinge on the quality of the waterways or the amenity of the area, they should be planned in conjunction with LIMA, whose input in their assessment should be sought.

The management programme includes a concept plan for development at Vittoria Bay. The management programme recognises the following aspects about development of this piece of land, in regard to its state at that time:

- access to the site represents a traffic hazard on its present alignment (referring to Taylor Road);

- the river bank itself has become denuded of vegetation and serious river bank erosion has occurred;

- the Vittoria Bay site should be opened up as a predominantly public recreation reserve, particularly the very attractive beach;

- the design should be planned in sympathy with the natural features of the site;
- wetland areas should be retained in their natural form, and supplemented by re-vegetation of the area with suitable species tolerant to the salinity levels of the water bodies; and
- the natural drainage points to the Inlet should be deepened and landscaped to improve drainage, which will continue to be an important function as this land lies within the Collie River flood plain.

The development site is in a condition similar to that in 1983, when the Leschenault Inlet Management Plan was prepared. However the vegetation in general, and that along the Collie River foreshore in particular, has become more degraded.

2.2 PROJECT HISTORY

2.2.1 Previous Assessment

A proposal to develop a holiday resort and sporting recreation complex on Pelican Point was submitted in a PER for evaluation by the EPA in 1986 (LSC, 1986). That proposal involved development of the land located north of the Old Coast Road to provide:

- a resort hotel and country club;
- sporting facilities;
- a range of accommodation units;
- a shallow boat haven;
- a nine-hole golf course;
- a riverside function complex; and
- ornamental lakes and landscaped gardens.

The concept plan for the 1986 proposal is presented in Figure 8. This proposal also provided for a single management body to control and be responsible for all facets of resort management.

The proposal was assessed jointly by the EPA and LIMA, who concluded (DCE Bulletin 267, October 1986) that "... the proposal is not inconsistent with the Leschenault Inlet Management Programme for Vittoria Bay and Pelican Point". The DCE report further recommended that "... the resort development on Pelican Point could proceed immediately in an environmentally acceptable manner", subject to the following modifications:

"• the proposal should comply with all aspects of the Collie River Flood Strategy (WA Water Authority Plan PWD, WA 52387-14-1);

• the function centre complex should be located in a place other than the floodway;

- a 50-metre wide foreshore area should be provided along the Vittoria Bay and Collie River foreshores;

- the golf course proposal in its present form is environmentally unacceptable. Development of an environmentally acceptable golf course as part of the project could be achieved within the overall site formed by Pt Loc 26 and the ILDA land. This would involve the provision of an 18-hole golf course and retention of the wetland area so as to incorporate the natural conservation values of the whole area. In developing the combined Pt Loc 26 and ILDA site, it would also be necessary to ensure that the relief floodway required under the Collie River Flood Strategy was also designed and constructed in an environmentally acceptable manner. The development of the combined Pt Loc 26 and ILDA site should only proceed following acceptance by the two Authorities of modified proposals."

2.2.2 Purchase of ILDA Land

The above recommendation basically inhibited the proposal from proceeding because the provision of a golf course was an essential component of the resort complex. The Proponent subsequently sought access to the ILDA land as recommended by the EPA and LIMA, and after first obtaining approval from DPUD to rezone the land to allow residential subdivision in November 1989, was granted conditional approval in May 1990 to purchase the land at current valuation, but taking into account its proposed use and development (as depicted on concept plans submitted to ILDA). A major condition of purchase agreement was that all housing development on the subject land should take place as far north as possible to provide a buffer between residences and the proposed Preston River diversion and port-related industrial zones. The provision of 100 residential units and a commercial centre, in addition to the golf course and wetlands, was accepted by ILDA (Appendix 1) as a necessary prerequisite to enable funding of the land purchase and to produce viability to the project as a whole. It was also recognised that the additional 100 residential units provide vital cash flow in the first stage of the project when loan exposure is at its maximum.

2.2.3 Groundwater Supply

Prior to finalising the purchase of the ILDA land, the Proponent had to establish a source of water supply for irrigation of the golf course and landscaped areas. The Proponent therefore commissioned a hydrogeological investigation of the site at a cost of approximately $100,000 to sink one deep bore (180 m depth) and 11 shallow bores over the project site. The investigation proved the availability of an adequate supply of water and an application to the Water Authority of Western Australia (WAWA) for a licence to abstract groundwater has been made. In subsequent correspondence WAWA have responded to the licence application, indicating that upon receipt of EPA approval for the project, 200,000 m^3/annum could be obtained from the Leederville Formation. This

volume is sufficient for the irrigation of the golf course, however further investigation of alternate sources, i.e. the superficial aquifer and mains supply, will be undertaken for the supply of irrigation requirements within the remainder of the development.

2.2.4 Mosquito Problem and Wetland Studies

Subsequent to the release of the PER in 1986, the Health Department of Western Australia released the Report on Mosquito Eradication Campaign in the Bunbury Region, Western Australia (Wright, 1986). This report identified the location of mosquito breeding sites in the vicinity of Eaton and Bunbury (refer Fig. 9). The project site was identified as a major breeding area in the region, containing some five high priority mosquito control sites and two moderate priority control sites.

Subsequently the Waterways Commission established the Mosquito Control Review Committee (MCRC) in 1987 to advise on mosquito control measures appropriate to conserving the ecological values of breeding sites. This Committee commissioned a study of Leschenault Inlet wetlands aimed at determining the significance of mosquito breeding areas to waterbirds. Forty waterbird sampling sites were monitored on nine occasions between September 1987 and October 1988. As a result, an improved understanding of waterfowl use of wetlands in the region was obtained.

The MCRC subsequently formulated a regional mosquito control strategy (Klemm, 1989) and the recommended strategies for the region surrounding Pelican Point have been implemented. However, control measures for Pelican Point have not been implemented, awaiting the outcome of the proposal contained in this document. It is generally accepted by the MCRC that the proposed project, if approved, will substantially reduce mosquito breeding on the site.

2.2.5 Water Quality and Odour Problems

In December 1989, the Health Department of Western Australia convened a meeting of the various authorities concerned with the management of the Pelican Point wetlands with the objective of trying to resolve the recurrent and long standing problem of offensive odour that exists in the area (refer Appendix 1).

Apparently, both Bunbury City Council and the Dardanup Shire have received numerous complaints regarding an odour emanating from Pelican Point at the beginning of summer each year. The cause of the problem is algae decaying in a seasonal water body situated adjacent to the Old Coast Road. The stench emanates for about four to seven weeks each year.

The stench is strong and unpleasant, causing hardship to the corner store and caravan park situated near the Collie River bridge. The stench has been recorded for as long as people have been residing in Eaton, but appears to have increased in strength in recent years, possibly as a result of Council works to restrict tidal flow into the Pelican Point wetlands in an effort to restrict mosquito breeding activity in the wetlands.

This problem has not yet been resolved and is awaiting the outcome of the proposal contained in this document, since it is generally accepted that the project has been designed to resolve the problems of poor water quality and odour in the wetlands concerned.

2.2.6 Consultation and Resolution of Issues

Once the likelihood of access to the ILDA land had been confirmed, the Proponent submitted a new project design concept to the EPA for comment and re-initiation of the environmental assessment process in September 1989. The response from the EPA (refer Appendix 1) in January 1990 confirmed that the EPA recommendations presented in Bulletin 267 were still applicable and identified the issues of development to be:

- appropriate re-establishment and management of wetland waterbird habitats;
- public access to foreshores;
- set-back of development from the Collie River foreshore;
- appropriate mosquito control;
- appropriate buffer (as modified) to adjacent industrial land;
- hydrogeology of the site and adequate water supply;
- the treatment of existing urban drainage from the Eaton subdivision onto the ILDA land; and
- adequate commitments and undertakings in respect to the management of the project by the Proponent.

The EPA response also stressed the need for appropriate treatment of all wetlands, both natural and artificial, in the project area and advised the Proponent to consult with officers of the Waterways Commission before finalising design details. The level of assessment was set at Consultative Environmental Review (CER). This level of assessment was subsequently raised to PER in mid-1990 as a result of the incorporation of a canal component into the project design. This latter modification was introduced in an effort to improve the economic viability of the project and to increase the diversity of accommodation styles. Maximising the value of the Pelican Point land also allowed a reduction in the density of accommodation units on Pelican Point and provided the financial capacity for the creation of a public park on the tip of Pelican Point. This public park and the treatment of the Collie River foreshore were negotiated at length with Bunbury City Council and representatives of LIMA, resulting in a rational equity transfer between the Proponent and the authorities.

As advised, the Proponent and his consultants have held discussions regarding the achievement of an acceptable project design with all Government authorities involved.

- The Waterways Commission and CALM have been consulted regarding wetland modification and mosquito control strategies.

- DMH have been consulted regarding canal design concepts, wall treatments and jetty licence.

- WAWA have been consulted regarding floodway design requirements and availability of water supply.

- DPUD have confirmed the adequacy of the buffer between residential areas and the port industrial area.

- The Health Department of Western Australia has been consulted regarding proposed wetland treatment for control of mosquitoes and odour problems.

- Agreement has been reached with Bunbury City Council regarding on-going foreshore management and waterways management.

- Discussions with LIMA, Bunbury City Council and DPUD on the housing mix has lead to the adoption of the "managed housing" concept being applied to the majority of the proposed units within the project.

- The Waterways Commission and DMH have been consulted on water quality and management within both the navigable and non-navigable waterways.

The present design concept has developed as a result of the above discussions and negotiations, all aimed at resolving the issues identified by the EPA.

The development as proposed incorporates the following features:

- The golf course, originally proposed as a nine-hole course, located on the southern portion of Part Lot 26, is now proposed to be wholly located to the south of Old Coast Road, on Lot 100, the adjacent ILDA land. This golf course will attract public patrons from both the visitor and resident populations. It will also have a private component.

- The flood management requirements of WAWA have been complied with. Specifically, there are no structures proposed within the "Recommended limit of floodplain encroachment", shown in the Collie River flood strategy, in the present development proposal.

- The 250 m wide relief floodway, which was previously to form part of the golf course, is now proposed as a naturally vegetated wetland reserve for conservation of waterfowl habitat.

- Provision has been made for a 50 m wide reserve along the Vittoria Bay foreshore.

- A foreshore reserve is to be provided along the full length of the Collie River foreshore, with provision for access around the marina/canal entrance and hotel promenade.

- Public facilities along the foreshores will be improved.

- Improved public access to all foreshore and public open space areas will be provided.

- Existing seasonal wetlands and native vegetation, particularly mature trees, have been retained wherever possible with modifications to make the wetlands permanent, to improve water quality and reduce mosquito breeding.

- Additional permanent saline and freshwater wetlands are to be created within the golf course (ILDA land).

- The management of all wetlands within the project will be undertaken according to management plans to be approved by the relevant authorities.

However, in order to provide all of these features and to maintain the economic viability of the project, it has been necessary to increase the amount of accommodation provided within the development in comparison to that proposed in 1986 and to include a proportion of residential housing. Discussions have been held over an extended period of time with DPUD and the City of Bunbury in order to arrive at the present proposal, which seeks to integrate residential development with short-stay/holiday accommodation to produce a viable development. "Managed housing" provides owners with the option of leasing their house or unit through a control management and maintenance group (corporate body). The balance between permanent and non-permanent will be the subject of the legal agreement with Council to be finalised before final approval of the zoning.

It is considered that an acceptable balance of accommodation has been provided in the concept plans, while public equity in the form of facilities, access to and use of the foreshores and open space is ensured.

A draft copy of the PER was submitted to the EPA for comment and review in October 1990. In its response of April 1991, the EPA drew attention to the recent release of its Draft Environmental Protection (Swan Coastal Plain Wetlands) Policy, March 1991 and requested that the Proponent's consultants demonstrate the enhanced wetlands environmental values in accordance with guidelines presented in the recently released EPA Bulletin 374 (EPA, 1990).

This request has subsequently been complied with and the draft PER report was approved for public display in June 1991.

2.3 NEED FOR DEVELOPMENT

Population projections, together with the predicted expansion of the tourist industry in the Bunbury region (Section 3.5.1.2), indicate a requirement to cater for the recreational and housing needs of the growing resident and visitor population. At present, tourist facilities are limited, and recreational pursuits centre around the natural attributes of the region. Proposed projects include a small holiday resort at Point Duoro and the Bunbury Harbour City development, which incorporates a hotel, marina, fishing wharf, condominiums, offices and residential uses. Neither of these developments incorporate a golf course or

canal waterway component. There are presently two 18-hole golf courses in the Bunbury region, one at Australind and one at Capel, both of which are private clubs.

The Pelican Point site is in a prime waterfront location and has expansive vistas, attributes which have lead to its identification as a future resort area. The proposed development would extend these benefits to both the tourist population and local residents.

The proposed development is located on the only site within the Leschenault Inlet Management Area where a comprehensive resort of this type can be developed. The resort is ideally situated to provide recreational access to the waters and beaches of the proposed Leschenault Regional Park comprising Leschenault Peninsula and Inlet.

The project site is currently degraded, unmanaged and little used except by crabbing parties and horse riders along the Vittoria Bay foreshore. It is also a major mosquito breeding area within the region and suffers at times from odour problems.

Development of the site will enable:

- increased public access to the Inlet and River foreshores;
- long-term management of foreshores and public facilities;
- management of odour and mosquito breeding problems;
- achievement of land-use planning objectives for the region; and
- improvements to the recreational facilities of the region.

Support for site development has been received from the Bunbury City Council since 1986, when conditional planning approval for the original development proposal was granted. Subsequently, the Council has supported the project by:

- selling Council-owned land to the Proponent for incorporation into the project;
- initiating the rezoning application required to allow the current proposal to proceed;
- convening co-ordination meetings of all representatives of Government departments involved in approval of the development.

The State Planning Commission subsequently endorsed the rezoning application for public review subject to only minor conditions which are acceptable to the Proponent.

2.4 ALTERNATIVE DEVELOPMENTS

The potential alternatives to the proposed development of the subject land, as perceived by the Proponent, are:

- retain the present zoning of the land south of Old Coast Road as a rural holding with resort development on the land north of Old Coast Road;
- develop a traditional urban residential subdivision;
- develop a regional recreational facility; and
- no development.

These options are discussed further in the following sections.

2.4.1 Resort and Rural Use

This development option is consistent with current zonings, however it would limit the ability of the Proponent to provide the required range of recreational facilities within the development. Principally, the opportunity to develop a golf course within the region would be lost. Previous EPA and LIMA assessment of the proposal to develop a nine hole golf course on land to the north of Old Coast Road concluded that this option was not environmentally acceptable.

Development of a golf course is essential to maximising the public recreational use of the site, and is consistent with the recreation objective of all relevant land use plans for the region.

Additional development of the land to the south of Old Coast Road, to achieve greater agricultural productivity, could be expected to result in further alteration of the site and thereby reduce the habitat value of the land to waterfowl.

Therefore, this alternative is not economically viable and is not consistent with the recreation objective of land-use plans for the region.

2.4.2 Urban Subdivision

Standard residential subdivision of Pelican Point and the northern part of the ILDA land is a feasible land use, although inconsistent with the intent of the present "Rural" and "Special Use" zonings and the Bunbury Region Plan's resort and recreation policy for the site. This form of development has previously been rejected by planning and management authorities and is not considered as an acceptable option.

2.4.3 Regional Recreation Facility

Development of a regional recreation facility, incorporating a golf course and resort development, while also allowing for the Collie River floodway, is not an economically viable option in the absence of integrated residential development. Capital outlay on the site needs to be recouped from the sale of residential property to provide the means for establishing the project in the short to medium term, and subsequently to provide future funds for long-term management of the site.

2.4.4 No Development Option

The subject land to the south of Old Coast Road is currently used for grazing activities, while the land to the north of Old Coast Road has (a derelict) chalet development and a public boat launching ramp. The Vittoria Bay shoreline is used for crabbing and other

passive recreational activities. The majority of the site vegetation has been degraded by previous human activity, and access to the foreshore regions is presently restricted due to wetlands on the site. The no-development option would allow further degradation of the site to occur, especially as population growth in the area puts pressure on the foreshore areas for recreation. In particular, the erosion and loss of fringing vegetation along the Collie River is of concern.

In addition, failure to develop the site as proposed would mean that benefits to the local community, including the provision of a golf course, boat ramp, hotel and convention facilities, as well as a range of other resort and tourist facilities, rehabilitation, management and provision of formal access to the foreshore, and wetland rehabilitation and provision of managed waterfowl habitat, would be lost.

3 EXISTING ENVIRONMENT

3.1 INTRODUCTION

The development site and adjacent foreshore reserves total 133.95 ha in area, and are located approximately 5 km to the north of the commercial centre of Bunbury (Fig. 6). The subject land incorporates Part Location 26 (Pelican Point itself), Lot 11 and Lot 100 (Fig. 2). Old Coast Road separates the resort and associated residential land from the land proposed for the golf course and golf residential estate. The site is bounded by Eaton to the east, the lower reaches of the Collie River to the north-east, Vittoria Bay to the west, the proposed Preston River diversion to the south-west, and the railway line to the south (Plates 1 & 2).

The following description of the salient physical, biological and social characteristics details the local environment (the project site and adjacent areas) and places the project in the context of the regional environment. The information presented has been obtained from a desk review of available documents, in particular the documentation of the 1986 Pelican Point proposal (LSC, 1986). In addition, recent on-site surveys have been conducted to gain information about terrestrial assemblages for Lot 100, groundwater quality and availability, waterbird usage of wetlands, and archaeological and ethnographic significance of the site. A topographic survey has also been conducted to accurately define the floodway boundaries.

3.2 AVAILABLE INFORMATION

Details of the regional setting of the project site, including hydrology, oceanography, geomorphic processes and habitats in the study area and adjacent, have been taken from LSC (1986). The geomorphology of the subject land has been described in Semeniuk and Meagher (1981) and Semeniuk (1983). An assessment of water quality within the Collie River was undertaken by LSC (1986), and recent Waterways Commission monitoring data for the Collie River has been referred to within this document.

The estuarine biology of Leschenault Inlet has been described by Meagher (1971), Semeniuk and Meagher (1981), LSC (1983) and Chalmer and Scott (1984). Information regarding ecosystem dynamics and condition is presented in LSC (1983), and the conservation significance of the project site is discussed in EPA (1983), LSC (1986) and Ninox Wildlife Consulting (1989). Mosquito nuisance is discussed by Wright (1986) and Klemm (1989).

The human environment has been described by the Environmental Protection Authority (EPA, 1983), the Waterways Commission (Kinnaird Hill deRohan & Young Pty Ltd, 1983) and Taylor & Burrell (1987).

3.3 PHYSICAL ENVIRONMENT

3.3.1 Regional Setting

3.3.1.1 Climate

The regional climate of the Swan Coastal Plain in the vicinity of Bunbury is very similar to that of Perth, some 155 km to the north. It may be described as Mediterranean, with hot, dry summers and mild, wet winters. The components of the climate which are important to the development and to the maintenance of the habitats of the study area are temperature, rainfall, evaporation and seasonality of phenomena.

The mean daily temperature for the area around Bunbury varies from a maximum value of 27.4°C in summer to 16.5°C in winter, while the mean minimum temperature is 16.5°C in summer and 8.3°C in winter. These temperatures are mild and typical of subtropical climates. Rainfall is moderate (c. 881 mm/y) and falls mainly between May and August. Evaporation in the region is high (c. 1,984 mm/y).

Wind data analysed by Steedman (1976) show that two wind systems affect the Bunbury region. These are:

(i) cyclonic and anticyclonic winds; and
(ii) a landbreeze and seabreeze system.

Cyclonic and anticyclonic winds are linked to the seasonal north-south migration of eastward-travelling high and low pressure systems that traverse the southern parts of Australia (Gentilli, 1972). During summer, when the centre of the anticyclonic belts are situated far to the south of the continent, winds originate from the eastern sectors. In winter, the belt is located to the north of Bunbury and, as a result, winds originate from the north-west to southern sectors.

A landbreeze and seabreeze system is developed in response to solar heating followed by cooling of land and sea surfaces, and is consequently most strongly developed during the summer months. Landbreezes originate from eastern sectors, while seabreezes are predominantly west to south-westerly.

3.3.1.2 Geomorphology

The region encompassing Leschenault Inlet and the Collie delta is located in the southern portion of the Swan Coastal Plain, and it contains a variety of landforms of Pleistocene to Holocene age (McArthur & Bettenay, 1960; Semeniuk & Meagher, 1981).

The most recent descriptions of the region are presented in papers by Semeniuk and Meagher (1981), and Semeniuk (1983). These papers relate Holocene features to climate,

specifically rainfall, wind and evapotranspiration, and to oceanography. The authors recognised four geomorphic units in this area (Fig. 1), including:

(i) Leschenault Peninsula, a narrow barrier of dunes belonging to the Quindalup system;

(ii) Leschenault Inlet, a narrow estuarine lagoon;

(iii) a hinterland of Bassendean and Spearwood Dunes and Pinjarra floodplain elements; and

(iv) a delta complex comprising various sediment types deposited at the mouth of the Collie and Preston Rivers.

The Inlet is a tidal lagoon some 14 km long, between 1.5 km and 2.5 km wide and 0.3 m to 2 m deep. It lies parallel to the coast and is protected from the Indian Ocean by the Leschenault Peninsula.

The Collie River delta is digitate in form (i.e. has several finger-like sections). The delta has been formed where the Collie River has discharged fluvial sediments into a protected lagoon. The Collie delta is deltoid (triangular) in shape and has one major distributary channel which separates the delta through its central and outer portions around mid-channel islands.

The Inlet, delta and associated drainage systems and the interdunal depressions of the adjacent dune sytems contain an extensive array of permanent and seasonal wetlands (Fig. 10) of varying salinity.

3.3.1.3 Hydrology

The Collie River drains a catchment of some 3600 km^2 in area, of which the upper 2830 km^2 is dammed to form the Wellington Reservoir. Below the dam, the River drains mainly grazing pasture. The Brunswick River discharges into the Collie a few kilometres upstream from the Collie delta. The Wellington Reservoir is used for irrigation purposes, so there is a restricted but steady flow of fresh water in the River for most of the year. Construction of the dam has reduced the quantity of flow discharged during the winter and spring, although input from the Brunswick River still causes a marked reduction in water salinity and an increase in flow during winter.

3.3.1.4 Hydrodynamics

Construction of the "Cut" through the Leschenault Peninsula has changed the hydrodynamic characteristics of both the Leschenault Inlet and the lower reaches of the Collie River. The "Cut" has improved flushing and water exchange and transformed the lower reaches of the Collie River from being a fluvial-dominated system to a tidal-dominated system.

The tidal regime of Leschenault Inlet is dominated by astronomical tides. However, although the range of the daily astronomic tides in the Inlet is only about half of that of the tides in the open sea and seldom exceeds 0.3 m, the rate of tidal exchange within the Inlet remains high because the water is very shallow. Barometric tides, with periods of several days and a range of about 0.3 m, are superimposed on the astronomical tides.

The average maximum water level range experienced within Leschenault Inlet is about 1.2 m, however during Cyclone Alby the water level near the mouth of the Collie River rose to 1.43 m Australian Height Datum (AHD). The level expected from the 100 year average recurrence interval (ARI) flood is 1.92 m AHD in the estuary and 2.16 m AHD at the Collie River Bridge.

3.3.2 Local Setting

3.3.2.1 Topography and Bathymetry

The topography of the development site is depicted in Figure 11. Pelican Point is low-lying (generally less than 2 m AHD), flat land which has only minor undulations. The topography of the proposed golf course land is also mostly flat, excepting the south-eastern section, where a dunal ridge reaches an elevation of approximately 18 m AHD.

Examination of dredging records and soundings show the maintenance of the channel past the bar island at about -1.6 m AHD. The channel depth was unchanged over a six year period to 1985, requiring no dredging. The depth of the Collie River at the site of the entrance to the proposed canal has remained constant over the period 1965-1985 at an average of -2.3 m AHD. River depths in the vicinity of the lake connection are in the order of -1.6 m to -2.3 m AHD.

3.3.2.2 Soils

The shallow stratigraphy and soils of the Collie delta and Pelican Point are variable. Typically, former flood plain deposits are interspersed with former sand-filled channels, mud-filled billabongs and blocked channels. These are capped by flood plain sheets and/or aeolian sheets. The lowermost unit of estuarine mud is commonly overlain by medium-grained flood plain sands which are locally incised by a channel filled with coarse alluvial sand. This sequence is veneered by further flood plain deposits of fine to medium-grained shelly sand and muddy sand, as well as by aeolian fine sand.

The topsoil of the dunal ridge, an area of higher topographic relief in the southern portion of the site, consists predominantly of medium to coarse-grained quartz sand. In the south-eastern section medium-grained yellow quartz sand is present to a depth of 10 m. The south-western section of the site is of similar composition with varying silt content.

3.3.2.3 Hydrogeology

Four aquifers underlie the development site, namely the superficial formations, the Leederville Formation, the Yarragadee Formation and the Cockleshell Gully Formation. Regional groundwater flow is in a north-westerly direction and groundwater discharges into Leschenault Inlet and the Collie River.

The superficial formations extend from the ground surface to depths of approximately 20-25 m. These sediments consist primarily of alluvial and littoral deposits which form a heterogeneous, unconfined aquifer. Groundwater in the superficial formations is saline [12,000-15,000 mg/L Total Dissolved Solids (TDS)] over most of the resort area. The horizontal extent of saline intrusion is generally 600-800 m from the Vittoria Bay foreshore. Fresh groundwater occurs within the superficial formations below the dunal ridge and toward the south-eastern portion of the site.

The water table in the superficial formations lies within 2 m of the ground surface, except in the elevated south-eastern part of the site, where the water table occurs at a depth of 10-12 m below ground level (Fig. 11). Following rainfall recharge during winter, groundwater levels in the superficial formations rise to cause inundation of lower lying areas.

The Leederville Formation unconformably overlies weathered Bunbury Basalt and forms a semi-confined, multi-layered aquifer. Groundwater is fresh (350-800 mg/L TDS) and has soluble iron concentrations high enough (0.6 mg/L) to cause staining and encrustation of fixtures.

3.3.2.4 Drainage

On the project site, surface drainage features are poorly developed. Low relief surface topography and predominantly sandy soils enhance direct infiltration and thus most drainage takes place as sub-surface flow. Ponding does, however, occur during winter in low-lying areas where the water table is high, and natural or artificial infill of the natural drainage channels prevents or inhibits surface flow. Artificial channels have been constructed across the site to drain some of the areas of seasonally-inundated land.

3.3.2.5 Geomorphic Units and Habitats

The shallow stratigraphy, soils and geomorphology, combined with groundwater and soil water salinity, provide the basis for distinguishing the habitat types for terrestrial and tidal wetland vegetation. The habitats of the project site correspond to the five land units shown on Figure 12, which are:

(i) upland/terrestrial unit on Lot 100 (Plate 3);
(ii) lowland/wetland unit on Lot 100 (Plate 4);
(iii) Collie River foreshore (Plates 5 & 6);
(iv) Leschenault Inlet foreshore (PLates 7 & 8); and

(v) Pelican Point terrestrial and ephemeral wetland complex (Plates 9 & 10).

The southern portion of Lot 100 is an upland/terrestrial unit which comprises the western face of an aeolian Spearwood dune with an elevation of approximately 18 m AHD, together with the extended toe of the dune, a sloping plain with an elevation of between 1 and 2 m AHD. The dune ridge soils are composed almost entirely of quartz sands, while the soils of the lower slope consist of quartz sand, with a variable content of silt and organic matter.

To the north of the upland unit is a lowland/wetland unit comprising a low plain to a general elevation of 1.0 m AHD surrounding a small central depression at about 0.0 m AHD. The soils are reworked dune and fluviatile deposits and contain mostly quartz sands with variable organic and silt content, which may be high in the wetter depressions.

The Collie River foreshore comprises the relatively steeply sloped bank of a distributary channel backed by low levee banks and the river flood plain/delta. The river channel is incised into deltaic deposits which have been reworked, leaving a shoreline comprised of clean sands. The natural form of the river bank has been modified in places by entrance training walls and erosion protection measures.

The Leschenault Inlet foreshore is comprised of tidally reworked deltaic and estuarine sands which form a gently sloping beach rising from a shallow sub-tidal platform. The intertidal beach zone is backed by a slope and in places a low berm.

Pelican Point is located on the delta and comprises cut-off and infilled distributary channels separated by fluviatile deltaic deposits. The relict river channels contain deposits of silt and organic matter while the intervening deposits are generally composed of sand sized particles. A deposit of sand and shell fragment near the tip of Pelican Point is comprised of spoil dredged from the mouth of the Collie River.

3.3.2.6 Water Quality Near the Project Site

A review of water quality data from recent (Waterways Commission) and previous (LSC, 1983; LSC, 1986) studies has been used to assess the water quality status of the lower reaches of the Collie River.

In an evaluation of water quality data to 1986, LSC (1986) concluded that the water quality characteristics of the lower Collie River were similar to those of other rivers on the Swan Coastal Plain. However, the reduced phytoplankton population of the lower reaches of the Collie River was found to be more typical of coastal marine embayments and this was attributed to the high rate of exchange between the estuarine lower reaches of the Collie River and Leschenault Inlet, and between Leschenault Inlet and the sea. The artificial opening to the sea at Turkey Point (the "Cut") is responsible for the rate of flushing within the estuarine system.

Since 1986, water quality surveys in the Collie River have been less frequent, and much of the sampling by the Waterways Commission has been conducted upstream of the traffic

bridge, between Alexander Island and Point Lautour. The data from these surveys, collected between 1987 and 1990, record values for total nitrogen between 400 µg/L and 3,500 µg/L, total phosphorus between 20 µg/L and 360 µg/L, and chlorophyll 'a' between 4 µg/L and 340 µg/L. These data provide evidence of phytoplankton bloom development in this section of the Collie River.

The major source of nutrients to the Inlet is the input of nutrient-enriched fresh water from agricultural areas within the Collie River catchment and input from the Brunswick and Wellesley Rivers. Analysis of data by LSC (1986) determined the nutrient status of the nearshore waters to be low for most of the year, however on occasions decreased salinities and slightly elevated nutrient levels were recorded, resulting from high winter flow rates in the Collie River.

Algal blooms have been recorded at the Collie River mouth (LSC, 1986), however due to the limitations of recent data, the frequency of blooms in this region since that time can not be determined. These events are expected to be less common than blooms further upstream due to the influence of flushing with the more marine water of the lower Inlet.

3.3.2.7 Geomorphic Processes Operating Near the Project Site

The dynamic processes operating within the Leschenault Inlet system include wind waves, generated on the expansive shallow water body of the estuary by prevailing winds and storms, tidal exchange between the estuary and the ocean via the "Cut", river flood waters, evaporation, and ocean wind and swell waves.

While the Collie delta was originally formed by fluvial deposits from river flow, the reduction is sediment load caused by the Wellington Dam and the onset of tidal fluctuation in water levels caused by construction of the "Cut", has resulted in wind waves becoming the dominant process operating to shape the delta.

A comparison of survey data collected between 1897 and 1984, including an aerial photographic analysis between 1941 and 1984, was previously undertaken for the site region (LSC, 1986). Historical shoreline movement is depicted in Figure 8. The results indicate that apart from the northern tip, the shoreline of the development site has been relatively stable over a long period of time. The northern tip appears to have eroded considerably in the early years following the 1897 survey, but has stabilised with time. It is considered that the growth of Bar Island, through accretion and dredge spoil disposal, has provided Pelican Point with greater protection from wave action (LSC, 1986).

3.4 BIOLOGICAL ENVIRONMENT

3.4.1 Estuarine Biota

Elements of the estuarine biology of Leschenault Inlet have been described by Meagher (1971), Semeniuk and Meagher (1981), LSC (1983) and Chalmer and Scott (1984). The

study area may be considered as two units, these being the tidal reaches of the Collie River and the tidal waters of Leschenault Inlet.

3.4.1.1 Collie River

There is little submerged aquatic vegetation in the lower Collie River, although emergent species of rushes and *Casuarina obesa* fringe the banks.

The fauna within the River, particularly fish, vary as a result of the alternating presence of marine water (summer) and freshwater (winter). The river is used by fish such as the Perth herring, yellow-eye mullet, sea mullet, black bream and mulloway, and forms a nursery area for some of these species.

3.4.1.2 Leschenault Inlet

The shallow marginal shelves of Leschenault Inlet are densely vegetated with seagrasses, particularly *Halophila ovalis* and a range of algae, with an abundant and varied invertebrate fauna of bivalves, polychaete worms, crustaceans and gastropods.

The central basin supports little submerged aquatic vegetation, with the exception of masses of detached macroalgae which are occasionally deposited along the banks of the Inlet. Bivalve molluscs and polychaete worms constitute the dominant elements of the invertebrate fauna. The Inlet supports a substantial fish population, and also acts as a nursery area for the blue manna crab and some of the fish species.

3.4.2 Terrestrial Biota

3.4.2.1 Flora

The terrestrial biota are typical of those found elsewhere on the Swan Coastal Plain, and have been described by Speck (1952), Seddon (1972), Erikson *et al.* (1973) and Heddle (1979). The most conspicuous element of the terrestrial biota is the flora, which forms recognisable assemblages on the various geomorphic units of the delta.

A survey of the vegetative character of Pelican Point was conducted by LSC (1986). The vegetative character of Lot 100 was surveyed and mapped for this report. A variety of vegetation assemblages are present on the Collie delta. Each of these assemblages are linked closely to geomorphology and habitat types. The vegetation units are:

(a) *Eucalyptus* parkland and pastureland (Lot 100 upland);
(b) rush beds (Lot 100 lowland and Pelican Point);
(c) samphire herbland (Pelican Point and Lot 100 lowland);
(d) *Melaleuca* woodland fringe (Pelican Point and Lot 100 upland/lowland interface);
(e) *Eucalyptus* woodland (Pelican Point and Collie River foreshore);

(f) *Casuarina* fringe (Collie River); and
(g) *Jacksonia* shrubland (Pelican Point and Collie River foreshore).

A map of their distribution in shown in Figure 13.

The *Eucalyptus* parkland - pastureland is a highly modified environment found on the slope and hinterland plain on the southern part of Lot 100. The unit consists of remnant, mainly mature Marri, Jarrah and Peppermint, with an open understorey of pasture species (Plate 3).

The samphire herbland is dominated by *Arthrocnemum bidens* and *A. halocnemoides*, with some *Suaeda* and occasional emergent *Melaleuca cuticularis* shrubs. Exotic weeds are few. This assemblage occurs in the depressions and abandoned channels. It also occurs as a broad meadow within the northern sector of Lot 100 (Plate 4). On Pelican Point, this assemblage is in a less modified condition, although natural drainage characteristics have been modified in an effort to reduce mosquito breeding activity (Plate 9). Similarly, the assemblage located on Lot 100 has been drained, grazed and trampled.

The *Jacksonia* shrubland is dominated by scattered shrubs of *Jacksonia furcellata,* 1-2 m high. Locally *Viminaria* occurs. The natural understorey consists mainly of a monocot, *Conostylis*. However, in most areas pasture grasses have invaded the understorey. This assemblage occurs on the low ridges of the delta. It has been frequently burned and is weed infested.

The *Melaleuca* woodland generally forms a fringe to the abandoned channels. The assemblage contains the freshwater paperbark, *Melaleuca rhaphiophylla*, with subordinant *Melaleuca hamulosa*, forming a low woodland structure. The understorey consists of reeds (Plate 9).

The *Eucalyptus* woodland occurs on the sandy floodplain. The assemblage consists of Flooded Gum, *Eucalyptus rudis*, with an understorey of scattered *Jacksonia*, *Viminaria* and pasture grasses. This assemblage also shows evidence of burning and weed infestation.

The marsh consists of rushes forming a closed to open structure along the estuary and river foreshore and beach front. *Juncus krausii* dominates the assemblage. Along the Collie River this assemblage has been impacted by erosion and damage caused by fishing and crabbing parties (Plate 6).

The *Casuarina* fringe occurs along the banks of the Collie River. The unit is composed of a fringe of scattered *Casuarina obesa* trees which border and overhang the river bank (Plate 5). The understorey is rushes, exotic weeds or samphire.

No rare or endangered species of flora were found in the study area during the course of field investigations undertaken for this project and it is concluded from a review of Western Australia's Endangered Flora (Hopper *et al.*, 1990) that no species listed as endangered would be expected to be found in the habitats present in the area of the proposed development.

3.4.2.2 Fauna

The faunal character of the project site is described in detail by Ninox Wildlife Consulting in Appendix 4. This work is based on field surveys conducted in 1985 and subsequently during the period 1987-1988, augmented by literature review. A summary of salient information is presented below.

(a) Waterbirds

Avifaunal surveys have been conducted within Leschenault Inlet and peripheral wetlands as a part of a 12-month study by the Mosquito Control Review Committee (MCRC) to define the importance of mosquito breeding areas to waterbirds (Ninox Wildlife Consulting, 1989). Forty sites were sampled, six of which were within or immediately adjacent to the proposed development area. The results of this survey were analysed to determine the current usage of the proposed development area, and the adjacent estuary.

The results of the MCRC waterbird survey which are pertinent to the project site are:

- Leschenault Inlet is an important regional waterfowl refuge. During the survey some 62 species of waterbird and 23,470 individuals were recorded throughout the total sampling area.

- Of the above, some 41 species and 4,965 individual waterbirds were recorded in the vicinity of the project site.

- Of the birds recorded in the project vicinity, only 928 individuals in total were recorded on land within the development site, the remaining 4,037 were recorded on the tidal flats of the adjacent estuary.

- Of the 928 waterbirds recorded on the development site, the majority were common birds such as pelicans, cormorants, seagulls, ducks (black, grey teal) and swans. Some 198 wading birds were recorded, the majority of which belonged to the heron/egret/ibis/spoonbill group (97 records).

- Within the development site, the habitats used most frequently were the inundated samphire and isolated pools, plus the Collie River and estuary foreshore. Most birds recorded in the ponds were feeding (ducks, swans, herons, egrets, etc.). Most birds recorded on the estuary foreshore were roosting or loafing (seagulls, cormorants, etc.).

- The intertidal flats of the estuary were predominantly utilised by transequatorial migratory shorebirds (stints, plovers, sandpipers) and silver gulls, swans and cormorants, amongst others.

- There is a strong seasonal pattern in use made of waterbird habitats in the vicinity of the development site. During winter and spring, the wetlands within the development site tended to support higher numbers of individuals and a

greater range of species than the intertidal flats adjacent. The trend reversed markedly in summer and autumn. This seasonality in distribution and abundance of waterbirds is due to the seasonality in availability of isolated pools and the abundance of various species of waterbird. The migratory shorebirds arrive at Leschenault Inlet in summer and leave by autumn (November-March). During winter and spring the wetlands on the development site are full of water and they support breeding pairs of ducks, large numbers of cormorants and moderate numbers of herons, egrets and spoonbills. During summer and autumn these wetlands dry up and are little used.

- Eleven of the 32 species of shorebird recorded on the intertidal flats adjacent to Pelican Point are protected under agreements between Australia and China, and Australia and Japan (CAMBA and JAMBA Treaties). Seven of these species were recorded on the development site, but of these only one (the Great Egret) used the site for feeding. The other six were recorded infrequently loafing on the foreshore during blustery winds and a high tide and were more commonly recorded on the intertidal flats which are their feeding ground.

- The inundated samphire and isolated pools of the development site are seasonal feeding grounds for the Great Egret and the Yellow-billed Spoonbill, both of which have breeding colonies within 11 km. During the period of the survey, some 24 Great Egrets and 27 Yellow-billed Spoonbills were recorded using these wetlands. The wetland most frequented by these birds is the seasonally inundated circular depression which occurs on Lot 100 (ILDA land; Fig. 11). These wetlands have also been identified as high priority mosquito breeding control areas (Wright, 1986).

- No birds gazetted as "rare or otherwise in need of special protection" were recorded on the subject land.

(b) Bushbirds

Twenty-three species of bushbird were recorded during a field survey in 1985 within the proposed development area (Ninox Wildlife Consulting, 1985), and the area is expected to support a total of 54 species. The mature Tuart (*Eucalyptus gomphocephala*) and Marri (*E. calophylla*) on the high ground at the southern limits of the site, and the Flooded Gums (*E. Rudis*) and Paperbark (*Melaleuca priessiana*) trees fringing the Collie River are the preferred habitats of these birds. Birds were uncommon within the central portion of Pelican Point.

(c) Mammals

Only one introduced species of mammal (rabbit) has been recorded on the site. However, six introduced species including rabbits, rats, mice, foxes and cats are expected to be present in the development area.

Only three terrestrial species of native mammal are expected from the area (the common Dunnart, Southern Brown Bandicoot and the water rat). The remainder of the native mammals are bats which are likely to occur in the few hollow trees available on the site.

(d) Amphibians and Reptiles

One frog and one reptile were recorded from the site in 1985. However, up to six species of frogs are expected to be present when water is available. Some 20 species of reptile may also occur. Snakes are likely to be present next to the wetlands, while geckos, skinks and monitor lizards are likely to occur on the high land located at the southern extremity of the development site. However, the abundance of these animals is likely to be seasonal and low as a result of the seasonal availability of water and the highly degraded nature of most of the terrestrial habitats within the development site.

3.4.3 Present Condition of Ecosystems

Leschenault Inlet has been substantially modified by various developments, flood control programmes, agriculture and damming of the Collie River in the catchment area, commercial and recreational fishing, dredging and boating activities.

The construction of both the "Cut" to the west of the Collie River mouth and the Wellington Dam on the Collie River have changed the hydrodynamic characteristics of Leschenault Inlet and have also influenced the processes acting to maintain the system. Further, the relatively high levels of nutrients in the Collie River, probably resulting from use of agricultural fertilisers, has caused eutrophication of river waters upstream of Alexander Island.

Shoreline modification associated with recreational usage of the River and Inlet has resulted in habitat alteration, and the shallow waters of Leschenault Inlet have been dredged in places to allow boating in the estuary. The mouth of the Collie River has also been dredged to maintain the depth of the channels.

Thus Leschenault Inlet cannot be regarded as being in pristine condition and many of the biological habitats which now occur in the Inlet are the result of human interference with the natural ecosystem. Despite this, when compared with the Peel-Harvey Estuary, Leschenault Inlet is in a relatively satisfactory condition from a biological viewpoint (LSC, 1983) in that it does not experience the algal bloom problems associated with the Peel-Harvey system.

The present condition of the project site ecosystem is described below in terms of its conservation value.

3.4.4 Conservation Value of the Project Site

The conservation value of the project site is discussed below in terms of its geomorphic, vegetative, avifaunal and wildlife condition.

3.4.4.1 Geomorphic Status

The Collie delta is an example of a fluvial delta formed by discharge of a river into a comparatively protected estuarine lagoon.

The Collie delta is not in pristine condition. It has been substantially altered by the construction of bridge abutments, training walls and boat ramps. The mouth of the Collie River has also been regularly dredged to maintain navigability, and spoil has been disposed of on the delta, including the project site. Drains have also been cut through the northern part of the delta. In addition, the natural forces which were responsible for its formation are no longer in operation. The River has been dammed (Wellington Dam) and flow is controlled at a steady rate for downstream irrigation purposes. The "Cut" through Leschenault Peninsula introduced marked changes by improving flushing of the estuary (Leschenault Inlet) and introducing marine waters. Much of the terrain is artificially drained and is traversed by tracks and excavations. There is a carpark, boat launching ramp, boat shed and caravan park at Pelican Point. The delta is also traversed by a major road. Deltas of similar origin include the Murray, Serpentine and Harvey deltas.

Hence, its conservation value for scientific purposes is limited, although it still has local value for education in geomorphic principles.

3.4.4.2 Vegetative Status

The vegetation of the proposed development site is generally described as disturbed (Pearson, 1989) and of moderate (Pelican Point) or low (Lot 100) conservation value (Chester & Klemm, 1990). Apart from the samphire communities, which form relatively pure stands, most of the vegetation assemblages have been modified as the result of: changes to the drainage pattern on the site, grazing, burning and weed invasion. Much of the *Eucalyptus* woodland and *Jacksonia* shrubland have understoreys of pasture grasses which have suppressed the natural understorey vegetation. Consequently, in its present state, much of the vegetation could not be viewed as having a high conservation value. The samphire wetlands, however, because of the nature of the saline soils and dampness of the habitat, are weed-free and free of fire damage. The samphires are relatively important in that they provide feeding grounds for waterbirds.

The area south of Estuary Drive has been pasture for several decades and is largely devoid of taller vegetation, except for scattered mature trees at the southern limit. The lowland portion supports scattered wetland fringing vegetation, such as paperbarks and sedges.

3.4.4.3 Avifaunal Status

The conservation of waterfowl is identified as an important use of Leschenault Inlet by the System 6 Study Report (EPA, 1983). More than 60 species utilise the Inlet (Appendix 4). Although not specifically identified in the System 6 study, Pelican Point is recognised as contributing to waterfowl habitat. However, apart from certain species of conservation importance, such as the Great Egret and the Yellow-billed Spoonbill, the landward habitats of the proposed development area are relatively poorly used by waterbirds. The tidal flats of the adjacent estuary showed much larger concentrations of waterbirds, including a high proportion of trans-equatorial migratory shorebirds covered by international treaties. The most valuable habitats in the proposed development area are isolated pools, tidally inundated samphire and the estuary and river foreshore.

3.4.4.4 Wildlife Status

No rare and endangered species are known or expected to occur on the development site. The highly degraded nature of the terrestrial habitats of the development site indicate that any wildlife populations which may occur on the site are likely to be relictual and in low abundance. The site is also likely to support moderate numbers of introduced vermin species.

3.5 HUMAN ENVIRONMENT

3.5.1 Regional Setting

3.5.1.1 Historical Land Use Perspective

(i) Aboriginal use

Prior to European settlement of the region in the mid-nineteenth century, the region was inhabited by aborigines of distinct sociological groupings based on kinship and a regional system of land tenure. They were hunters and gatherers and therefore spent much of their time in the vicinity of food resources. Archaeological investigations (refer Appendix 6) have shown that Aborigines congregated around the estuaries, lagoons and permanent lakes of the Swan Coastal Plain during summer and dispersed in small groups during winter into the Darling Scarp and Plateau. Aboriginal occupation of the Swan Coastal Plain was believed to be near its peak at the time of European contact.

Subsequent to contact with Europeans, Aborigines were forced from their traditional lands, became town fringe dwellers, and lost their cultural identity. The remnants of the aboriginal population formed widely scattered groups of mixed ethnic backgrounds during the latter part of the nineteenth century. These people are now known as Nyungars.

(ii) Early European settlement

The region was first settled by Europeans in 1841 with the establishment of the town of Bunbury situated on the coast near the mouth of what was then the Leschenault Estuary. Soon after, Australind was established on the eastern shore of Leschenault Estuary as the centre for an ill-fated London based business venture to breed horses for the Indian army. The venture failed within a few years and the settlement dwindled in size. Bunbury, however, continued to develop its role as a regional centre and continually improved its harbour facilities by construction of a series of breakwater extensions and jetties during the early and mid-1900s. The main produce shipped to this time was timber and agricultural products (wood, wheat and livestock).

(iii) Post-war development

The 1960s saw further development and growth in the region with the opening of mineral sands mines at Capel and the establishment of the Laporte Titanium pigment plant at Australind. This period initiated the modern development of Australind, Clifton Park and Eaton.

The "Cut" at Turkey Point was constructed during this period as a flood mitigation measure to protect Bunbury.

In 1976 the "inner harbour" was constructed to cater for further industrial expansion in the region as the result of bauxite mining and alumina refining and woodchips export. These harbour works filled in part of the original estuary and formed the estuary mouth into an inlet of the sea. The Preston River was also redirected to its present location.

The 1980s saw the development of the Kemerton Industrial Area, the Australind By-Pass, the Lord Forest Hotel and re-development of the city centre in Bunbury, as well as substantial residential development in and around Bunbury.

(iv) The present

Bunbury is now a city of some 40,000 people. It has grown to be the State's largest population centre outside Perth and the major distribution and service centre for the South-West Region of the State.

3.5.1.2 Future Land Use

The population of the Bunbury region is predicted to reach 50,000 by the year 2001 and 100,000 by 2034 (Taylor & Burrell, 1987). The region is expected to undergo further industrial development and plans are currently being reviewed to expand the inner harbour and divert the Preston River yet again to make room for industrial land adjacent the expanded port. There are also plans to re-develop the outer harbour by construction of a marina and associated tourist, commercial and recreational facilities.

Future land uses on the margins of Leschenault Inlet are likely to emphasise the already recognised recreational and conservation attributes of the area. These attributes have been recognised in the following documents:

- Conservation Reserves in Western Australia - EPA (1983);
- Leschenault Inlet Management Plan - Waterways Commission (1983);
- City of Bunbury Town Planning Scheme No. 6 - Bunbury City Council (1984);
- Draft Land Use Plan for Leschenault Coastal Park and Kemerton Community Park - South West Development Authority (1985); and
- the Bunbury Region Plan - State Planning Commission (1987).

Leschenault Inlet, the Collie River and Leschenault Peninsula are recognised by all of the above reports as being of importance for conservation and recreational purposes. The EPA (1983) recognises the importance of the waterbody, the Peninsula and the foreshores to the north of the Collie River and recommends their inclusion into a Regional Park to be managed for recreation, conservation of natural resources, and scientific and educational uses.

This recommendation was the basis for the South West Development Authority's 1985 plan for the Leschenault Coastal Park, which recognises the growing population's future requirements for recreational amenity areas. The Bunbury Region Plan indicates that urban expansion is expected to continue along the eastern shoreline and hinterland of Leschenault Inlet. It also identifies tourism among the major growth industries of the south-west region. Hence it can be expected that recreational use of Leschenault Regional Park will steadily increase in future years.

There was a clear recognition in public submissions to the Bunbury Region Plan (Options A & B) and subsequently endorsed by Cabinet that residential settlement had to be given adequate recognition and environmental safeguards in its relation to industry. Pelican Point, Eaton and the newly emerging living area of Glen Iris all fall within the "Residential Rigden Line" defined in the Bunbury Region Plan.

For the past two decades successive councils have recognised the tourist, recreation, resort and residential potential of the Pelican Point area. Over this time the view has been reinforced by numerous studies which, far from challenging its designated use in TPS No. 6, acknowledge that there are few less environmentally significant areas. The site is central to the city of Bunbury and at the same time separated from the urban fabric by river and estuarine foreshores.

The Pelican Point proposal is capable of achieving a modest profile in the tourist and visitor market and at the same time supply part of the urban recreation and resort requirement of the local community.

3.5.2 Local Setting

3.5.2.1 Land Tenure

That part of the development site which lies to the north of Old Coast Road and includes Part Location 26 and Lot 11 is freehold land owned by Pelican Point Pty Ltd (Fig. 2). The adjacent land (Lot 100), on which it is proposed to construct an 18-hole golf course and golf estate, is the subject of a purchase agreement between Pelican Point Pty Ltd and ILDA, who are the present owners of the land. Small parcels of land adjacent Taylor Road are presently owned by either the Bunbury City Council or Telecom.

3.5.2.2 Access

The major road providing access to the proposed development site is Old Coast Road, which separates the golf course land from Pelican Point itself. Access to Pelican Point is provided by Taylor Road, a minor sealed road which joins Old Coast Road immediately south of the Collie River Bridge and provides access to the boat launching ramp on the Collie River. Access to Lot 11 is also available from Old Coast Road and is normally gained from the southern end of the land where the road lies close to the foreshore and vehicular access has been provided. Vehicular or pedestrian access in other areas is constrained by the presence of wetlands. There is no formal access available to the ILDA land (Lot 100).

3.5.2.3 Land Use

At present most of the land which comprises Pelican Point and the adjacent land to the west of the Old Coast Road is unused, with the exception of Taylor Road, which provides access to the boat launching ramp. This land has been used for grazing in the past, and this is believed to be the major cause of the degradation of the vegetation on Pelican Point.

Use of the estuary foreshore to the south of Pelican Point is limited due to lack of access because of the wetlands situated between Estuary Drive and the foreshore. Consequently, public use of this area tends to be concentrated in the narrow strip of land on Vittoria Bay at the south-western corner of the site. This land, which is mainly grassed, provides ready access to the Inlet. The major uses of this area are crabbing and picnicking, horse riding and motor bike riding.

The proposed golf course land has previously been used for grazing. Clearing, fire, the introduction of pasture species and ground compaction by stock animals have resulted in degradation of this land.

3.5.2.4 Wetland Use

Human use of the wetland areas within the development site is low largely due to lack of access and the occurrence of nuisance organisms. The wetlands within the development site have been modified by either drainage or damming to prevent tidal inundation in an effort to control mosquito breeding. The proposed development site is a major breeding area and has been identified as a high priority mosquito control area (Wright, 1986) by the Mosquito Control Review Committee. Further control procedures are planned, but await the outcome of this assessment.

The long wetland which runs adjacent the Old Coast Road has also been the source of a severe odour problem, which appears to have worsened in recent years as a result of preliminary mosquito control measures.

3.5.2.5 Groundwater Use

In the immediate vicinity of the project site there are no completed domestic bores in the superficial formations. Existing bores on the project site are currently used to draw small supplies from the superficial formations for stock watering or pasture. There is no private domestic use of groundwater from the Leederville Formation because of the depth to the aquifer. Industrial and Public Water Supplies are drawn from the Leederville Formation and the nearest bores are about 2 km from the project site.

3.5.2.6 Use of Leschenault Inlet (Beneficial Uses)

The waters of Leschenault Inlet and the lower reaches of the Collie River are used extensively for recreational and commercial fishing and recreational boating. Crabbing, prawning and line fishing are popular activities on the Inlet. A small commercial fishing industry based on crabs, cobbler, mullet and whiting also operates in the Inlet. Sail boarding and shallow draft yachting are popular on the Inlet, while canoeing is popular on the river.

Bulletin 103 of the EPA (DCE, 1981) describes water quality criteria to ensure the protection of identified Beneficial Uses of marine and estuarine waters in Western Australia. Those uses considered to apply to Leschenault Inlet are:

- Beneficial Use 1 - Direct Contact Recreation;
- Beneficial Use 2 - Harvesting of Aquatic Life (Excluding Molluscs) for Food;
- Beneficial Use 5 - Passage of Fish and Other Aquatic Life;
- Beneficial Use 7 - Maintenance and Preservation of Aquatic Ecosystems;
- Beneficial Use 8 - Maintenance and Preservation of Foreshores and Banks;
- Beneficial Use 9 - Scientific and Educational Uses;
- Beneficial Use 10 - Flushing Water and Water Replenishment; and
- Beneficial Use 16 - Navigation and Shipping (for small boats).

3.5.2.7 Aboriginal Use

An archaeological and ethnographic site survey conducted for this development (Appendix 6) has located two archaeological sites within the study area, in addition to the four sites identified as a result of previous research in the area. The sites are all small surface artefact scatters in disturbed locations. It was concluded by the survey that they are of minor archaeological importance and no further archaeological investigation was recommended at any of these sites.

There were no sites of ethnographic significance identified within the study area.

3.5.2.8 Recognised Conservation Value

The development site and adjacent foreshores do not occur within the area identified in the System 6 Report (EPA, 1983) as having conservation value. All reports (Section 3.5.1.2) highlight the area's recreation value. The Leschenault Inlet Management Plan and the Bunbury Region Plan both acknowledge the recreational and potential resort value of Pelican Point.

4 DESCRIPTION OF PROJECT

4.1 DESIGN CONSTRAINTS

There have been several attempts to re-develop Pelican Point over recent years. All except that proposed in 1986 (LSC, 1986) relied on some form of residential subdivision to make the project economically viable. These projects did not proceed because planning guidelines did not support residential development of Pelican Point. The 1986 Pelican Point Country Club proposal attempted to produce a viable development within the planning guidelines, but it too failed when the EPA Report and Recommendations (DCE, 1986) (Section 2.2.1) recommended against access to Lot 11 for a golf course.

The project which is outlined in the following sections of this report has been designed specifically to resolve all of the planning guidelines and requirements which apply to the site. The major design constraints were:

- the EPA and WAWA requirement to comply with all aspects of the Collie River flood strategy;
- the EPA requirement to maintain or enhance and manage the wetland function of the site for use by waterfowl;
- the Waterways Commission and Health Department requirements for mosquito and odour control in wetlands;
- the EPA and Bunbury Council requirement for a 50 m foreshore reserve along both the Leschenault Inlet and Collie River foreshores; and
- the EPA and SPC (DPUD) requirement for public access to foreshores;
- the DPUD requirement for a buffer between residential land and port-related industrial land.

Other design constraints proposed by the Proponent included:

- the need to raise much of the site to acceptable construction levels; and
- the need to make the project economically viable in the long term.

4.2 RESOLUTION OF DESIGN CONSTRAINTS

The design constraints outlined in Section 4.1 have been resolved in the manner described in the following sections.

4.2.1 Flood Mitigation

The Public Works Department undertook a study of the regional flood characteristics of the Collie River and Leschenault Inlet (PWD, 1981) (Fig. 14). The requirements of the flood strategy have been included in concept planning for the proposal. The 250 m wide relief floodway has been incorporated into the development as a wetland reserve, incorporating a shallow tidal wetland system, for public recreation and conservation of waterfowl habitat. Old Coast Road is elevated to 1.25 m AHD. To maintain the flood relief characteristics of the site such that floodwaters can be dissipated across the site, the floodway will be excavated to this level. A detailed topographical survey of the subject land indicates that only a small portion of the site would require excavation to lower the floodway to 1.25 m AHD (Fig. 11).

The Collie River flood strategy also dictates a "recommended limit of floodplain encroachment" along the foreshore. There are no structures proposed within this region which would hinder the dissipation of floodwaters. As a result, the situation as it exists at present on the Collie River foreshore is not expected to change markedly if the proposed development proceeds.

To set floor levels for the development at Pelican Point, calculations need to take into account the 100 year ARI flood level of 1.92 m AHD in the estuary and 2.16 m AHD at the Collie River Bridge. In addition, WAWA recommends that floor levels be fixed 0.3 m above the 100 year ARI flood levels. An additional 0.3 m is also allowed for potential sea level rise as a result of the 'Greenhouse Effect'. To meet these requirements, floor levels have been set at 2.76 m AHD at the eastern side of the development and 2.52 m AHD at the western side of the development. An average fill level of 2.4 m AHD has been adopted, and floor levels will be raised appropriately.

4.2.2 Wetland Function Maintenance and Mosquito and Odour Control

The EPA Bulletin No. 374 (EPA, 1990) loosely defines wetland function maintenance as the maintenance of natural attributes and ecological functions of wetlands. The Bulletin outlines means of achieving this objective as involving:

- Protection and management of existing wetlands of high conservation value.
- Enhancement of existing ecological functions and provision for human uses.
- Modification or replacement of degraded wetlands with enhanced and managed wetlands of equivalent or greater ecological value.

The MCRC report on Mosquito Control in the Leschenault Estuary Region (Klemm, 1989) identifies appropriate mosquito control options for the region as involving:

- infilling of breeding sites;

- channelling to improve drainage, water exchange and predator access to breeding sites;
- inhibiting tidal inundation of breeding sites; and
- application of appropriate insecticides when and where required.

The Health Department of Western Australia (Appendix 1) has indicated that the odour problem associated with the wetlands on Pelican Point could be resolved either by:

- filling in the wetland;
- excavating the wetland; or
- improving water exchange in the wetland.

A combination of all of the above methods is proposed for the development. Specific design initiatives proposed for the site include (refer Fig. 3):

(i) The preservation and enhancement of the wetland located within the floodway reserve on Pelican Point. This wetland will be connected to the Collie River by a non-navigable waterway to improve water exchange and predator access, thereby solving the current odour and mosquito problem. The wetland will be enhanced by creation of an island and plantings of appropriate native wetland herb shrubs and trees. Modification of the samphire flats will be minimised. The wetland reserve waterway will be permanently inundated and water levels will fluctuate tidally. Intertidal foreshores will be re-sloped to maximise drainage and minimise potential for mosquito breeding.

(ii) The modification of remaining wetlands on Pelican Point by either infilling, or excavation to provide a permanent freshwater lake and small island. This lake will be sealed to prevent freshwater loss and used as a drainage compensation basin and holding pond for irrigation of adjacent landscaped areas.

(iii) Replacement and enhancement of existing wetland values of the project site by creation of additional permanent freshwater and saline wetlands within the golf course proposed for the ILDA land.

Dense stands of existing natural vegetation will be maintained for incorporation into islands or natural edges to the wetlands. Islands have been incorporated to provide protection from foxes, dogs and cats. Permanent freshwater soaks will be provided near the southern boundary of the project site adjacent to a dense stand of Marri and Peppermint for drought use by waterfowl, bushbirds and other wildlife. These wetlands will be designed to maximise waterfowl use by provision of irregular slopes, shallow wading areas and deeper areas for swans and diving birds.

Two saline lakes and one freshwater drought refuge will be constructed in the more remote parts of the ILDA land, separated from the residential estate by the golf course.

(iv) Provision of additional freshwater lakes between the residential estate and the golf course. The function of these lakes will be to hold freshwater for golf course and landscape irrigation as well as providing compensation basins for stormwater runoff. These lakes will be sealed and landscaped and as such will also provide a freshwater source and a drought refuge for less reclusive species of waterfowl.

(v) The provision of additional foreshore reserve and public open space at Pelican Point itself. This area has been set aside to provide additional buffer to intertidal flats located near the river mouth, which are presently heavily utilised at times by trans-equatorial migratory shorebirds.

4.2.3 Foreshore Reserve and Public Access

The title boundaries of Pelican Point encompass the shores and in some cases extend to below high water mark on both sides of Pelican Point. So that public access to the foreshore is ensured, the Proponent proposes to transfer title of the foreshores to the Crown following development of these areas and a maintenance period of three years. The proposed foreshore reserve along the Vittoria Bay shoreline is 50 m wide (Fig. 3), as is the existing southern portion.

In their assessment of the proposal documented in 1986 (LSC, 1986), the EPA and LIMA (DCE, 1986) stated that:

> "in the case of the Collie River side of the project site, the Recommended limit of floodplain encroachment shown on Plan PWD WA 52387-14-1 approximates the recommended position for the foreshore reserve. Therefore, the Authorities accept that this limit would represent an appropriate boundary for the foreshore area along the river".

The proposed foreshore reserve along the Collie River follows the limit of flood plain encroachment, as defined by the Public Works Department of Western Australia (PWD, 1981). The Proponent proposes to redevelop the boat ramp and provide car and boat trailer parking, and any additional land along this area of the foreshore, as shown on the land transfer plan (Fig. 15), would be transferred to the Crown.

A public park is proposed to be created on Pelican Point itself for public enjoyment of the expansive vistas available from this area.

It is proposed to incorporate the landscaping of the foreshores within the overall landscaping of the project. Typical plan and section views through the foreshore are presented in the landscape master plan prefacing this report and in the enlarged sections shown in Figures 15 to 20. The existing grassed Vittoria Bay foreshore will be improved

and additional trees planted. Similar treatment will be given to the Collie River foreshore, however in this area additional *Casuarina* will be planted along the bank, and localised erosion protection measures undertaken to protect the remaining rush fringe.

Three public toilet blocks are proposed to be provided along the foreshore and several access points would be provided at areas favoured for crabbing and other forms of recreation. Public access throughout all foreshore areas would be provided by a dual use pathway. A defined public access-way is also proposed from the boat ramp on the Collie River to the Vittoria Bay foreshore. Parking areas are proposed in all defined areas of public open space which lie adjacent to the foreshore reserve, including the floodway wetland reserve and the public park on Pelican Point.

Prior to development taking place, a foreshore management plan will be developed to the satisfaction of the City of Bunbury and LIMA. It is assumed that the foreshore reserves will ultimately be vested in the City of Bunbury for the purpose of public recreation. The general foreshore development concept is shown on the Frontispiece.

4.2.4 Industrial Buffer

The DPUD requirement for a substantial buffer between residential land and industry has been complied with by the location of all residential and commercial activities in the northern tip of the ILDA land. As indicated in Section 2.2.2, this design has been accepted by DPUD and ILDA.

4.2.5 Fill Requirement

All fill material required to raise ground levels will be obtained from within the project site. Some 145,000 m^3 will be obtained from the dunal ridge and lowlands of the ILDA land, 82,000 m^3 of which will be used on the ILDA land. Much of the fill required for development of Pelican Point will be obtained from the proposed wetland and waterway excavation. Some of this material is silty clay and is unsuitable for housing foundations. The silty material will be stockpiled and used for golf course landscaping.

4.2.6 Project Viability

The economic viability of the project rests not only on the need to fund the ILDA land purchase, but also on the need to provide nine holes of golf course during early stages of the development and the need to provide funds for long-term management of the wetlands. This can only be achieved by offering part of the development for residential use. Most residential areas will be located on the golf course estate, but some will also be required on inland portions of Pelican Point. Wherever possible, short-stay accommodation units have been located adjacent estuary foreshores and the floodway wetland reserve, with residential units being located along accessways or facing artificial waterways and lakes.

4.3 LOCATION WITHIN LOCAL AND REGIONAL LAND USE FRAMEWORK

The development site is bounded by the Eaton to the east, the Collie River to the north, Leschenault Inlet and the proposed Preston River diversion to the west and the railway and Australind Bypass to the south. Pelican Point is located approximately 5 km north of the commercial centre of Bunbury. Land to the west of the Preston River diversion is proposed for industrial development and buffer zones.

Planning documents for the region recognise the need for urban expansion while retaining the conservation and recreation values of the area, and the proposed development is consistent with land use policies and development trends in the area.

4.4 PROPOSED LAND USE AND TENURE

Subject to finalisation of proposed land transfers, including the agreed purchase of Lot 100 from ILDA (Fig. 15), the Proponent will own 93% of the land proposed for development. The site is 133.9497 ha in total area. The remaining area comprises foreshore land owned by the Bunbury City Council (9.6280 ha) and a Telecom site of 0.1012 ha.

Housing of different types and forms of tenure will achieve a balance between tourist-oriented accommodation requiring high service levels and the more permanent, low key housing. Parts of the development land will be sold as freehold land for private dwellings or rental accommodation, however in all cases land owners will be required by caveat on land title to become members of a community association which will maintain and manage the Pelican Point development as a whole.

The project will be bordered by publicly-owned land on all sides, and the reserves proposed along the Vittoria Bay and Collie River foreshores will be transferred to the Crown free of cost. The land proposed as a floodway wetland reserve and the areas of public open space will also be transferred to the Crown.

4.5 PROJECT COMPONENTS

The Pelican Point development, as proposed, will have several components (Fig. 3) which will be built in seven sequential stages.

(i) Stage One

The first stage of the project is proposed to include development of the Golf Estate (maximum 100 units) and local shopping centre, incorporating:

- nine holes of golf course, interspersed with a series of freshwater lakes which will serve as storage for irrigation water, as well as being designed to provide a freshwater source for waterfowl;

- two large permanent saline wetlands and one permanent freshwater wetland located within the southern and western parts of the ILDA land;
- 40 golf units in the form of condominiums to cater for tourists making short-term stays of two or three days;
- 60 Golf Estate lots for private dwellings, which will be largely independent and privately owned, however all owners will be required to become members of a community association which will maintain and manage the estate;
- the golf clubhouse, which will initially be developed on the southern corner of the Old Coast Road and Australind Road intersection, and will be relocated to dominant high ground in the centre of the golf layout on construction of the second nine holes (Stage Seven); and
- a shopping centre, including club house, tavern, restaurant, supermarket, speciality shops, fast food outlets and service station.

(ii) Stage Two

This stage is situated immediately north of Old Coast Road and would comprise a large freshwater lake bounded by a mix of tourist accommodation and managed housing. It is likely that a separate community association will be established to manage and maintain this estate and its facilities, including the lake and open space. The various unit types have been identified as follows:

- the second phase of the Golf Estate, incorporating managed housing on 27 lots;
- bay units facing Vittoria Bay, incorporating 29 units for short stay tourist accommodation;
- apartments located at both ends of the lake, in one group of 24 units and one group of eight; and
- lake villas mostly clustered around the lake's edge, incorporating a total of 54 units to be managed for longer term stays and maintained by an association with a central rental facility.

(iii) Stage Three

This stage consists of the following:

- a wetland, which will occupy the 250 m wide relief floodway designated for the lower Collie River, and will be landscaped to incorporate the tidal wetland with wide intertidal zones. The parkland will be landscaped with native wetland species;

- car parking adjacent to Vittoria Bay (partly paved and partly grassed) and toilet facilities associated with the carpark and foreshore;
- an area of public open space combined with the public boat launching facility, proposed adjacent to the Collie River, also including a public toilet block; and
- a saline, non-navigable waterway connected to the Collie River, incorporating 41 lake villas in an area immediately north of the floodway.

(iv) Stage Four

A canal estate is proposed to form the basis of this stage, including:

- a single canal, linking up with the Collie River, accommodating a design boat length of 10 m;
- forty-three managed canal units, most of which will have direct access to the water's edge;
- small jetties or landings, which may be built to allow private mooring of boats.

(v) Stage Five

This stage includes Pelican Point and extends along the Collie River and Vittoria Bay. A variety of bay and river units are proposed to be developed, with most taking advantage of views over Vittoria Bay and the Collie River:

- sixty eight bay units and nine riverfront units proposed for short-term tourist accommodation;
- a private marina with 22 marina units and 18 canal units, proposed as accommodation for permanent residents, however this estate will be managed by a community association and have a central rental facility;
- a small road bridge crossing the canal to provide access to Pelican Point;
- a public park (1.2 ha) which is proposed to be landscaped before being handed over to the Crown as a reserve for recreation; and
- a car parking area and toilet block, which will form part of the park.

(vi) Stage Six

This stage is proposed to contain:

- the resort hotel and function centre situated on the eastern side of the canal entrance, incorporating a range of boating and water-related recreation facilities;
- a small complex of condominiums may be attached to the hotel to provide alternative low key accommodation;
- jetties adjacent to the hotel for mooring of ferries and private pleasure craft; and
- a range of service and convenience uses such as cafe, tavern or small shops between the boat ramp and the hotel.

(vii) Stage Seven

This final stage would be located at the southern end of the site and would consist of the second nine holes of the golf course and the Golf Club Resort, including meeting rooms, restaurant and a professional golfer's shop.

4.6 SERVICES

4.6.1 Water Supply

4.6.1.1 Domestic Supply

The development can be satisfactorily served by an extension from an existing water main near the Collie River Bridge. The WAWA does not envisage any problems in servicing the development.

4.6.1.2 Irrigation Supply Requirements

It is proposed that the irrigation water supply for the golf course will be obtained by groundwater abstraction from the Leederville Formation. Groundwater would be pumped into a series of inter-connected lakes which would be lined to form a water storage facility, from which the reticulated water supplies would be drawn.

The total water requirement for irrigation of the golf course and landscaped areas of the resort is estimated to be 365,000 m^3/y on average, which includes an allowance of about 11,000 m^3/y for evaporation loss from the storage lakes. The peak abstraction rate during summer is estimated to be 3,000 m^3/d, and no irrigation is proposed during the winter months. An average requirement of 1,000 m^3/d is anticipated. Additional water will be

required during the grow-in period (1-2 years) for establishment of the turf. The WAWA have indicated that they would be willing to issue a licence for the abstraction of 200,000 m^3/y of groundwater from the Leederville Formation (Appendix 5). The Proponent will further investigate the superficial aquifer as an additional source of water to provide the balance of 165,000 m^3/y predicted to be the requirement to irrigate the landscaped areas of the resort.

4.6.2 Sewerage

The proposed development would be fully deep sewered. The point of connection to the existing sewer network is approximately 900 m to the east of the site, therefore the construction of a pump station and installation of a rising main to the connection point would be required. The majority of the site would feed directly to this pump station by a gravity system, however a second pump station would be required to transfer flows from the Bay Units along Vittoria Bay (Fig. 21).

4.6.3 Gas, Electricity and Communications

The State Energy Commission of Western Australia has advised that the provision of electricity and gas to the development can take place in a progressive, orderly manner in accordance with the various stages. It is proposed to service all buildings with underground power reticulation.

Servicing of the development by Telecom would require the creation of two new distribution centres, the cost of which will be borne by Telecom. Internal reticulation costs are the responsibility of the developer.

4.6.4 Site Drainage

Stormwater from the development is proposed to be disposed of on site to localised soakage pits to the maximum extent possible. Excess flow will discharge to the perched lakes within the development. Under extreme storm conditions stormwater will discharge to the residential canal or non-navigable floodway lake.

It is proposed that the golf estate be divided into three catchments draining to the freshwater irrigation lakes. It may be necessary to link the lakes and provide an overflow to the saline wetlands on the golf course. To cater for extreme storm events, these lakes will require an overflow drain to Vittoria Bay. Similarly, the perched lake would receive piped flows from the lake villas, and would ultimately discharge by piped overflow to the floodway wetland and non-navigable waterway.

It is proposed to incorporate silt and grease traps into the drainage system to trap all contaminants possible before runoff and stormwater drainage is discharged to these waterways. The pattern of drainage under maximum storm events is shown on Figure 21.

A limited flow from the existing Eaton urban area crosses under the bypass road and discharges onto the site. This flow would be allowed for in the golf estate drainage system.

4.6.5 Road Access

The two existing roads serving the land, Old Coast Road and Australind Road, will provide the primary road network. No frontage will be permitted to these roads, with access only to the major generators of traffic, such as the golf resort and shopping centre. The current intersection of these two roads would be realigned to produce safer traffic movement and recognisable entry statements for both Pelican Point and Eaton. Engineers from the Main Roads Department (MRD) have been consulted on this arrangement to ensure sight distances and intersection separation are appropriate.

Other internal roads would be constructed to the specifications of the Bunbury City Council and in accordance with Roads Policy of DPUD. Vehicular access within the resort would be minimised. In addition, a comprehensive walkway and cycleway system will traverse the whole of the resort, thus allowing visitors the opportunity to experience the different sights and vistas available from within the resort.

4.7 CONSTRUCTION METHODS AND SCHEDULE

The engineering aspects of developing the project site were investigated by Riedel and Byrne in the 1986 proposal (LSC, 1986), and the details of these investigations are presented in Appendix 3 of that document. As the present development proposal differs from that assessed by LSC (1986), the additional aspects requiring engineering assessment have been addressed by Riedel and Byrne in Appendix 7 of this PER. The results of both engineering reports are drawn upon in the following discussion of construction details.

4.7.1 Site Preparation

A geotechnical investigation of the Pelican Point site was previously conducted to evaluate the sub-surface conditions. Soil conditions are summarised in Section 3.3.2.2. The presence of a layer (about 3 m thick) of loose silty clay and sand at a shallow depth beneath the sandy topsoil necessitates special consideration of construction methods.

Prior to initiating construction, a detailed landscape Master Plan will be prepared to guide landform modification. All mature trees, foreshore vegetation and selected portions of wetland vegetation will be maintained where possible to preserve existing landscape aesthetics.

Site preparation would include clearing of all vegetation and stripping of topsoil, within the immediate boundaries of construction activity, to a depth of approximately 0.2 to 0.3 m, depending on the depth of the organic layer. The topsoil would be stockpiled during the construction phase for later use in landscaping of the golf course and areas of

public open space. Vegetation within the floodway wetland reserve and along both the Collie River and Leschenault Inlet foreshores will be retained.

To allow for differential settlement, building works would not proceed until at least three months after filling to the design level, during which time it would be necessary to monitor the settlement characteristics. Construction of the residential canal and non-navigable floodway lake will not commence until monitoring indicates that no further significant settlement of the fill is occurring.

4.7.2 Earthworks

The volume of fill required is approximately 300,000 m^3. Approximately half of this volume will be obtained from the dunal ridge on the ILDA land. The rest will be obtained from excavating wetlands and artificial waterways on Pelican Point. Excess material generated by excavations will be used for landscaping the golf course.

The excavation of the canal would generate approximately 224,000 m^3 of mainly fine silty clay and sand. This material would be stockpiled and later used to raise the level of other areas of the development. The bank slopes around the perimeter of the canal are proposed to be placed at a grade of 4 (horizontal) to 1 (vertical) to maintain the stability of the banks. It is proposed to excavate the centre line of the canal to -2 m AHD to allow for sedimentation.

Excavation of the non-navigable waterway would generate approximately 95,000 m^3 of fill, the majority of which would be re-used to raise the level of the adjacent villas. The residential portion and the connection channel to the floodway wetland reserve would be excavated to a depth of -1.6 m AHD. From this point invert levels would increase to mean water level at the southern portion of the wetlands lake.

The excavation of the canal and lake is proposed to be undertaken under dry conditions with traditional earthmoving equipment wherever possible. This requires dewatering of the site by pumping groundwater from the basin to lower the water table so that scrapers or other mechanical earth movers can operate on the floor of the basin. It is proposed to hold extracted water in settling ponds to capture suspended particulate material before discharging dewatering fluids to the Collie River.

Turbid water within the canal and non-navigable lake will be contained until the connections to the Collie River are breached. Timing of these operations will be towards late autumn.

4.7.3 Earthworks Schedule

The development will take a number of years to complete. Bulk earthworks will be undertaken in two separate phases. Phase One will mainly be undertaken on the ILDA land and will involve the construction of:

- all artificial wetlands on the golf course;
- the golf course residential estate and commercial centre; and
- nine holes of the golf course.

Phase one will also involve undertaking sufficient earthworks on Pelican Point to:

- resolve the mosquito and odour problem in the cut-off river channel by connecting it to the Collie River;
- lower parts of the wetland reserve for floodway purposes; and
- modify the shore of the floodway wetland reserve to improve drainage for mosquito control.

Phase Two will be undertaken between one and three years after Phase One depending on the demand for residential units within the golf estate. It will involve the major modification for Pelican Point by construction of artificial wetlands, non-navigable waterways, the canal and the placement of fill to raise levels to the required height.

The staging of the bulk earthworks is a management initiative aimed at minimising disturbance of the wetland values of Pelican Point until replacement wetlands created on the ILDA land have developed sufficiently to provide alternative feeding habitat for the range and number of waterfowl which presently use the Pelican Point wetlands.

4.8 OPERATION METHODS

4.8.1 Management Programmes and Project Agreement

Management programmes will be designed to guide the treatment of those aspects of the construction and operation of the development which have the potential to adversely impact upon the existing environment. The details of proposed project management strategies are given in Section 6 of this report.

A Project Agreement will be finalised between the Proponent, the State and the City of Bunbury detailing all commitments and actions to be undertaken in order that the project may proceed, and delegating management responsibilities.

4.8.2 Projected Lifetime of Project

The project has an indefinite lifespan. All structures will be designed and constructed in accordance with standard engineering practice.

5 ENVIRONMENTAL EFFECTS AND MANAGEMENT

5.1 INTRODUCTION

A range of actual and potential effects of the proposed development on the natural environment and local community have been recognised and assessed in this document. They are identified below for both the construction phase and the subsequent operation phase of the project. Further detail on potentially significant effects and management requirements to minimise scale of effect is provided later. The management strategies presented in this section form the basis of the environmental management programmes presented in Section 6.

5.1.1 Construction Effects Summary

(a) Physical

(i) Landform modifications resulting from excavation of wetlands and waterways and placement of fill to raise levels to design height.

(ii) Temporary and localised effects of groundwater drawdown during dewatering operations.

(iii) Temporary and localised effects on water turbidity in the Collie River during dewatering and final dredging works in the canal.

(iv) Temporary destabilisation of soil surfaces during the bulk earthworks programme.

(b) Biological

(i) Habitat alienation and wetland replacement and enhancement.

(ii) Modification of some wildlife and waterfowl distribution patterns.

(c) Social

(i) Temporary effects of construction activity and noise on the local community.

(ii) Reduced public access to Pelican Point during construction works.

(iii) Loss of minor Aboriginal archaeological sites.

(iv) Modification of landscape aesthetics from degraded wilderness and grazing fields to a built and managed environment.

5.1.2 Operation Effects Summary

(a) Physical

(i) Groundwater consumption. Minimal long-term drawdown effects are anticipated and no other users of the resource are likely to be disadvantaged.

(ii) Natural drainage patterns will be modified by construction of waterways. When possible, stormwater runoff will be contained on site. Potential for nutrient accumulation will require management.

(iii) Potential effects on the water quality of the Collie River and Leschenault Estuary as a result of nutrient input from both runoff and groundwater infiltration. A nutrient management programme for the golf course and public open spaces will be required to manage this potential impact.

The navigable and non-navigable waterways will flush adequately and no adverse effects on regional water quality are anticipated.

(iv) Potential effects of increased public access and use on shoreline stability. These can be minimised via appropriate foreshore design and management of public access.

(b) Biological

(i) While use of Pelican Point by wildlife and waterfowl is likely to reduce as a result of disturbance caused by human pressure and domestic pets, a substantial increase in the diversity and abundance of wildlife and waterfowl is anticipated on the golf course as a result of the provision of drought and predator refuges. The provision of these refuges is seen as a major positive effect of the development.

It is also likely that the trans-equatorial shorebirds which have roosted on the higher parts of Pelican Point on occasion will no longer do so. However these birds will continue to feed on the intertidal habitat offshore and will roost elsewhere. The carrying capacity of the estuary for these birds is therefore unlikely to change as a result of the development proceeding.

(ii) Increased fishing pressure on marine biota is inevitable as the local and regional population expands. The construction of the canal and non-navigable waterway will provide a small increase in fish nursery habitat within the estuary.

(iii) The proposed development will markedly reduce the number of mosquito breeding areas in the locality.

(c) Social

(i) Both the regional and local communities will benefit substantially from the proposed development as a result of:

- achievement of regional planning objectives;
- provision of high quality public recreation facilities;
- stimulus for local tourism industry;
- provision of short and long-term employment opportunities;
- improved access to the estuary and river foreshores;
- control of mosquito and odour problems;
- provision of residential land; and
- provision of tourist facilities.

(ii) Regional conservation and recreation values will not be adversely affected by the proposed development, which is ideally located to enhance the community's enjoyment of these values.

(iii) Existing community services and facilities will not be adversely affected and road systems will be modified to cater for the increased traffic resulting from the development.

5.2 CONSTRUCTION IMPACTS AND MANAGEMENT

5.2.1 Effects on Physical Environment

5.2.1.1 Landform Modification

The topography of Pelican Point and adjacent land will be modified as a result of earthworks required to:

- raise the level of residential and commercial sites above the 100 year flood level (including an allowance for sea-level rise);
- excavate the relief floodway, and re-shape parts of the Pelican Point wetland to provide tidal flushing;
- excavate the canal and non-navigable lake;
- contour the golf course; and
- landscape the development and golf course.

To minimise the impact of the development on landform, filling of the site will only occur to the level required for engineering purposes and only in areas not required for flood

mitigation. The retention of mature trees wherever possible and rehabilitation of the site will reduce the visual impact of the project.

5.2.1.2 Groundwater Drawdown

Excavation of the canal, non-navigable floodway lake and storage lakes will have some impact on the groundwater system of the project site. Localised dewatering of the uppermost 3-4 m of the superficial formations will be required to construct the canal and allow excavation of the lakes. These developments are largely within the saline portion of the shallow aquifer and can be undertaken without any detrimental effects (Appendix 5). Dewatering activities undertaken to create the lined freshwater lakes may result in short-term, marginal landward migration of the saline interface with the shallow aquifer. However, natural throughflow within the shallow aquifer, together with rainfall infiltration and enhanced recharge associated with development, will limit the period and extent of landward migration of the saline groundwater.

Dewatering operations are not anticipated to affect the groundwater usage of local residents due to the distance of the site from domestic bore users in Eaton, where the closest domestic bores within the superficial formation are located. Comments made by WAWA on the 1986 proposal, which involved similar construction methods, indicated that the proposal would have minimal implications for the shallow groundwater resource (DCE, 1986).

5.2.1.3 Excavation Effects on Water Turbidity

Water from dewatering operations will be impounded on site to allow suspended particulates to settle out before the water is discharged to the Collie River. Turbid water will be contained within the canal and non-navigable lake until the connections are breached.

The artificial waterways will be constructed in an area adjacent to a part of the Collie River which has been dredged in the past by the PWD. The increased water turbidity associated with dredging of the "plug" between the artificial waterways and the river, disposal of impounded dewatering fluids and disturbance as excavation and stabilisation works are completed, will be short-term and localised, the impact of which will be minimised by the safeguards incorporated into the construction management programme. As a consequence it is not expected to cause measurable impact on the biota of the Inlet or the Collie River.

The Inlet and River ecosystems are naturally modified by the seasonal change in salinity which occurs at the time of year the dredging will take place. The Inlet ecosystem in particular is highly dynamic, and variations in distribution and abundance of species of biota occur seasonally as a result of natural variations in water quality characteristics. Any effect resulting from construction of the proposed development would be of short-term duration and unlikely to be measurable against the natural variation in abundance and distribution of biota which naturally occurs.

However, the need to minimise the input of turbid water to the Inlet through dredging or dewatering is recognised. The requirement for environmentally acceptable construction techniques and timing will therefore be specified in contract documents. Construction details will subsequently be forwarded to LIMA for licensing prior to implementation, and will also be to the satisfaction of the EPA.

5.2.1.4 Soil Stabilisation

Earthworks involving the movement of soil have the potential to generate dust until stabilised. Disturbed land surfaces and stockpiled topsoil will be stabilised to prevent erosion or the generation of dust. Dust will be suppressed by watering if necessary. Exposed soil surfaces will be revegetated by sowing appropriate grasses as soon as possible. Once construction is complete, permanent landscaping will be undertaken.

5.2.2 Effects on Biological Environment

5.2.2.1 Habitat Modification and Effect on Waterfowl and Wildlife

The proposed golf course, tourist and residential development and provision of associated facilities will result in the loss or modification of much of the terrestrial habitat, including wetlands, pasture and parkland. Although the environmental status of the habitats on the subject land has been assessed as low, due to their predominantly degraded and modified nature (refer to Section 3), the loss of wetlands and associated habitats, irrespective of condition, is viewed as important when considered in the context of the cumulative effects of wetland removal on the Swan Coastal Plain.

The Proponent has acknowledged the importance of the existing wetlands to waterbirds, and proposes to modify, or create new, waterbird habitat to replace existing sites. The requirements of waterbirds with regard to water, shelter and food have been incorporated into the variety of wetland types planned, to encourage a diversity of species to the area. The artificial wetlands planned for the development will incorporate:

- existing wetland vegetation where possible;
- a variety of water depths;
- natural or artificial variations in water levels;
- revegetation using indigenous plant species; and
- islands.

Strategies proposed for individual wetlands are outlined in Appendix 3 and Appendix 4.

The variety of water depths planned in the creation of wetlands will provide extensive areas of shallows to encourage emergent plant growth and the presence of invertebrates, and thus attract a variety of waterbirds, while deeper areas will be used by diving bird species.

Seasonal variations in water levels will be allowed to occur naturally, allowing waterbird access to additional food sources.

Sedges and reeds will be planted around wetland edges, and suitable local shrub and tree species will be planted further from the wetland edge to provide shelter for waterbirds. Islands will provide shelter and act as refuges, particularly from domestic pets and foxes.

An adequate food supply for waterbirds will naturally follow the creation and revegetation of wetlands. The creation of artificial, freshwater wetlands will allow an increase in frog numbers and may allow colonisation by summer breeders such as the Golden Bell Frog (*Litoria moorei*). Frogs and their tadpoles are an important dietary component of herons, egrets and spoonbills and these species may therefore be advantaged by an increase in amphibians. Aquatic vertebrates and invertebrates will colonise from other areas, and gently sloping grassed banks may assist in attracting bird species not otherwise found in the area (Curry, 1981).

Following comprehensive studies of the use of the development site by waterbirds and other fauna, Ninox Wildlife Consulting (Appendix 4) states that:

> "the establishment of a series of permanent, freshwater and saline wetlands, removal of stock animals and the presence of a golf course in the proposed development area will more than offset any waterbird habitat loss by providing a greater range of wetland and bushland niches than now occur. The permanent, freshwater wetlands with various types of island will also operate as valuable drought refuges in summer and the number of waterbird and bushland species currently using the area is expected to rise."

Regarding other fauna, the area is already modified through fire, stock grazing, ground compaction and clearing, and remnant populations of terrestrial vertebrates are judged to be very low. Bushbirds, however, are reasonably common in selected areas such as the banks of the Collie River, taller vegetation fringing the wetlands and in the mature trees at the southern end of Lot 100.

The provision of landscaped areas, including a high proportion of native flowering shrubs, retention of mature trees and areas of bushland within the golf course, and the creation of freshwater and saline lakes and the floodway wetland reserve are proposed to replace faunal habitat lost as a consequence of the development.

The introduction of these measures is expected to result in a large number of bushbirds, probably more than occur at present, being attracted to the area. The retention of natural bushland should also encourage the continued use of the area by bats.

Consideration of species such as the Southern Brown Bandicoot will occur in the planning of the development, and landscaping will attempt to integrate suitable areas of habitat for these species within the golf course. Bandicoots are reported to use the grounds of various outlying tertiary institutions in Perth (Appendix 4), and might be expected to use suitable habitat within the project site.

It is expected that some relict reptile populations will persist in areas of natural bushland and may colonise areas of the golf course. While no kangaroos currently utilise the area, their presence on other golf courses in the region indicates that they too may colonise the new golf course. Such an occurrence is seen as desirable.

5.2.2.2 Detailed Assessment of Wetland Modification

It is recognised that some of the wetland habitats to be modified have local conservation value as seasonal feeding areas for limited numbers of waterfowl species, particularly those belonging to the heron/egret/spoonbill group of wading birds. It is also recognised that the scale of development proposed for the land north of Old Coast Road may inhibit use of the floodway wetland reserve and the artificial freshwater lake by shy wading birds, although many other less sensitive species of waterfowl (such as ducks, swans, cormorants, pelicans and ibis) are likely to be attracted to these wetlands. To compensate for this loss, wetlands have been incorporated into the golf course design specifically to provide food and habitat of value to species such as spoonbills and egrets.

In recognition of the importance attached to maintenance and enhancement of wetland function by the EPA, the PER contains a separate assessment section (Appendix 3) which concentrates solely on evaluating pre- and post-development wetland values. The assessment is based on the numerical classification system described in EPA Bulletin No. 374 (EPA, 1990). This system seeks to determine a score for various wetland attributes which, when totalled for each wetland, enables its classification into one of the following categories:

- H: High conservation
- C: Conservation
- O: Conservation and recreation
- R: Resource enhancement
- M: Multiple use

For the purpose of this assessment, the project site was divided into five land units which are distinguishable on the basis of both natural characteristics and the type and scale of land use proposed for each unit. The five units (Fig. 12) correspond to the major habitats described in Section 3, i.e.:

- upland/lowland terrestrial unit;
- lowland wetland unit;
- delta complex (Pelican Point);
- Leschenault Inlet foreshore; and
- Collie River foreshore.

For each unit, its present use, condition and habitat value are described and assessed where applicable using the numerical evaluation system to derive a value classification. Subsequently its modified use, condition and habitat value are described and also assessed to derive its likely post-development value classification.
The results of this assessment are summarised below.

LAND UNIT	CLASSIFICATION	
	Pre-development	**Post-development**
Upland/lowland terrestrial	No existing wetlands	R
Lowland wetland	M	O
Delta complex	M	R
Leschenault Inlet foreshore	H	H
Collie River foreshore	Not applicable	Not applicable

The above results indicate that both natural attributes and human use of the five land units will improve due to the proposed development proceeding. This result is largely due to the fact that existing wetlands are largely degraded and under-utilised, are seasonal in importance and are recognised problem areas for mosquito breeding and odour. The proposed development will involve the modification of these wetlands to create permanent bodies of shallow water and islands of natural vegetation which will not only provide food all year round, but will also provide drought and predator refuge. The increased diversity of habitat type and its permanence is designed to compensate for the loss or modification of the existing wetlands.

The amenity value and utility of the project site will also substantially increase as a result of the provision of foreshore access, public recreation facilities and the golf course.

5.2.3 Effects on Social Environment

5.2.3.1 Construction Activity, Noise and Vibration

During the construction phase of the project, residents of Eaton may be inconvenienced at times by noise associated with earthmoving activities on site. However, as the nearest residences of both Eaton and Clifton Park are located more than 500 m from the Pelican Point site, where the majority of construction activity will occur, inconvenience is unlikely to be severe.

Ground vibration caused by construction operations is unlikely to affect nearby residential areas. The distance involved is expected to markedly reduce the potential for inconvenience from this source.

To minimise inconvenience to existing residents hours of operation will be subject to approvals to be granted by the City of Bunbury. Since all fill material will be obtained from, and replaced on, the project site, construction traffic is unlikely to be a problem except where movement between Pelican Point and the ILDA land necessitates crossing the Old Coast Road. Under these circumstances, appropriate traffic management techniques will be employed to ensure safety of road users.

5.2.3.2 Public Access

Public access to the site will be prohibited during the construction phase to ensure public safety.

The construction site will be fenced and appropriately worded signs will be erected at access points around the project area to enforce access restrictions.

5.2.3.3 Historic, Archaeological and Ethnographic Sites

An ethnographic and archaeological survey conducted on the subject land identified four previously recorded archaeological sites and discovered two additional sites within the development boundaries. All six sites are small artefact scatters found in disturbed locations and no further archaeological work has been recommended at any of these sites (refer Appendix 6).

There were no sites of ethnographic significance identified during the course of the ethnographic survey.

In accordance with the Western Australian *Aboriginal Heritage Act 1972-1980*, the Proponent will make an application under Section 18 of the Act in the event that any of the known sites is proposed to be disturbed, and further, will in accordance with the provisions of the Act, report the finding of any new site discovered in the course of construction.

5.2.3.4 Landscape Aesthetics

The proposed modifications to the existing landscape will not be of sufficient magnitude to markedly alter the present land surface, and the concept plan has been designed to blend with the existing landscape as much as possible. However, construction of the tourist and residential accommodation will alter the present skyline as viewed from the site. The area will change from being a semi-natural, although somewhat degraded environment, to being a developed and intensively managed environment.

Buildings will be confined to two development levels.

A comprehensive landscape master plan for areas of public open space will be prepared. Public open space areas will be developed by the Proponent, and maintained for three summers after practical completion before handing on-going management responsibility over to the City of Bunbury. Landscaped areas to be provided within the development will incorporate:

- retention of mature trees, fringing vegetation and areas of bushland wherever practicable; and

- planting of indigenous vegetation species, including a high proportion of flowering shrubs.

Landscaping is expected to conceal most of the development from public areas other than the adjacent foreshores, Estuary Drive and from the Australind Bridge.

5.3 OPERATION IMPACTS AND MANAGEMENT

5.3.1 Effects on Physical Environment

5.3.1.1 Groundwater Consumption

The long-term drawdown effects of pumping from the Leederville Formation are anticipated to be minimal. At the level of extraction described in Appendix 5, approximately 1 m of drawdown would be expected up to 2 km from the bore site and 0.5-1 m of drawdown up to 10 km from the bore site within the Leederville Formation These predictions are the probable maximum estimates as they are based on a fully confined aquifer regime, whereas the aquifer is semi-confined, with significant leakage occurring during pumping. Drawdown within the Leederville Formation will not affect domestic users as there are no domestic bores drawing from this aquifer.

As described in Section 4.6.1.2, groundwater resources in the Leederville Formation are predicted to be adequate to meet the likely demand for the irrigation supply to the Pelican Point development.

The development will result in changes to the local water balance of the project site, however future water table fluctuations are unlikely to be significantly different from the range of 0.4-0.6 m currently estimated for the site (Appendix 5). No detrimental effects are anticipated due to enhanced recharge of the superficial aquifer.

There will be further investigation of potential groundwater supply from the superficial aquifer prior to the granting of a groundwater extraction licence for the project. It is proposed to monitor groundwater drawdown, quality, levels and movement of the saline interface within the Leederville Formation to confirm the predictions of availability and to ensure the sustainability of the groundwater resource within the Leederville Formation.

Groundwater abstraction is subject to licensing by WAWA.

5.3.1.2 Drainage

The natural drainage of the proposed development site will be altered due to clearing and sealing of cleared surfaces.

Stormwater runoff will be contained on site where possible. Where there is a requirement to discharge excess flow to the artificial waterways, the storm water drainage plan proposed will ensure that silt, grease and other contaminants are trapped. The drainage system will be maintained to ensure effective trapping of contaminants.

Discharge of drainage water derived from surface runoff will be directed via the irrigation lake systems to the saline wetlands. Vegetative nutrient traps will be planted to utilise nutrients contained in runoff.

5.3.1.3 Estuary Water Quality

(i) Nutrient flux from groundwater

Groundwater quality may be affected by nutrients derived from fertilisers applied to the golf links, gardens and recreation areas within the resort site. Infiltration of nutrients leached to the superficial formations could occur relatively quickly due to the shallow depth to water table and the sandy soil profile. The significantly greater depth to the water table upon the dunal ridge in the elevated south-eastern portion of the site will allow greater time for adsorption of nutrients before they reach the water table.

Leschenault Inlet already receives large inputs of nutrients from both the Collie and Preston Rivers, mainly during winter floods. Fortunately, much of this input discharges to the sea via "the Cut". Furthermore, "The Cut" promotes tidal flushing of the lower estuary which tends to maintain water quality at acceptable levels. However, the need to minimise additional input of nutrients to the Inlet is recognised.

To minimise nutrient migration from the project site, it is proposed to implement a comprehensive nutrient and irrigation management plan.

The basis of nutrient management will include:

- regular soil sampling and testing to determine residual soil nutrient levels and soil moisture levels, and adjustment of fertiliser and irrigation application rates according to results of the analyses. This work will be completed on the golf course and areas of public open space;

- application of chemical products which enhance the moisture retention characteristics of the soil and improve infiltration to the root zone;

- minimising water application by establishment of deep-rooted turf and by planning of irrigation schedules to avoid excessive losses due to evaporation and wind interference and over-saturation during storm events;

- minimising water application by regular maintenance of the golf links and gardens, which will enhance infiltration to the root zone and reduce evaporation losses;

- use of loamy fill materials with good phosphorus retention characteristics in areas to be landscaped subsequent to filling;

- design and implementation of a detailed fertiliser programme based on application of slow release fertilisers and foliar feeding;

- encouragement of private lot owners to selectively cultivate native gardens and to use slow release fertilisers.

(ii) Potential waterway contaminants

It is recognised that water quality within artificial waterways can deteriorate if the input of contaminants is excessive. Contaminants may be introduced directly to artificial waterways primarily from the following sources:

- storm-water carried nutrients, silt and pollutants;
- accumulation of weed and debris;
- sewage;
- boat sullage discharge;
- antifouling paints;
- oil, fuel and grease spillages; and
- bilge water release.

Boat usage within the proposed canal is expected to be mainly by small power-boats, generally removed from the water, and lower numbers of moored boats of the small powered cabin-cruiser type. Therefore, contributions from boats accommodated within the proposed development is not expected to be important.

Long-term accommodation on houseboats within the development will not be permitted, and discharge from boat holding tanks will be strictly prohibited. The development site will also be fully deep sewered.

The re-fuelling facility will include appropriate drains to trap pollutants before runoff discharges into the canal. Boats with TBTO-based antifouling paint coatings will not be permitted to moor within the canal waterway or marina. All stormwater drains leading to the artificial waterways will be fitted with silt traps.

Similar measures have been instigated in existing canal developments at Mandurah and monitoring of the water quality in these developments has confirmed the adequacy of these preventative measures (LSC, 1990).

The waterways will be inspected daily by the Proponent's Waterways Manager and any corrective action required to maintain water quality and aesthetics to the high standard required by the Proponent and Government agencies will be implemented immediately. Easements to the satisfaction of LIMA will be located at least every 300 m along the canal banks to facilitate access for canal maintenance.

Although most unlikely to occur, if water quality declines to the point where action is required, forced circulation and aeration will be achieved through use of a boat and compressor. If coliform counts exceed permissible limits, appropriate advisory signs will be erected around the canal shore, and water contact will be restricted as necessary. Such action has not been necessary for any of the existing, recently developed waterway projects in this State, largely because the exchange rate of the water in these developments has been adequate.

(iii) Flushing and exchange mechanisms

A model has been developed by Riedel and Byrne to predict water exchange and flushing rates of the canal and non-navigable waterway. The results of this study are presented in Appendix 7.

There are three likely mechanisms for the flushing of the proposed residential canal and non-navigable waterway at Pelican Point, resulting in the exchange of water between these water bodies and the Collie River:

- tidal exchange, which occurs at least once a day, and longer term barometric water level increase with periods of five to 20 days;
- wind-induced currents and mixing; and
- density currents due to salinity and temperature gradients.

The results of this study indicate that the effects of tidal flushing, wind-induced circulation and mixing, and gravitational flushing due to salinity and temperature gradients should ensure that the water quality in the canal and non-navigable lake will closely reflect that of the source water in the lower reaches of the Collie River.

The principal exchange mechanisms are wind circulation and density currents. Wind-induced currents are capable of total exchange of both the canal and lake over a period of one to two days. Density-driven currents are dominant, capable of total exchange of both waterways in a matter of hours.

A likely summer flushing time is predicted to be approximately 1.5 days for the canal and two days for the non-navigable waterway. The reduced wind field which occurs during winter and the increased movement of the saline wedge would indicate that a greater level of activity from density currents can be expected during this time. Thus, a winter flushing time of eight hours for the canal and 12 hours for the non-navigable waterway is estimated.

The Steering Committee on Canal Development (1984) recommended that water quality within canals should not adversely affect the following uses:

- occasional immersion and wading;
- boating;
- adjacent development; and
- passive recreation.

It is proposed to maintain water quality within the canal (within the limits imposed by the waters of the Collie River and Leschenault Inlet) to meet the criteria set down in Schedules 2, 5, 7, 8 and 16 of Bulletin No. 103 (DCE, 1981). These allow for:

(i) harvesting of aquatic life for food;
(ii) passage of fish and other aquatic life;
(iii) maintenance and preservation of the aquatic ecosystem;
(iv) maintenance of foreshores and banks; and
(v) navigation.

These criteria meet the objectives of canal uses (Steering Committee for Canal Developments, 1984), in addition to the general aesthetic guidelines listed in Item 6.4(e) of that document.

The combination of management proposals given above and the efficiency of flushing characteristics predicted for the waterways should ensure that these water quality criteria are met.

5.3.1.4 Shoreline Stability

It has been noted that there has been little movement of the shorelines around the site over the period between 1941 and 1986 (Section 3.3.2.7). The proposed foreshore reserves along the Collie River and Vittoria Bay shorelines, and the public park at the northern point, should provide an adequate buffer zone between the shore and the development and minimise any interference with natural slow shoreline change.

The Collie River shoreline has been modified previously by jetty and boatshed construction and associated shoreline erosion and by stabilisation works undertaken by the Waterways Commission. Retaining walls have been constructed upstream of Pelican Point, and there are also retaining structures at the public boat ramp on the development site.

The shoreline will be stabilised adjacent to the public boat launching ramp and at the entrance of the canal and non-navigable lake to ensure that erosion does not occur in this area.

Entrance channel stability has been assessed by Riedel and Byrne (Appendix 7). Exchange velocities in the entrance of the proposed canal and lake are estimated to be less than 0.1 m/s. Such velocities are considered to be insufficient to transport material in the entrance bed or side slopes. The flows out of the development are small and should have no measurable effect on the flow patterns of the Collie River or its adjacent banks.

Flows in the River are at most times tidal and of low velocity, however flood flow conditions over the winter months can be expected to result in bedload movement into the channel from time to time. Inspection of accretion records at the mouth of the River has shown the deposition rate to be small, and analysis of bed samples and flood flows indicates that significant transport will occur infrequently.

It is intended to maintain the navigable depth of the canal and entrance channel at -1.6 m AHD. Its construction to a centre line depth of -2.0 m AHD will allow for sedimentation which will gradually occur.

A survey of canal earthworks will be conducted prior to the cessation of dewatering. The depth of the canal and entrance will be regularly monitored (once per year after winter flow has ceased) to determine the necessity for and frequency of dredging. Plans for both dredging and disposal of dredged material will be submitted to LIMA for approval prior to their implementation.

Occasional dredging (once every 10 years) is expected to be required and will be carried out by the Proponent. An area of open space has been allocated at the end of the canal for disposal of spoil when this becomes necessary.

5.3.2 Effects on Biological Environment

5.3.2.1 Pressures on Artificial Wetland Habitats

At present the project site is used for rural purposes or is undeveloped and is subsequently detached from the immediate pressures associated with human habitation and the built environment.

As the wetlands proposed within the development area will be situated within a residential environment, waterbirds and other fauna utilising these habitats will be subjected to associated impacts. Ninox Wildlife Consulting (Appendix 4) identifies these to be:

- human disturbance;
- domestic and introduced predators;
- noise and light; and
- road casualties.

(i) Human disturbance

Until waterbirds become accustomed to human presence, regular disturbance can seriously disrupt activities such as feeding, breeding and roosting. An international literature search was conducted by Ninox Wildlife Consulting as a part of the avifaunal study for this PER. The findings showed that the primary impact on waterbirds, apart from continuing physical attrition of wetlands, resulted from disturbance through water sports, hunting and angling. None of these activities will take place in the series of permanent wetlands planned for the proposed development area.

As the golf course will incorporate shelter for birds in the form of patches of trees, natural shrubland, wetlands and islands, minimal human disturbance is predicted for this area.

Management strategies proposed to curtail the impact of human disturbance predicted for the series of freshwater wetlands scattered throughout the development include the creation of islands, planting of shelter belts, adequate set-back of paths from the water's edge and developing a public education programme.

(ii) Domestic and introduced predators

The introduction of pet dogs and cats into the estate can have an impact on waterbirds through harassment and predation. This impact will be cumulative upon that of foxes and feral cats which, while not recorded during the faunal surveys, must be present (Appendix 4).

The strict control of dogs will be enforced within the development with education of residents and appropriate signage throughout areas of open space and the foreshore. A fox and feral cat reduction programme will be formulated in association with the Agriculture Protection Board. The construction of islands in the saline wetland will provide predator refuges which are presently not available on the site.

(iii) Noise and light

An international literature search was commissioned by Ninox Wildlife Consulting as a part of the Port Geographe project (LSC, 1988), to clarify the perceived issues of noise and light with respect to waterbirds. No reference to light, nor to traffic noise and other suburban sound sources, was recorded in the literature as having an adverse impact on waterbirds. Noise and light are therefore not seen to be important impacts since there is evidence clearly indicating that waterbirds and migratory shorebirds habituate to these disturbances. Perth metropolitan wetlands adjacent to freeways or surrounded by housing estates and street lights are typical examples.

All lighting surrounding wetlands and along the foreshore will be directed away from the water. The provision of vegetated refuge areas and islands will reduce any potential effects of reflected light.

(iv) Road casualties

Road casualties are an inevitable impact associated with traffic and wildlife. Broods of young ducks moving from their breeding areas to wetlands are one of the main potential casualties, and this will occur in a northward direction from the extreme southern limits of the proposed development area in this case.

Traditional routes will be identified on the site and signs will be erected along road verges, as is the practice in similar situations within the Perth Metropolitan Region. In addition, speed limits within the resort area will be controlled with appropriate signs.

5.3.2.2 Pressure on Foreshores

The foreshore of the proposed development area is not used by large numbers of birds, but is rich in species, and it is adjacent to tidal flats where most feeding birds congregate.

The part of the foreshore of Pelican Point which has been identified as significant in providing waterfowl habitat is the shoreline fringing vegetation, and most particularly the trees which fringe the Collie River (i.e. *Casuarina obesa*, *Eucalyptus rudis*, and *Melaleuca cuticularis*). The proposed development will not have any measurable adverse impact on shoreline waterfowl habitat, and will enhance the present condition of foreshore vegetation for waterfowl.

Fringing shoreline trees will be retained wherever possible and additional plantings at an increased density will be made at the conclusion of the site preparation phase of construction. Where fringing rush vegetation remains along the Collie River foreshore, it will be protected wherever possible.

The development will increase human and animal pressures on waterfowl utilising the project area. While large numbers of feeding birds can co-exist with humans, as is evident at Koombana Bay to the south-west of the proposed development area it is unlikely that trans-equatorial shorebirds which currently loaf and roost on the landward edge of the Vittoria Bay foreshore will continue to do so. However, the birds will continue to feed on the intertidal flats and will roost in areas such as the Preston River delta. The carrying capacity of the estuary for these birds is unlikely to alter as a result of the development proceeding.

The buffer zone proposed for industry adjacent to the future Preston River diversion is expected to act as a conservation area for waterbirds, and the tidal delta area, which will form when the river is diverted, will become a valuable wildlife habitat.

In order to minimise the pressures of adjacent development and human disturbance on the foreshore regions, the following management strategies are proposed:

- the dual use pathways will be set well back from the water's edge;
- a public education programme will be established and implemented in order to stress the significance of waterbirds utilising the area; and
- signs will be erected to direct the strict control of dogs.

5.3.2.3 Increase in Fishing Pressure on Marine Biota

A potential medium to long-term effect of the development is to increase fishing pressure on local fish stocks. This could result in a reduction in fish and crustacean populations and consequent changes to local population structures.

This impact is regarded as an inevitable result of urbanisation, and the development is consistent with plans for increased recreational usage of Leschenault Inlet, as proposed in

accepted future development plans for the region. The proposed artificial waterways will provide additional marine habitat for a range of aquatic organisms.

Measures proposed to reduce the impact of the development on the marine biota include co-operating with the Fisheries Department in managing exploitation of the fish resource by informative signage within the marina and at the public boat ramp. Information provided would include minimum catchable fish sizes and bag limits.

5.3.3 Effects on Social Environment

5.3.3.1 Regional Planning Issues

The development of tourist and residential accommodation, resort facilities and a golf course is compatible with the statutory planning for the site within TPS No. 6 and with the intention of the Bunbury Region Plan's policy for Pelican Point and Lot 100 (Section 3.5.1.2). In addition, the proposed development is not inconsistent with the Leschenault Inlet Management Programme, and is considered to be complementary to the overall land use plans for the region i.e. a proposed Regional Park. Therefore it is considered that the proposed development will not adversely impact on recognised long-term plans for the region.

The proposed development is ideally located to enhance the community's enjoyment of the proposed Regional Park. Both the regional and local community will benefit substantially from the proposed development as a result of:

- improved access to the estuary and river foreshores;
- the provision of high quality public recreation facilities (boat ramp, parking areas, picnic sites, etc.);
- the provision of tourist facilities and a stimulus to the local tourism industry;
- the provision of residential land close to Bunbury; and
- the provision of short and long term employment opportunities.

5.3.3.2 Regional Conservation Values

Regional conservation values will not be adversely affected and local values will be enhanced as a result of the waterfowl drought and predator refuges proposed for the ILDA land. The carrying capacity (availability for feeding habitat) of the Inlet for trans-equatorial migratory shore birds will not alter.

5.3.3.3 Community Services and Facilities

The proposed development is not anticipated to cause any adverse impact on existing community services and facilities. As demonstrated in Section 4.6 all services are available within close proximity to the project site and can be provided as required without interfering with the local community's use of these services.

5.3.3.4 Traffic (Road Systems and Transport)

Taylor Road, the present access road to Pelican Point, will be closed and a new access road constructed by the developer. This is considered to be necessary because of the presently unsatisfactory nature of the intersection of Estuary Drive and Taylor Road.

Major road access will be via the bypass road, which will be connected to Estuary Drive with a roundabout to provide access to the development site (Fig. 22). When the development has been completed, the project may be expected to generate a total of 10,400 vehicle trips per day, mainly along Estuary Drive. This increase in traffic can be accommodated with ease on the existing roads (Taylor & Burrell, 1990).

All roads, roundabouts and other entry points to the development will be constructed to meet the safety standards and requirements of MRD and the City of Bunbury.

5.3.3.5 Land Use

The proposed development will transform the subject land into a resort development of high standard, comprising tourist and residential accommodation within a waterway setting, and a golf course with associated housing and facilities. This change in land use will allow increased public use of the subject land. In addition the diversity of waterbirds expected to utilise the site will provide the potential for wildlife education and amateur bird-watching activities. The proposed land use is consistent with existing plans for the Collie delta region, namely recreation and tourism.

5.3.3.6 Water Use

The waters of Leschenault Inlet and the Collie River are currently used for professional and recreational fishing and recreational boating. The proposed development will result in increased boating traffic in the lower reaches of the Collie River and an increase in recreational fishing activity in the estuary, however this is not expected to adversely impact upon present use of the estuary. The project is in accordance with recreation objectives for Leschenault Inlet.

5.3.3.7 Nuisance Organisms

The project site contains five locations classified as high priority mosquito control areas and two classified as moderate control (Wright, 1986). The proposed development of the site will result in the modification or destruction of these mosquito breeding areas, thus reducing mosquito nuisance in the Bunbury region.

Artificial wetlands created within the development will be designed to minimise mosquito breeding.

5.4 SYNTHESIS

The potential adverse impacts associated with construction and operation of the development on the existing environment, and the management strategies proposed to ameliorate these impacts, are given in Table 1 and Table 2, respectively. Each table outlines the predicted impact, and the management commitments made by the Proponent to ameliorate the impact.

The benefits predicted to result from the development are outlined in Table 3.

6 ENVIRONMENTAL MANAGEMENT PROGRAMME

6.1 INTRODUCTION

The proposed development is a complex project which has the potential to provide a wide range of benefits to the local and regional community. However, it is situated adjacent to Leschenault Inlet, a natural environment of high conservation and recreation value and hence will require substantial management to minimise its impact on that environment during both the construction phase of the development and its subsequent operation phase.

Virtually all of the potentially adverse effects identified in the preceding Environmental Effects section (Section 5) can be substantially mitigated through either appropriate design or sensible management practices. The range of management actions proposed for each of the recognised environmental effects is outlined in Tables 1 and 2 for the construction and operation phase, respectively.

These management actions will be incorporated into distinct management plans for various components of the proposed development. The management plans will also include monitoring programmes aimed at providing feedback on the effectiveness of management actions. The following plans are proposed:

- a Construction Management Plan;
- a Nutrient and Irrigation Management Plan;
- an Artificial Wetlands and Wildlife Conservation Management Plan;
- a Waterway Management Plan; and
- a Foreshore Reserve Management Plan.

The major tasks proposed for each management plan are outlined below. Subsequently, detail on proposed contingency plan and monitoring programmes proposed for each management plan is provided. Finally, this section outlines the administrative details and responsibilities of various authorities involved in management of the development.

6.2 PROPOSED MANAGEMENT PLANS

6.2.1 Construction Management Plan

Aim: To minimise construction effects on the local environment and community, and enhance the wetland functions of the project site.

Tasks: (i) Produce a detailed landscape Master Plan before initiating construction.

(ii) Preserve existing vegetation wherever possible, but especially on the River foreshore, in public open space and in the golf course.

(iii) Undertake bulk earthworks in two major phases to allow development of artificial wetland refuges on ILDA land before alienation of Pelican Point wetlands.

(iv) Release dewatering fluids and imponded waters to the Collie River under conditions specified by the Leschenault Inlet Management Authority (LIMA).

(v) Stabilise all disturbed soil surfaces by wetting and revegetation.

(vi) Preclude public access during construction works.

(vii) Comply with Section 18 of the *Aboriginal Heritage Act.*

(viii) Hours of operation to be approved by the City of Bunbury.

(ix) Monitor workforce compliance.

Responsible authorities: Liaison and reporting will be maintained with Bunbury City Council, LIMA and the Western Australian Museum.

6.2.2 Nutrient and Irrigation Management Plan

Aim: To minimise the potential for additional nutrient contamination of the River and Estuary.

Tasks: (i) Minimise application of fertiliser by:

- soil analysis to determine minimum nutrient requirements;
- monitoring soil and foliar nutrient levels to determine appropriate rates of nutrient application;
- use of slow release fertilisers;
- soil modification to enhance retention of nutrients;
- minimise grassed areas in the golf course and landscaped open spaces;
- use local species of grass wherever possible;
- encourage residents to minimise fertiliser application and plant native species.

(ii) Minimise groundwater use by:

- reducing the golf course grassed areas to minimum required;
- irrigation of grassed areas only. Intervening areas will be allowed to dry in summer;
- adoption of appropriate water conservation measures such as seasonal modifications to irrigation programme and dawn/dusk irrigation;

- use of stormwater runoff;
- monitoring of soil moisture levels to determine appropriate irrigation requirements;
- planting of native drought-tolerant species throughout landscaped parts of the development.

(iii) Monitor groundwater levels, abstraction rates, salinity and nutrient concentrations to provide feedback for management plan.

Responsible authorities: Monitoring results will be reported to LIMA, the Bunbury City Council, WAWA and the EPA.

6.2.3 Artificial Wetlands and Waterfowl Conservation Management Plan

Aim: To maximise the conservation potential of wetlands and minimise the potential for water quality problems and mosquito breeding.

Tasks: (i) Produce a Landscape Master Plan providing details of the wetland topography, areas of existing native vegetation to be retained, and plantings. Design of wetlands will be aimed at maximising diversity of habitat, providing predator refuges and shelter belts of native vegetation, and providing wetland nutrient traps.

(ii) Monitor water quality, particularly nutrients and oxygen concentrations.

(iii) Monitor the development of invertebrate biota, including mosquitoes, and amphibians.

(iv) Monitor the use of wetlands by waterfowl.

(v) Implement a fox control programme.

(vi) Enforce the strict control of dogs and cats in the development by signage and public education.

(vii) Plant a range of native flowering shrubs within the golf course and public open space to attract bush birds to the area.

Responsible authorities: Liaison with and reporting to the Department of Conservation and Land Management, LIMA and EPA.

6.2.4 Waterway Management Plan

Aim: To ensure the serviceability and integrity of all public infrastructure and to maintain acceptable water quality within waterways and the adjacent River.

Tasks: (i) Minimise the potential for water quality problems by:

- banning sewage discharge from boats;
- minimising the discharge of stormwater and constructing silt and grease traps at all drainage points to the waterways.

(ii) Monitor water quality, especially nutrients and chlorophyll 'a'.

(iii) Monitor sediment quality, especially nutrients, and metals.

(iv) Monitor the condition of wall structures, sedimentation rate and navigable depth.

(v) Establish contingency plans.

Responsible authorities: Liaison and reporting to LIMA, EPA, Bunbury City Council and the Department of Marine and Harbours.

6.2.5 Foreshore Management Plan

Aim: To protect the conservation value of intertidal flats for shorebirds while enhancing the value of foreshores for passive recreation.

Tasks: (i) Minimise disturbance to waterfowl by:

- public education;
- strict control of dogs;
- set paths back from the waters edge; and
- additional plantings of appropriate trees.

(ii) Control public access via appropriate location of:

- car parks;
- toilets;
- picnic areas; and
- boat ramps.

(iii) Monitor the success of management actions.

(iv) Monitor the use of intertidal flats by shorebirds.

Responsible authorities: Liaison and reporting to the Bunbury City Council and LIMA.

6.3 CONTINGENCY PLANS

The following contingency plans will be incorporated into the Waterway Management Plan.

6.3.1 Navigable Entrance and Canal

In the event of unforeseen siltation of the canal and entrance channel, or damage to canal walls, the Waterways Manager will undertake the required works to remedy the situation.

6.3.2 Water Quality Maintenance

Minor fuel spills which occur during refuelling operations will be allowed to dissipate naturally. In the event of a major fuel or oil spill, the Waterways Manager will be responsible for taking the necessary steps to contain the spill. All contingency actions will be environmentally compatible.

6.3.3 Sewerage System

As WAWA is responsible for the sewerage system, the authority to initiate or undertake any repairs or works on the system lies with that department. Therefore, in the event of failure of the system, the Proponent can only implement contingency measures to prevent any discharge from the sewerage system into the waterways until WAWA has rectified the fault. Contingency measures to this effect will be documented.

6.3.4 Storm and Flood Damage

Damage to supporting structures (entrance and canal walls) caused by a severe storm or extreme flood event will be rectified as soon as possible under the direction of the Waterways Manager.

6.4 MONITORING PROGRAMMES

6.4.1 Objectives

The objectives of the proposed monitoring programme are:

(i) to confirm predictions made in this PER;

(ii) to provide feedback on the effectiveness of management and rehabilitation programmes so that they can be amended if necessary; and

(iii) to provide warning of the occurrence of potentially undesirable and unexpected changes to affected ecosystems.

6.4.2 Construction Monitoring

Workforce compliance with:

- vegetation protection requirements,
- Aboriginal heritage requirements,
- release of dewatering liquids and imponded waters,
- dust minimisation requirements, and
- soil stabilisation requirements

will be independently monitored at appropriate intervals during the construction phase of the development.

6.4.3 Nutrient and Groundwater Monitoring

Monitoring of groundwater resources is proposed to include (Appendix 5):

- water levels in production bores and monitoring bores on a monthly basis;
- groundwater abstraction rates on a monthly basis;
- water levels in irrigation lakes on a monthly basis, together with irrigation rates and distribution of water volumes throughout the resort;
- electrical conductivity of groundwater discharged from each production bore on a quarterly basis;
- the position of the saline interface within the Leederville Formation on a quarterly basis;
- nutrient concentrations in the superficial formations in the vicinity of the golf course and areas of open space on a quarterly basis; and
- soil moisture levels.

Nutrient monitoring strategies will include soil and foliar sampling and testing for residual nutrients.

6.4.4 Artificial Wetland Monitoring

6.4.4.1 Water Quality

Aesthetic water quality characteristics of the artificial wetlands will be inspected on a weekly basis by resort management staff.

In addition, nutrients (i.e. total phosphorus, orthophosphate, total nitrogen and inorganic nitrogen) and oxygen concentrations will be monitored on a quarterly basis within the freshwater and saline wetlands.

6.4.4.2 Biota

The development of aquatic invertebrate and vertebrate fauna will be monitored on a quarterly basis during the first five years of operation. Mosquito breeding activity will also be monitored at the same time.

Colonisation of the wetlands by waterfowl will be monitored opportunistically by resort management staff and professionally on a quarterly basis.

6.4.5 Waterway Monitoring

6.4.5.1 Water Quality

Water quality will be monitored at selected sites both within the canal and lake and within the Collie River (Fig. 23) commencing on completion of the construction phase. Monitoring will occur on a quarterly basis for the first five years of operation, with future monitoring being dependent upon a review of the initial monitoring results. The parameters to be monitored include:

- chlorophyll 'a' (surface and 0.5 m from the base of the water column);
- suspended solids (surface and 0.5 m from the base of the water column);
- dissolved oxygen (surface and 0.5 m from the base of the water column);
- biochemical oxygen demand (surface and 0.5 m from the base of the water column);
- total phosphorus (surface and 0.5 m from the base of the water column);
- orthophosphate (surface and 0.5 m from the base of the water column);
- total nitrogen (surface and 0.5 m from the base of the water column);
- inorganic nitrogen (surface and 0.5 m from the base of the water column);
- salinity (throughout water column to check for stratification);
- temperature (throughout water column to check for stratification);
- light attenuation (by Secchi disk); and
- aesthetics (by visual observation).

Aesthetics parameters will include floating or submerged material, colour, odour, settleable material, oils, grease and surfactants. Aesthetics are judged on an essentially subjective basis and results can not be quantified.

Bacteria levels will be monitored five times over a 30 day period in January and February each year.

6.4.5.2 Canal Sediments

Sediments within the canal will be monitored as follows:

(i) twice-yearly in the canal for nutrients, organic matter and carbonate; and

(ii) when the canal is initially opened, and subsequently in years three and five for a range of metals and derivatives. These are copper, zinc, cadmium, tin, lead and chromium. Sediments will be sampled at the water quality monitoring sites identified in Figure 23.

6.4.5.3 Condition of Canal and Entrance Walls

The condition of wall structures within the canal and lake will be monitored on an annual basis for five years, commencing within one month of practical completion. A monitoring programme will be developed to confirm that the design and construction of the walls and scour protection material is satisfactory.

6.4.5.4 Sedimentation in Canal

A survey of canal earthworks will be conducted prior to the cessation of dewatering. Annual hydrographic surveys will be carried out and compared with the "as constructed" survey to establish whether sedimentation is occurring and thus the necessity for, and frequency of, dredging.

6.4.5.5 Condition of Shoreline Structures

The condition of shoreline stabilisation structures will be monitored on an annual basis for five years.

6.5 ADMINISTRATIVE DETAILS

6.5.1 Reporting Schedule

6.5.1.1 Timing

Results obtained from the monitoring programme will be collated and analysed on an annual basis, and a report will be produced containing this information. Based on the results of monitoring, the programme will be reviewed annually. A major review will take place after five years.

6.5.1.2 Reporting Authorities

The annual and final monitoring reports will be made available to the City of Bunbury and State agencies with responsibilities and interests in the project, including the EPA, LIMA and DMH.

6.5.2 Authorities Responsible for Management

6.5.2.1 The Proponent

The proponent will be responsible for all aspects of the project, including the management programmes detailed within this document. Subject to detailed arrangements being finalised in the project agreement between the Proponent, the local authority and the State, some aspects of management will revert to the Government.

6.5.2.2 City of Bunbury

Upon completion of the project, the City of Bunbury will be responsible for the management of public roads, areas of public open space outside the resort areas, and normal ratepayer services. The City of Bunbury will become the Waterways Manager for the Pelican Point development, however responsibility for water quality, depths and navigation will rest with the Home Owners Association. Foreshore reserves will be vested in the City of Bunbury following a maintenance period to be specified in the Project Agreement.

6.5.2.3 State Government

Navigation aids within the canal and marina will become the responsibility of DMH following their construction.

6.6 LEGAL AGREEMENT

The commitments outlined in the above management plans, plus any conditions subsequently imposed on the project by the EPA, LIMA and other affected government authorities will be incorporated into a Legal Agreement between the Proponent and the Bunbury City Council. It is envisaged that an appropriate mix of tourist, managed residential and conventional residential development will be negotiated with LIMA and the City of Bunbury, and resulting ownership and management commitments will be incorporated into the Legal Agreement. The need for short-stay tourist and holiday accommodation adjacent to the foreshores and floodway wetland reserve is acknowledged, and appropriate commitments to this effect will also be incorporated into the Legal Agreement.

Approval of the rezoning application by the Minister for Planning is conditional on prior finalisation and acceptance by the Proponent and City of Bunbury of the commitments contained in the Legal Agreement.

7 CONCLUSION

The proposed development has been researched by the Proponent since 1986. It has been designed to accommodate planning guidelines for the site and the region and to overcome environmental constraints applicable to the area. The Proponent has addressed recommendations made by the EPA and LIMA in DCE Bulletin No. 267 (DCE, 1986) and in subsequent correspondence, in the design of the proposed development. Extensive consultations have been held with all appropriate land and water use regulating authorities.

The local conservation value of some of the wetlands on the site have been recognised and compensation for their modification has been incorporated into the golf course design. The conservation and recreational values of Leschenault Inlet will be protected via a combination of appropriate design and sensible management practices.

The major permanent effect of the development will be the change of landscape aesthetics from a vista of degraded wilderness and open grazing fields to one of a landscaped and built environment. While some may see this as an adverse effect, others will see it as an improvement.

The proposed development will provide substantial benefits to the local and regional community, including:

- community access to and managed use of the estuary and river foreshores in perpetuity;
- provision of short and long-term employment opportunities;
- control of mosquito breeding and odour problems;
- provision of tourist facilities and stimulus of the local tourism industry;
- provision of a diverse range of residential units between Bunbury and Australind adjacent to Eaton townsite;
- provision of public recreation facilities to benefit both the existing and proposed community;
- provision of waterfowl and wildlife refuges.

It is therefore considered that the Proponent has adopted an environmentally responsible approach to the development of a project which will benefit the community. As such it is submitted that the project is environmentally acceptable and the Proponent seeks approval to proceed with the proposed development subject to the design and management commitments made being formally incorporated into the project agreement.

8 COMMITMENTS

The Proponent undertakes to abide by all commitments made in this PER. The project will be operated and maintained in accordance with the guidelines established in the management programmes detailed in Section 6 of this document. These commitments, which the Proponent accepts as being legally binding on approval of the project by the Government of Western Australia, will be incorporated into the Environmental Management Programme and any agreement entered into between the Proponent, the State and the City of Bunbury.

8.1 CONSTRUCTION MANAGEMENT

Pelican Point Pty Ltd (the Proponent) undertakes to carry out the following works prior to or during construction of the Pelican Point project:

8.1.1 Public Access During Construction

(i) In the interests of public safety the construction site will be fenced and appropriately worded signs will be erected at access points around the project area to enforce public access restrictions, to the satisfaction of the City of Bunbury.

8.1.2 Ethnographic and Archaeological Sites

(i) The Proponent will comply with the provisions of the Western Australian *Aboriginal Heritage Act 1972-1980*, and in particular will make application under Section 18 of the Act in the event that it is proposed to disturb any identified site.

8.1.3 Landscape Aesthetics and Landform

(i) A comprehensive landscape master plan for areas of public open space will be prepared to the satisfaction of EPA, LIMA and the City of Bunbury, prior to construction. Landscaped areas to be provided within the development will incorporate:

- retention of mature trees, fringing vegetation and areas of bushland wherever practicable; and
- planting of indigenous vegetation species, including a high proportion of flowering shrubs.

(ii) All housing and tourist accommodation within the site will be constructed outside the industrial buffer zone as defined by the Rigden Lines. Tree belts will be planted within this zone along the western boundary of Lot 100.

(iii) Buildings will be restricted to two development levels.

(iv) Power supply to the development will be underground and constructed to SECWA approved standards.

(v) The provisions of the Collie River Flood Study, notably the adoption of the recommended development set-back from the Collie River and the provision of a 250 m wide relief floodway, will be incorporated to the satisfaction of WAWA.

(vi) The relief floodway will be established as a wetland reserve.

8.1.4 Traffic, Noise and Vibration

(i) Hours of operation will be subject to approvals to be granted by the City of Bunbury. All construction vehicles will be fitted with effective emission controls. Ground vibration will be monitored on site and in surrounding areas if this is identified as a problem. Liaison with the City of Bunbury throughout the construction phase will identify any public concerns arising from noise or vibration.

(ii) All roads, roundabouts and other entry points to the Pelican Point development will be constructed to meet the safety standards and requirements of the Main Roads Department and the City of Bunbury.

8.1.5 Importation of Fill and Disposal of Spoil

(i) Bulk earthworks will be undertaken in two phases separated by 1-3 years. Phase One will involve construction of Stage One of the project on the ILDA land. Works to resolve the mosquito and odour problem on Pelican Point will also be undertaken during Phase One.

(ii) Filling of the site will only occur to the level necessary to comply with flood level requirements and potential sea level rise, to an average level of 2.7 m AHD. In general the fill levels will be set at the minimum level required by the City of Bunbury for the various land uses proposed.

(iii) Topsoil removed during construction will be stockpiled on parts of the site which will be subsequently disturbed. Excavated soil will later be used in landscaping the golf course and areas of public open space within the resort. There will be no export of spoil from the site.

(iv) Stockpiled topsoil and spoil will be stabilised to the satisfaction of the City of Bunbury to prevent erosion or the generation of dust. Dust will be suppressed by watering if necessary. Exposed soil surfaces will be revegetated with appropriate grasses, e.g. cereal rye, for interim soil stabilisation. As earthworks are completed the land will be revegetated with native species or planted to lawn and trees as appropriate.

8.1.6 Excavation and Dredging

(i) Dewatering fluids will be impounded on site to allow suspended particulates to settle out before the water is discharged to the Collie River. Turbid water will be contained within the canal and lake until the entrance is breached. Timing of discharge of dewatering fluids and breaching of the canal and lake connections to the estuary will take place when turbidity is seasonally high and flow is out to sea. Construction timing and techniques will be subject to approvals by LIMA and the City of Bunbury.

(ii) The residential portion and the connection channel of the non-navigable waterway will be excavated to a design depth of -1.6 m AHD, to the satisfaction of EPA and LIMA. From this point invert levels will increase to mean water level at the southern portion of the wetlands lake to ensure that water does not stagnate within the waterway.

(iii) The non-navigable waterway will be transferred to the Crown free of cost and where it forms part of a private housing and resort development, will be maintained initially by the Proponent and subsequently by a Home Owners Association, or alternatively, by the City of Bunbury under a possible differential rating scheme. Those sections of the non-navigable waterway which lie within the Collie River foreshore reserve or within the floodway, will be established and maintained by the Proponent during the agreed maintenance period, after which time the City of Bunbury will become responsible for ongoing maintenance and management.

(iv) Excavation of the canal and non-navigable floodway lake will be undertaken under dry conditions with traditional earthmoving equipment wherever possible, to the approval of LIMA and City of Bunbury.

(v) The canal and entrance channel will be excavated and maintained at a depth of -1.6 m AHD, with a centre line depth of -2 m AHD to allow for sedimentation, to the satisfaction of DMH and the City of Bunbury.

(vi) The canal waterway will be transferred to the Crown free of cost and be maintained, initially by the Proponent and subsequently by a Home Owners Association, or alternatively, by the City of Bunbury under a possible differential rating scheme.

8.1.7 Wetland Reconstruction and Rehabilitation

(i) Artificial wetlands planned within the development (perched freshwater lakes, irrigation lakes and saltwater lakes) will be developed and maintained in accordance with a management plan to the satisfaction of EPA, LIMA and the City of Bunbury. These water bodies will remain in private ownership and be maintained initially by the proponent and subsequently by a Home Owners Association, or alternatively, by the City of Bunbury under a possible differential rating scheme.

(ii) Artificial wetlands and associated vegetation will be designed to replace traditional sites lost as a result of the development. The design of artificial wetlands planned for the development, which will be further detailed in the management plan, will incorporate:

- existing native wetland vegetation;
- a variety of water depths;
- natural or artificial variations in water levels;
- revegetation using indigenous plant species; and
- islands for refuge.

8.2 OPERATIONS MANAGEMENT

The Pelican Point project involves the management of a number of interactive aspects which have the potential to adversely impact on the environment, if not adequately managed. These include:

- mosquito breeding;
- odour;
- drainage;
- groundwater;
- nutrients;
- wetland water quality and productivity;
- canal water quality, siltation (water depth) and structural integrity; and
- landscape.

The commitments given by the Proponent in relation to each of these issues are described in the following sections.

8.2.1 Mosquito Breeding

(i) Sites in which mosquito breeding currently takes place will be modified to reduce or eliminate breeding, to the satisfaction of the City of Bunbury. Artificial wetlands created within the development will be designed to minimise mosquito breeding to the satisfaction of the Mosquito Control Review Committee.

8.2.2 Odour

(i) The existing odour problem generated by wetlands which dry in summer will be eliminated by converting the wetland to a tidally-flushed permanent wetland to the approval of LIMA and the City of Bunbury.

8.2.3 Drainage

(i) Stormwater from the development will be managed to the satisfaction of the City of Bunbury and LIMA. Disposal will be on site to localised soakage pits to the maximum extent possible. Excess stormwater will be discharged to the perched lakes within the development and by discharge to the residential canal or non-navigable lake. The stormwater drainage plan proposed will ensure that silt, contaminants and nutrients are trapped before discharge to the artificial waterways. The drainage system will be maintained to ensure effective trapping of contaminants.

8.2.4 Groundwater Management

(i) Groundwater will be pumped from the Leederville Formation, subject to the granting of a licence by WAWA prior to the commencement of abstraction, into a series of interconnected lakes which will be lined to form a water storage facility, from which the reticulated water supplies will be drawn.

(ii) The availability of shallow groundwater to supplement that drawn from the Leederville Formation will be further investigated and reported to WAWA prior to the commencement of abstraction.

8.2.5 Nutrient Management

Nutrient management will be implemented through a comprehensive nutrient and irrigation management plan prepared to the satisfaction of the EPA and LIMA. To minimise nutrient migration from the site, the following management strategies are proposed:

(i) Minimise application of fertiliser by:

- soil analysis to determine minimum nutrient requirements;
- monitoring soil and foliar nutrient levels to determine appropriate rates of nutrient application;
- use of slow release fertilisers;
- soil modification to enhance retention of nutrients;
- minimising grassed areas in the golf course and landscaped open spaces;
- use of local species of grass wherever possible;
- encouraging residents to minimise fertiliser application and plant native species.

(ii) Minimise groundwater use by:

- reducing the golf course grassed areas to minimum required;
- irrigation of grassed areas only. Intervening areas will be allowed to dry in summer;
- adoption of appropriate water conservation measures such as seasonal modifications to irrigation programme and dawn/dusk irrigation;
- use of stormwater runoff;
- monitoring of soil moisture levels to determine appropriate irrigation requirements;
- planting of native drought-tolerant species throughout landscaped parts of the development.

8.2.6 Artificial Wetland Habitat Management

To manage urban, human, domestic and feral animal pressures on the use of wetlands by waterfowl, the following measures will be introduced:

- creation of islands;
- planting of shelter belts;
- setting paths back from the water's edge;
- development of a public education programme;
- strict control of dogs;
- formulation of a fox and feral cat reduction programme if required in consultation with the Agriculture Protection Board;
- direction of light away from water;
- provision of vegetated refuge areas;
- provision of warning signs indicating the possibility of wildlife movement within the development; and
- enforcement of speed limits within the development.

These measures will be incorporated into a wetland management plan prepared to the approval of the EPA.

8.2.7 Foreshore Management

A foreshore management plan for the Collie River and Leschenault Inlet foreshores adjacent to the development will be finalised following negotiation between the Proponent, the local authority and LIMA incorporating the following elements.

(i) Land, identified on the land transfer plan (Fig. 15), will be transferred to the Crown free of cost.

(ii) Fringing shoreline trees will be retained wherever possible and additional plantings at an increased density will be made at the conclusion of the site

preparation phase of construction. Those parts of the Collie River foreshore which still support a fringing rush vegetation will be protected wherever possible.

(iii) The Proponent will re-construct the Collie River public boat ramp, and car and boat trailer parking will be provided.

(iv) A kiosk and associated parking area will be constructed on freehold land adjacent to the boat ramp facility to provide convenience items to the boating public and foreshore users.

(v) A dual-use pathway is proposed around the Collie River and Vittoria Bay foreshores, as well as through the development to facilitate access between the two foreshores. Three public toilet blocks are proposed in locations along the foreshore and at the boat launching ramp.

(vi) A public thoroughfare around the foreshore of the hotel and accommodation units will be maintained by way of an easement on title in favour of Bunbury City Council and LIMA. This easement will provide continuous pedestrian access and limited vehicular access for maintenance purposes in perpetuity.

(vii) Areas of the foreshore which are currently degraded will be grassed to provide for greater public use.

(viii) Parking areas will be provided in all defined areas of public open space within the development which lie adjacent to the foreshore reserve.

(ix) To minimise the pressures of adjacent development and human disturbance on the foreshore regions, the following management strategies are proposed:

- the dual use pathways will be set back from the water's edge;
- a public education programme will be established and implemented in order to stress the significance of waterbirds utilising the area; and
- signs will be erected to direct the strict control of dogs.

8.2.8 Canal and Navigable Waterway Management

A management plan designed to address the operational aspects of the waterways will be prepared to the satisfaction of the City of Bunbury, EPA, DMH and LIMA and will incorporate the following commitments:

Physical requirements

The physical elements of the canal and artificial waterway system are generally discussed in the construction programme. The following relate however to the on-going management of the project:

(i) Easements to the satisfaction of LIMA and the City of Bunbury will be located at least every 300 m along the canal banks to facilitate access for canal maintenance.

(ii) The Collie River shoreline will be stabilised adjacent to the public boat launching ramp and at the entrance of the canal and non-navigable lake to the satisfaction of LIMA and the City of Bunbury.

(iii) Navigation aids to the approval of DMH will be provided within the canal and adjacent estuary. Following their construction responsibility for navigation aids will be handed over to that authority.

Water quality

It is proposed to maintain water quality within the canal (within the limits imposed by the waters of the Collie River and Leschenault Inlet) to meet the criteria set down in Schedules 2, 5, 7, 8 and 16 of Bulletin No. 103 (DCE, 1981). To achieve these aims the following commitments are made:

(iv) Discharge from boat holding tanks will be strictly prohibited.

(v) Long-term accommodation on boat vessels within the development will not be permitted.

(vi) The development site will be fully deep sewered to the satisfaction of WAWA.

(vii) The refuelling facility will include appropriate drains to trap pollutants before runoff discharges into the canal.

(viii) A ban on the use of TBTO-based antifouling paint coatings on vessels less than 25 m in length will come into effect in July 1991, but will take up to five years to become fully effective. In the interim boats with TBTO coatings will not be permitted to moor within the canal waterway or marina.

(ix) In the event that water quality declines to the point where ameliorative action is required, forced circulation and aeration will be achieved through use of a boat and compressor. If coliform counts exceed permissible limits, appropriate advisory signs will be erected around the canal shore, and water contact will be restricted as necessary.

Fishing pressure

(x) The Proponent will co-operate with the Fisheries Department in developing a public education programme aimed at managing exploitation of the fish resource. It is proposed to provide informative signage within the marina, including information about minimum catchable fish sizes and bag limits.

Contingency plans

(xi) Contingency plans to ensure the navigability of the canal entrance, water quality maintenance, the prevention of accidental overflow from the sewerage system and repair of storm and flood damage will be documented in an Emergency Procedures Manual to the satisfaction of DMH, LIMA and the City of Bunbury.

8.3 MONITORING PROGRAMMES

8.3.1 Nutrient and Groundwater Monitoring Programme

(i) Nutrient monitoring will include recording the levels of nutrient used within the site on the golf course and public areas and the monitoring of nutrient levels within the soil and plant tissues in order to determine application rates, based on application at the minimum rates necessary to maintain the health of the target species.

(ii) Monitoring of groundwater resources will include:

- observation of the migration of the seawater interface over time, so that action can be taken to protect the aquifer within the Leederville Formation from seawater intrusion if necessary;
- water levels and quality (including nutrients) on a monthly basis; and
- groundwater abstraction rates on a monthly basis.

(iii) Monitoring results will be reported annually and reviewed following five years of operation.

8.3.2 Wetland Monitoring Programme

Monitoring of the wetlands within the project site will incorporate the following:

(i) Nutrient, dissolved oxygen and salinity levels within the lakes.

(ii) Re-establishment of wetland vegetation around the margins of the lakes.

(iii) Use of the wetlands by birds and other vertebrate animals.

(iv) Productivity of the lakes in terms of invertebrate and amphibians.

8.3.3 Canal and Artificial Waterway Monitoring Programme

A canal and artificial waterway monitoring programme will be detailed to the satisfaction of the City of Bunbury and LIMA, incorporating the following commitments:

(i) A survey of canal earthworks will be conducted prior to the cessation of dewatering. Subsequently, an annual hydrographic survey will be undertaken and compared with the "as constructed" survey to establish whether sedimentation is occurring and thus the necessity for, and frequency of, dredging. Navigable water depth will be maintained by dredging as required. Plans for both maintenance dredging and the disposal of dredged material will be submitted to LIMA for approval prior to dredging.

(ii) The condition of wall structures within the canal and lake will be monitored on an annual basis for five years, commencing within one month of practical completion, and the results reported to the City of Bunbury. A monitoring programme will be developed to confirm that the design and construction of the walls and scour protection material is satisfactory.

(iii) The artificial waterways will be inspected daily by the Waterways Manager and any corrective action, required to maintain water quality and aesthetics to the high standard required by the proponent and Government agencies, will be implemented immediately.

(iv) The condition of shoreline stabilisation structures will be monitored on an annual basis for five years by the Proponent and the results reported to the City of Bunbury and LIMA.

(v) Water quality monitoring of physical, chemical and aesthetic parameters will be conducted at selected sites both within the canal and lake and within the Collie River commencing on completion of the construction phase. Monitoring will be conducted on a quarterly basis for the first five years of operation and be reported on annually to the City of Bunbury, LIMA and the EPA. Monitoring after the initial five years will be dependent upon a review of the initial monitoring results.

Parameters to be monitored and the frequency of monitoring will be as follows:

- Bacteria levels within the canal will be monitored five times over a 30 day period in January and February each year.

- Nutrients (i.e. total phosphorus, orthophosphate, total nitrogen and inorganic nitrogen) will be monitored within the artificial wetlands on a quarterly basis.

- Sediments within the canal will be monitored as follows:

(a) biannually in the canal for nutrients, including apatite and non-apatite phosphorus; and

(b) when the canal is initially opened, and subsequently in years three and five for a range of metals and derivatives. These are copper, zinc, cadmium, tin, lead and chromium. Sediments will be sampled at the water quality monitoring sites identified in Figure 23 and at a control site within the Collie River.

9 REFERENCES

Bunbury City Council, 1984. Town Planning Scheme No. 6. *Western Australian Government Gazette*, April 1984, pp 948-951.

Chalmer, P.N. & Scott, J.K., 1984. *Fish and Benthic Faunal Survey of the Leschenault and Peel-Harvey Estuarine Systems of South-Western Australia in December 1974.* Bulletin No. 149, Department of Conservation & Environment, Perth, Western Australia.

Chester, E.T. & Klemm, V.V., 1990. *Draft Integrated Mosquito Control Strategy for the Leschenault Estuary Region, Western Australia.* Prepared for the Mosquito Control Review Committee. Report No. 21, Waterways Commission, Perth, Western Australia, 68 pp.

Curry, P., 1981. *A Survey of the Birds of Herdsman Lake 1980-81.* Bulletin No. 105, Department of Conservation & Environment, Perth, Western Australia.

Department of Conservation & Environment, 1981. *Water Quality Criteria for Marine and Estuarine Waters of Western Australia.* Bulletin No. 103, Department of Conservation & Environment, Perth, Western Australia.

Department of Conservation & Environment, 1986. *Pelican Point Country Club and Resort Bunbury. Report and Recommendations by the Environmental Protection Authority and the Leschenault Inlet Management Authority.* Bulletin No. 267, Department of Conservation & Environment, Perth, Western Australia.

Environmental Protection Authority, 1983. *Conservation Reserves for Western Australia as Recommended by the Environmental Protection Authority - 1983. The Darling System - System 6. Part II: Recommendations for Specific Localities.* Report No. 13, Department of Conservation & Environment, Perth, Western Australia.

Environmental Protection Authority, 1989. *Proposed Bunbury Holiday Resort Lot 5 Old Coast Road Australind. Report and Recommendations of the Environmental Protection Authority.* Bulletin No. 375, Environmental Protection Authority, Perth, Western Australia.

Environmental Protection Authority, 1990. *A Guide to Identifying Wetland Management Objectives in the Perth Metropolitan Area.* Bulletin No. 374, Environmental Protection Authority, Perth, Western Australia, 48 pp.

Erikson, R., George, A.S., Marchant, N.G. & Morcombe, M.K., 1973. *Flowers and Plants of Western Australia.*

Gentilli, J., 1972. *Australian Climate Patterns.* Nelson, Sydney.

Hallam, S.J., 1986. *Prehistoric Aboriginal Populations on the Swan Coastal Plain, Western Australia.* Final report on the project: Australian Research Grants Scheme.

Heddle, E.M., 1979. Mapping the vegetation of the Perth region. In: Gentilli, J. (ed). *Western Landscapes*. University of Western Australia Press, Nedlands, Western Australia, pp 153-182.

Hopper, S.D., van Leeuwen, S.I., Brown, A.P. & Patrick, S.J., 1990. *Western Australia's Endangered Flora and Other Plants Under Consideration for Declaration.* Department of Conservation and Land Management, Perth, Western Australia.

Kinnaird Hill deRohan & Young Pty Ltd, 1983. *Leschenault Inlet Management Programme.* Report to the Waterways Commission and Leschenault Inlet Management Authority. Kinnaird Hill deRohan & Young Pty Ltd, Perth, Western Australia.

Klemm, V.V., 1989. *Report on Mosquito Control in the Leschenault Estuary Region.* Unpublished report to the Mosquito Control Review Committee and the Government of Western Australia.

LeProvost, Semeniuk & Chalmer, 1983. *Bunbury C Power Station, Marine Environmental Studies*. Volumes 1, 2 & 3. Unpublished draft reports to the State Energy Commission of Western Australia, Report Nos R038D, R039D, R040D, LeProvost, Semeniuk & Chalmer, Perth, Western Australia.

LeProvost, Semeniuk & Chalmer, 1986. *Pelican Point Country Club and Resort Bunbury. Public Environmental Report.* Unpublished report to Paul Jones & Associates Pty Ltd. Report No. R132, LeProvost, Semeniuk & Chalmer, Perth, Western Australia.

LeProvost, Semeniuk & Chalmer, 1988. *Interstruct Pty Ltd. Naturalist Developments Pty Ltd. Port Geographe Environmental Review and Management Programme. Volume II - Appendices*. Report No. R235, LeProvost, Semeniuk & Chalmer, Perth, Western Australia.

LeProvost Environmental Consultants, 1990. *Mandurah Canal Estates Environmental Monitoring Programme Fourth Annual Report July 1989 to June 1990.* Unpublished report to John Holland Pty Ltd and Esplanade (Mandurah) Pty Ltd. Report No. R335, LeProvost Environmental Consultants, Perth, Western Australia.

McArthur, W.M. & Bettenay, E., 1960. *The Development and Distribution of the Soils on the Swan Coastal Plain, Western Australia.* CSIRO Soil Publication No. 16.

Meagher, T.D., 1971. *The Biology of the Blue Manna Crab (Portunus pelagicus) in South-Western Australia.* Unpublished Ph.D. thesis, The University of Western Australia, Perth.

Morris IV. F.W., 1981. *Residential Canals and Canal Network Design and Evaluation*". Report No. 43, Florida Sea Grant College.

Ninox Wildlife Consulting, 1985. *A Survey of the Birds of Pelican Point Near Bunbury, Western Australia*. Unpublished report to LeProvost, Semeniuk & Chalmer. Ninox Wildlife Consulting, Perth, Western Australia.

Ninox Wildlife Consulting, 1989. *The Significance of Mosquito Breeding Areas to the Waterbirds of Leschenault Estuary, Western Australia.* Unpublished report to the Mosquito Control Review Committee of the Waterways Commission. Ninox Wildlife Consulting, Perth, Western Australia.

Public Works Department of Western Australia, 1981. *Regional Flood Study of the Collie River and Leschenault Inlet.*

Seddon, G., 1972. *A Sense of Place.* University of Western Australia Press, Nedlands, Western Australia.

Semeniuk, V., 1983. The Quaternary stratigraphy and geological history of the Australind-Leschenault Inlet area. *Journal of the Royal Society of Western Australia* 66(3): 71-83.

Semeniuk, V. & Meagher, T.D., 1981. The geomorphology and surface processes of the Australind-Leschenault Inlet coastal area. *Journal of the Royal Society of Western Australia* 64(2): 33-51.

South West Development Authority, 1985. *Draft Land Use Plans for the Leschenault Coastal Park and the Kemerton Community Park.* South West Development Authority, Bunbury, Western Australia.

Speck, H.N., 1952. *Plant Ecology of the Metropolitan Sector of the Swan Coastal Plain.* Unpublished M.Sc. thesis, The University of Western Australia, Perth, Western Australia.

State Planning Commission of Western Australia, 1987. *Bunbury Region Plan Policy Statement.* State Planning Commission of Western Australia, Perth, Western Australia.

Steedman & Associates, 1976. *Preliminary Environmental Design Parameters for the Laporte Effluent Submarine Pipeline.* Unpublished report to Laporte Australia Pty Ltd and the Public Works Department of Western Australia. Steedman & Associates, Perth, Western Australia.

Steering Committee on Canal Developments, 1984. *Recommendations for the Development of Canal Estates.*

Taylor & Burrell, 1987. *Bunbury Region Plan.* Report to the State Planning Commission of Western Australia. Taylor & Burrell, Perth, Western Australia.

Taylor & Burrell, 1990. *Pelican Point Planning Report (Rezoning Application).* Unpublished report to Pelican Point Pty Ltd.

Waterways Commission & Leschenault Inlet Management Authority, 1983. *Leschenault Inlet Management Programme.* Waterways Commission, Perth, Western Australia, 55 pp.

Wright, A.E., 1986. *Report on the Mosquito Eradication Campaign. Survey of Mosquitoes in the Bunbury Region, W.A.* Unpublished report to the Mosquito Control Review Committee of the Waterways Commission.

10 GLOSSARY

ACRONYMS

AHD	- Australian Height Datum
ARI	- Average Recurrence Interval
DCE	- Department of Conservation and Environment
DMH	- Department of Marine and Harbours
DPUD	- Department of Planning and Urban Development
EPA	- Environmental Protection Authority
LEC	- LeProvost Environmental Consultants
LIMA	- Leschenault Inlet Management Authority
LSC	- LeProvost, Semeniuk & Chalmer, Environmental Consultants
MCRC	- Mosquito Control Review Committee
PER	- Public Environmental Report/Public Environmental Review
PWD	- Public Works Department
SECWA	- State Energy Commission Western Australia
SPC	- State Planning Commission
SWDA	- South West Development Authority
TDS	- Total Dissolved Solids
TPS	- Town Planning Scheme
WAWA	- Water Authority of Western Australia

SCIENTIFIC TERMS

abandoned channel	- drainage channel on an alluvial fan along which runoff no longer occurs
accretion	- gradual increase or extension of land by natural forces acting over a long period of time
aeolian	- wind-blown
algae	- aquatic unicellular or multicellular plants containing chlorophyll
algal wrack	- dead or decaying algae that is floating or washed ashore
alluvial	- material transported by a river and deposited
anoxic	- oxygen deficient
aquifer	- a subsurface rock formation that contains sufficient saturated permeable material to hold groundwater
astronomical tide	- daily tidal fluctuation
avifauna	- bird life
Bassendean Dunes	- a unit of degraded Pleistocene aeolian landforms and quartz sand
bathymetry	- bottom profile of a body of water
beach ridge	- low mound of beach material heaped up by the action of waves and currents
benthic	- zone of the floor of an ocean or lake where there are rooted organisms
benthos	- animals and plants living in substrate
biota	- the plants and animals of an area

bivalve mollusc	- animal with a shell in two parts hinged together e.g. mussels
bloom (algae)	- high concentration of algae occurring within a waterbody
catchment	- an area that collects and drains rainwater
chenier	- old beach ridges that are subsequently left inland by progradation of the coast
consumers	- animals which eat plants or other animals
crustaceans	- belonging to a class of aquatic arthropods including crabs, shrimps and barnacles
datum	- fixed reference level
delta	- a plain formed at the margin of a waterbody by deposition of stream-borne sediments at the mouths of streams
detritus	- organic debris from decomposing plants and animals
ecosystem	- the dynamic whole formed by the habitat and the association of living beings (biotic community) that occupy it
eutrophic	- applied to bodies of water which are rich in plant nutrients
evapotranspiration	- combined evaporation from soil surface and transpiration from plants
fauna	- animals
flood plain	- an area of land adjacent to a river which is usually dry, and becomes covered with water during times of high river flow
flora	- plants
fluvial	- of or pertaining to a river
foreshore	- the beach zone adjoining the river or sea
gastropods	- class of molluscs often having a single shell (i.e. snails)
geomorphology	- the description and interpretation of landforms
habitat	- the environmental conditions which are effective in determining the existence of a community in a certain place
hinterland	- area bordering an belt that has been subjected to folding and other deformation
Holocene	- youngest subdivision of the Quaternary period; following the Pleistocene, from 10,000 years ago to the present
hypersaline	- much saltier than the ocean
indigenous	- a plant or animal belonging to the original biota of an area
infauna	- bottom dwelling and burrowing animals
intertidal	- area periodically exposed between low and high tide marks
invertebrate	- animals without backbones
lacustrine	- pertaining to a lake
littoral zone	- area between the highest storm surge level and lowest level of spring tide
macroalgae	- aquatic plants
molluscs	- a large phylum of soft bodied, mainly aquatic animals with calcareous shells
nekton	- animals that can swim faster than the prevailing currents
oceanography	- pertaining to processes of the ocean
photosynthesis	- occurs in green plants, synthesis of organic compounds from water and carbon dioxide using energy absorbed by chlorophyll from sunlight
phytoplankton	- small unicellular algae that form the "plant life" of the plankton

Pinjarra Plain	- a geomorphic unit of the Swan Coastal Plain of Pleistocene to recent alluvial landforms and sediments
plankton	- usually small animals and plants which float or drift at the mercy of the prevailing currents
Pleistocene	- older subdivision of the Quaternary preceding the Holocene from about two million years ago to 10,000 years ago
polychaetes	- order of annelids, including bristleworms, tube-worms, fan worms
prograding	- building outward of shoreline or coastline by nearshore deposition or river-borne sediments or beach material
Quindalup Dunes	- a geomorphic unit of the Swan Coastal Plain of Holocene dunes and beaches forming along the modern coast
resource	- means that is available for supplying a want or need
runoff	- surface drainage
sandspit	- a sand ridge attached at one end to the mainland or beach and the other terminating in open water
sedimentation	- the process of deposition of mineral grains or precipitates in the beds of water bodies
shoal	- a submerged or intertidal sand ridge which is exposed at low water
silt	- very fine mineral particles
siltation	- deposition of silt in a water body
Spearwood Dunes	- a geomorphic unit of the Swan Coastal Plain of Pleistocene limestone ridges with intervening depressions
strand plain	- plain composed of sequentially deposited shorelines
stratigraphic	- divisions of geological time
stratification	- (of a water body) formation of separate layers of within the waterbody, distinguished by changes in salinity and temperature
substrate	- the bottom environment of a waterbody
subterranean	- formed or occurring beneath the Earth's surface
subtidal	- below the level of low water mark
Swan Coastal Plain	- an area of land which lies between Moore River in the north and Quindalup in the south, extending from the beach to the Darling Plateau north of Capel and to the Whicher Scarp south of Capel
Tamala Limestone	- limestone formed along the Western Australian coast during the Pleistocene
thallus	- a plant body not differentiated into leaf and stem, as of algae
turbidity	- cloudiness in a liquid caused by suspended material
wetland	- lands permanently or temporarily under water or waterlogged

TABLE 1

SUMMARY OF THE POTENTIAL ADVERSE IMPACTS PREDICTED AND MANAGEMENT PROGRAMME PROPOSED FOR THE CONSTRUCTION PHASE

PREDICTED IMPACT	PROBABILITY OF OCCURRENCE	MANAGEMENT COMMITMENTS
Alienation of terrestrial habitat, including wetlands, fringing vegetation, pasture and parkland.	Inevitable.	Creation of a range of artificial wetland habitats. Retention of mature trees and foreshore vegetation. Landscaping of public open space and the golf course.
Localised, short-term increase in turbidity of estuary waters on release of impounded waters and excavation of the canal and non-navigable lake entrance channels.	Inevitable.	Dewatering fluids will be impounded on site to allow settlement of suspended particulates before discharge to the Collie River. Timing of discharge of dewatering fluids and breaching of the canal and lake entrance channels will take place to the satisfaction of the EPA and LIMA.
Modification of landform with excavation and filling of the site.	Inevitable.	Filling of the site will only occur to the level required for engineering purposes (2.8 m AHD). Retention of mature trees and rehabilitation of the site.
Potential impacts associated with importing fill from off site to meet site requirements.	Low.	Approvals for the source of fill material and method of excavation will be sought from Council and LIMA.
Impact on soil stability.	Inevitable.	Exposed soil surfaces and stockpiled spoil and topsoil will be stabilised. Following construction, lawns and trees will be planted.
Dust impact on local residents.	Low.	Dust will be suppressed by watering.
Traffic, noise and vibration impacts on local residents.	Low.	Distance to the nearest residents should minimise impacts. Transport routes and hours of operation will be subject to approvals by the City of Bunbury. Liaison with the City of Bunbury during the construction phase.
Public access to the site will be prohibited during construction.	Inevitable.	The construction site will be fenced and signs erected at access points to enforce access restrictions.
Disturbance of Aboriginal artefact sites, assessed as being of low archaeological significance, identified on the subject land.	Inevitable.	The proponent will comply with the requirements of Section 18 of the *Aboriginal Heritage Act*.
The landscape of the area will be altered by construction of the development.	Inevitable.	The development has been designed to blend with the existing landscape as much as possible. Buildings will be confined to two development levels. A comprehensive landscape master plan will be prepared by the proponent. Public open space will be developed and maintained by the proponent for three years following practical completion.

TABLE 2

SUMMARY OF THE POTENTIAL ADVERSE IMPACTS PREDICTED AND MANAGEMENT PROGRAMME PROPOSED FOR THE POST-CONSTRUCTION PHASE

PREDICTED IMPACT AND TIMING	PROBABILITY OF OCCURRENCE	MANAGEMENT COMMITMENTS
PHYSICAL ENVIRONMENT		
Impact of groundwater abstraction from the Leederville Formation on the long-term sustainability of the groundwater resource and on the saline interface within the Leederville Formation.	Low.	Monitoring of groundwater drawdown, quality and levels within the Leederville Formation. There will be no abstraction of shallow groundwater.
Impact of nutrient infiltration from areas of public open space and the golf course on estuary water quality - on-going potential impact.	Low.	Slow-release fertilisers, native vegetation planting and turf management will minimise nutrient input from the golf course and landscaped areas. Nutrient monitoring programme.
Impact of the proposed drainage system on estuary water quality - on-going potential impact.	Low.	Stormwater runoff will be contained on site where possible. Silt, grease and other contaminants will be trapped before stormwater drainage is discharged to the waterways.
Occasional fuel/oil spills within the canal and marina - on-going risk.	Inevitable.	An Oil Spill Contingency Plan will be documented within an Emergency Procedures Manual to be prepared for the development.
Occasional accumulation of weed, rubbish and debris within the artificial waterways.	Inevitable.	Weed and debris will be removed by the Waterways Manager as necessary.
Nutrient and metal accumulation in canal sediments in the medium to long term.	Low.	Boats with TBTO-based antifouling paint will not be permitted to moor within the canal or marina. Discharge from boat holding tanks will be strictly prohibited.
Siltation of canal and entrance channels in the long term.	Inevitable.	Monitoring of canal depth will indicate the need for maintenance dredging, to be carried out by the Proponent as required.
Potential impact of the development on shoreline stability in the long term.	Low.	Building setbacks and reservation of foreshores. The shoreline adjacent to the canal and lake connections with the Collie River and the boat ramp will be stabilised subject to approvals by LIMA.
BIOLOGICAL ENVIRONMENT		
Potential on-going impact of increased urban, human and domestic and feral animal pressures on the use of artificial wetlands and the foreshore by waterfowl.	Medium.	Creation of islands; planting of shelter belts; setting paths back from the water's edge; development of a public education programme; strict control of dogs; formulation of a fox and feral cat reduction programme if required; direction of light away from water; enforcement of speed limits within the development.
Increased human use of the estuary may lead to a local decline in fish populations of Leschenault Inlet in the medium to long term.	Medium.	Co-operation with the Fisheries Department in educating recreational fishing enthusiasts on minimum catchable fish sizes and bag limits by appropriate signage within the marina.

TABLE 2

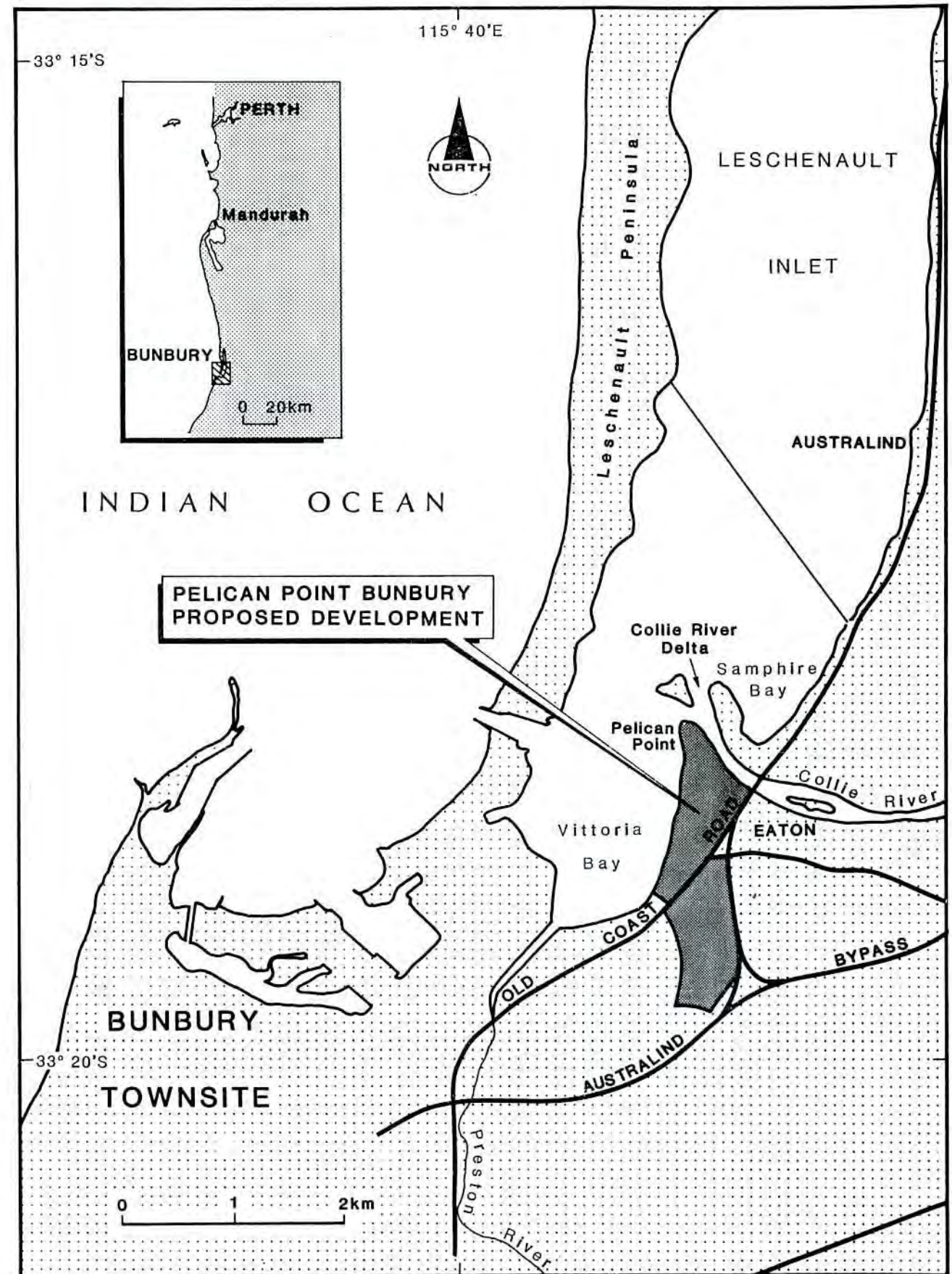
SUMMARY OF THE POTENTIAL ADVERSE IMPACTS PREDICTED AND MANAGEMENT PROGRAMME PROPOSED FOR THE POST-CONSTRUCTION PHASE

PREDICTED IMPACT AND TIMING	PROBABILITY OF OCCURRENCE	MANAGEMENT COMMITMENTS
HUMAN ENVIRONMENT		
Increased human use of estuary waters resulting from the development.	Inevitable.	Navigation aids will be constructed to the satisfaction of DMH.
Potential reduction in the conservation value on nearby System 6 areas and the subject land resulting from the development.	Low.	The Proponent's commitments with regard to provision of waterfowl habitat, rehabilitation and an integrated management programme are expected to enhance the value of the region for conservation and passive recreation.
ENVIRONMENTAL CONSTRAINTS		
Impact of the proposed industrial site west of the Preston River diversion on tourist/residential uses of the development land.	Inevitable.	Tourist and residential uses of the site have been planned external to the buffer zone (Rigden Lines) proposed for industry in the area. Tree belts will be planted between the industrial zone and housing on the site.
On-going mosquito nuisance.	Medium.	Mosquito controls formulated by the Mosquito Control Review Committee have been implemented on adjacent land and removal of mosquito breeding areas on Pelican Point should further reduce mosquito nuisance.
Flood risk in the event of the 1:100 year flood.	Inevitable.	The development incorporates the floodways recommended to maintain the flood compensation characteristics of the site. Building levels will be set above the predicted 1:100 year flood level.
Greenhouse Effect.	Inevitable.	Minimum fill levels for the development have included the accepted 30 cm allowance for potential sea level rise resulting from the Greenhouse Effect.

TABLE 3

SUMMARY OF THE BENEFICIAL IMPACTS PREDICTED TO RESULT FROM THE PELICAN POINT, BUNBURY DEVELOPMENT

BENEFICIAL IMPACT	PROBABILITY OF OCCURRENCE	HOW THIS WILL BE ACHIEVED
Rehabilitation and management of the Vittoria Bay and Collie River foreshores.	Inevitable.	The Proponent will re-develop the foreshores in accordance with a plan to the approval of LIMA and the City of Bunbury. The Proponent will manage the foreshores for an operational period of three years, at which time responsibility for foreshores will be handed over to the City of Bunbury.
Public ownership of foreshores will allow management of these areas in perpetuity.	Inevitable.	Estuary foreshores will be transferred to the Crown and vested with the City of Bunbury.
Provision of formal public access along the estuary foreshore.	Inevitable.	An dual use pathway is proposed to provide access along estuary foreshores and between the two shorelines.
Provision of new public recreation areas.	Inevitable.	A public 18 hole golf course and associated facilities, barbeque facilities, managed areas of public open space and grassed areas along the foreshore are proposed for public recreational use.
Improved public boating facilities and access for the boating public.	Inevitable.	Car and trailer parking is proposed and the existing boat ramp will be redeveloped. Safe boat moorings will be provided in the canal and marina.
Reduction of mosquito breeding grounds.	Inevitable.	Wetland areas which are currently high priority mosquito control sites will be modified to prevent mosquito breeding on development. Artificial wetland environments created will be designed to preclude mosquito breeding.
The development will provide short and long-term employment opportunities for local residents.	Inevitable.	The construction and operational workforce will be drawn from the Bunbury region.
The development proposed will create higher visual amenity than residential subdivision or high rise development, which are potential alternatives.	Inevitable.	Creation of an artificial waterway development designed to blend with the landscape of the area.
Provision of resort accommodation and facilities of benefit to local residents as well as attracting tourists to the region.	Inevitable.	Provision of a resort hotel, shopping complex, holiday waterside accommodation and recreational facilities.



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PELICAN POINT BUNBURY

LOCALITY MAP

Figure **1**

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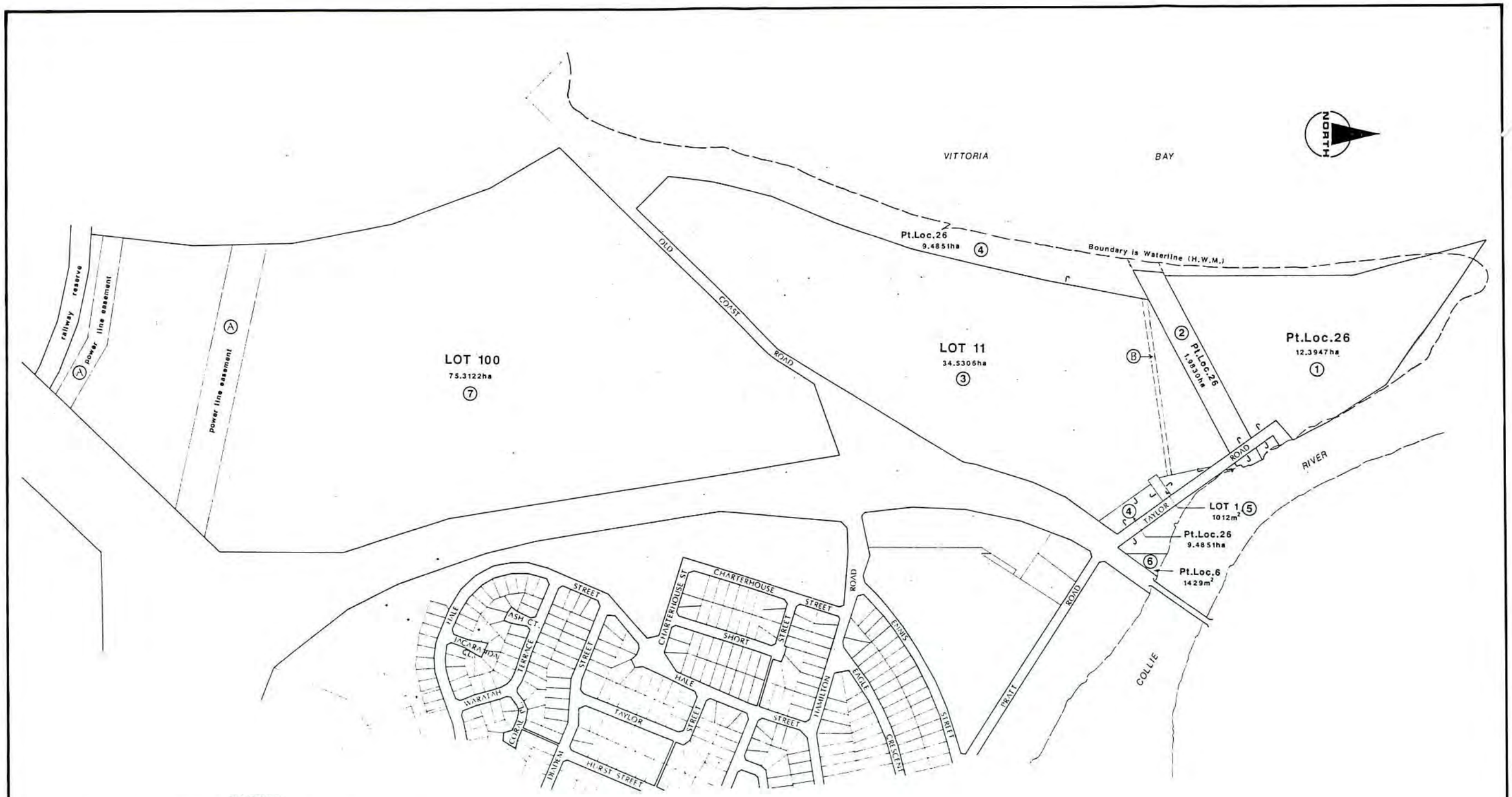

SCHEDULE

NOTES	LOT	AREA ha	Vol/Fol	
Note 1	Pt.Loc.26	12.3947	1598/355	Ausean Consultants
Note 2	Pt.Loc.26	1.9830	1498/954	Ausean Consultants
Note 3	Lot 11	34.5306	1758/659	Ausean Consultants
Note B	Foot & Cycle access in favour of B.C.C.			
Note 4	Pt.Loc.26	9.4851	1758/660	B.C.C.
Note 5	Lot 1	0.1012	1274/487	Telecom
Note 6	Pt.Loc.6	0.1429	1792/145	B.C.C.
Note 7	Lot 100	75.3122	1808/982	I.L.D.A.
Note A	SEC easement for powerlines Contracted to Ausean Consultants			
TOTAL		133.9497		

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PELICAN POINT BUNBURY

PROPERTY PLAN

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Figure 2

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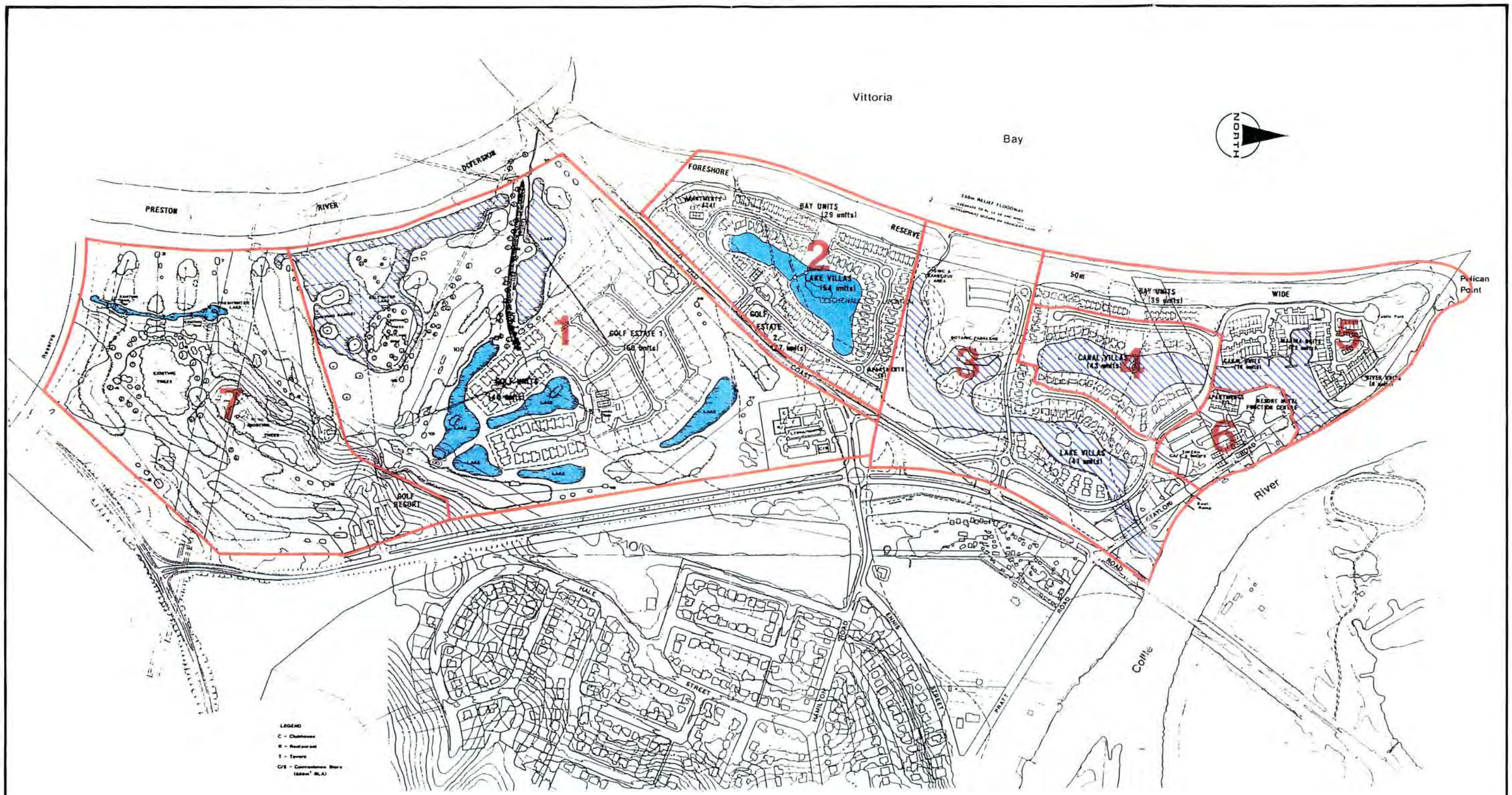
Auth : PC	Date 12/90	PELICAN POINT BUNBURY **DEVELOPMENT PLAN**

Figure **3**



Note : BULK EARTHWORKS COMPLETED AS A SINGLE STAGE

SALTWATER LAKE

FRESHWATER LAKE

0 100 200 300 400 500m

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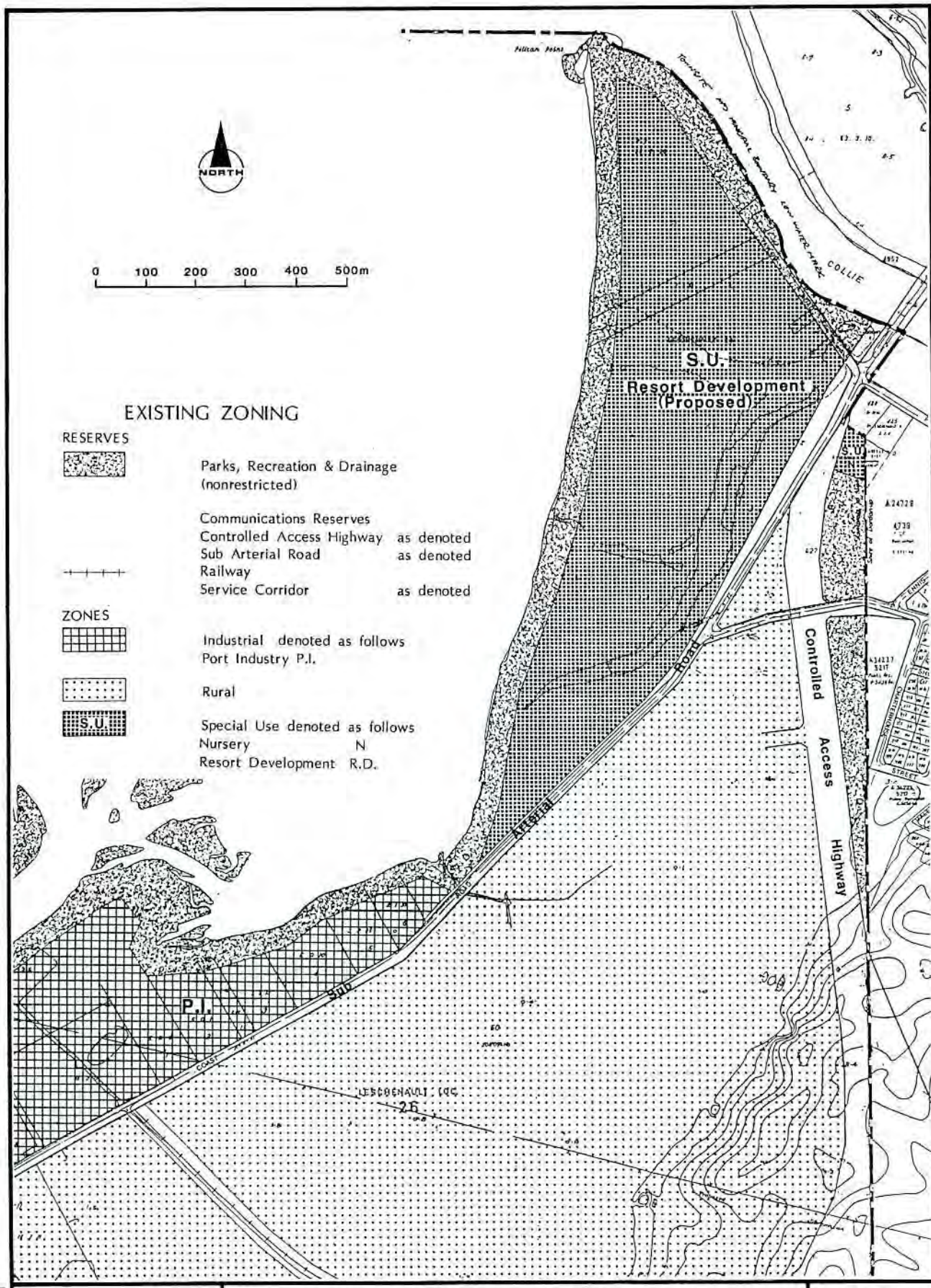
Auth : PC Date 12/90	PELICAN POINT BUNBURY **STAGING**	Figure **4**



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PELICAN POINT BUNBURY

EXISTING ZONING

Figure 5

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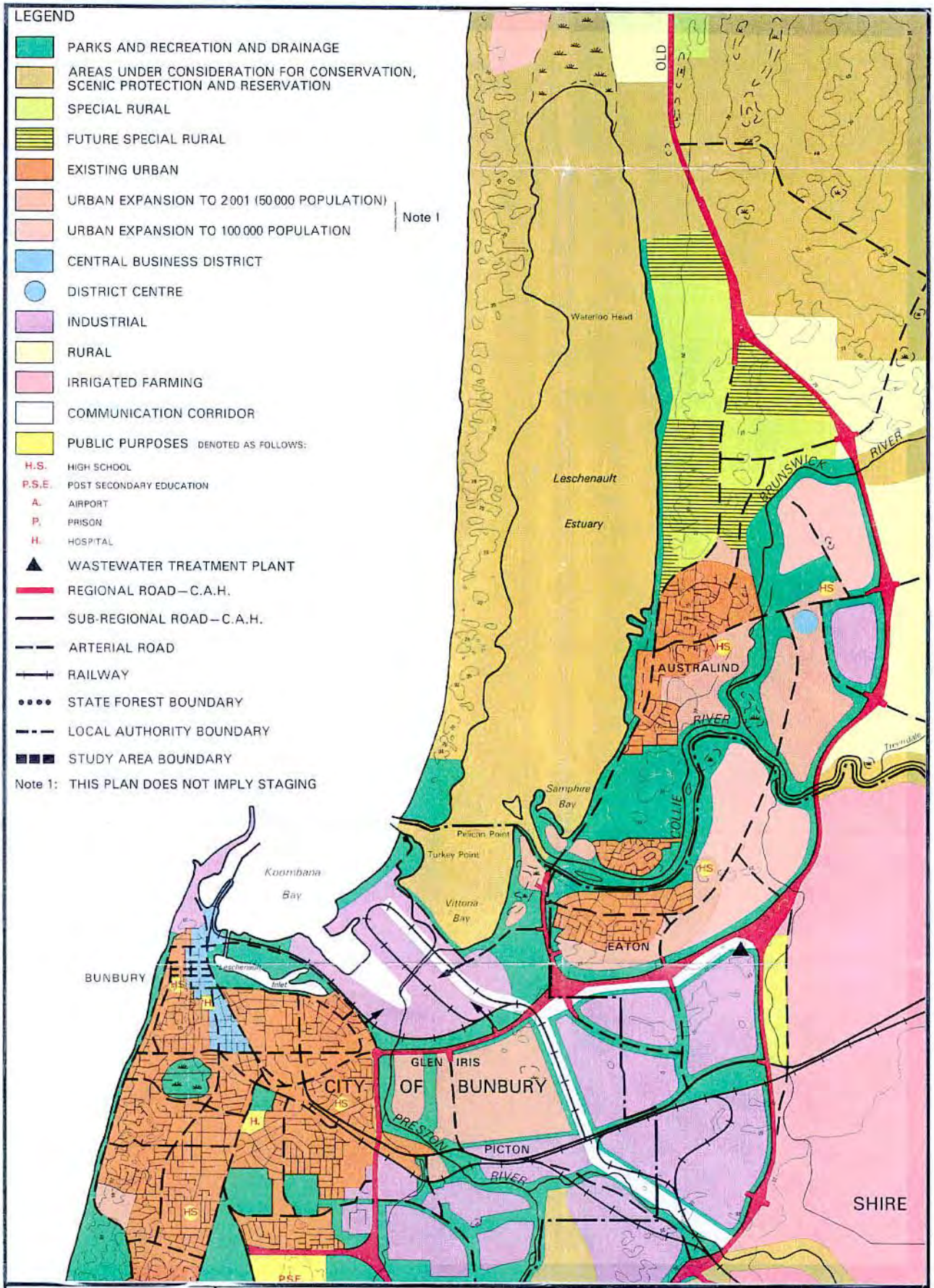

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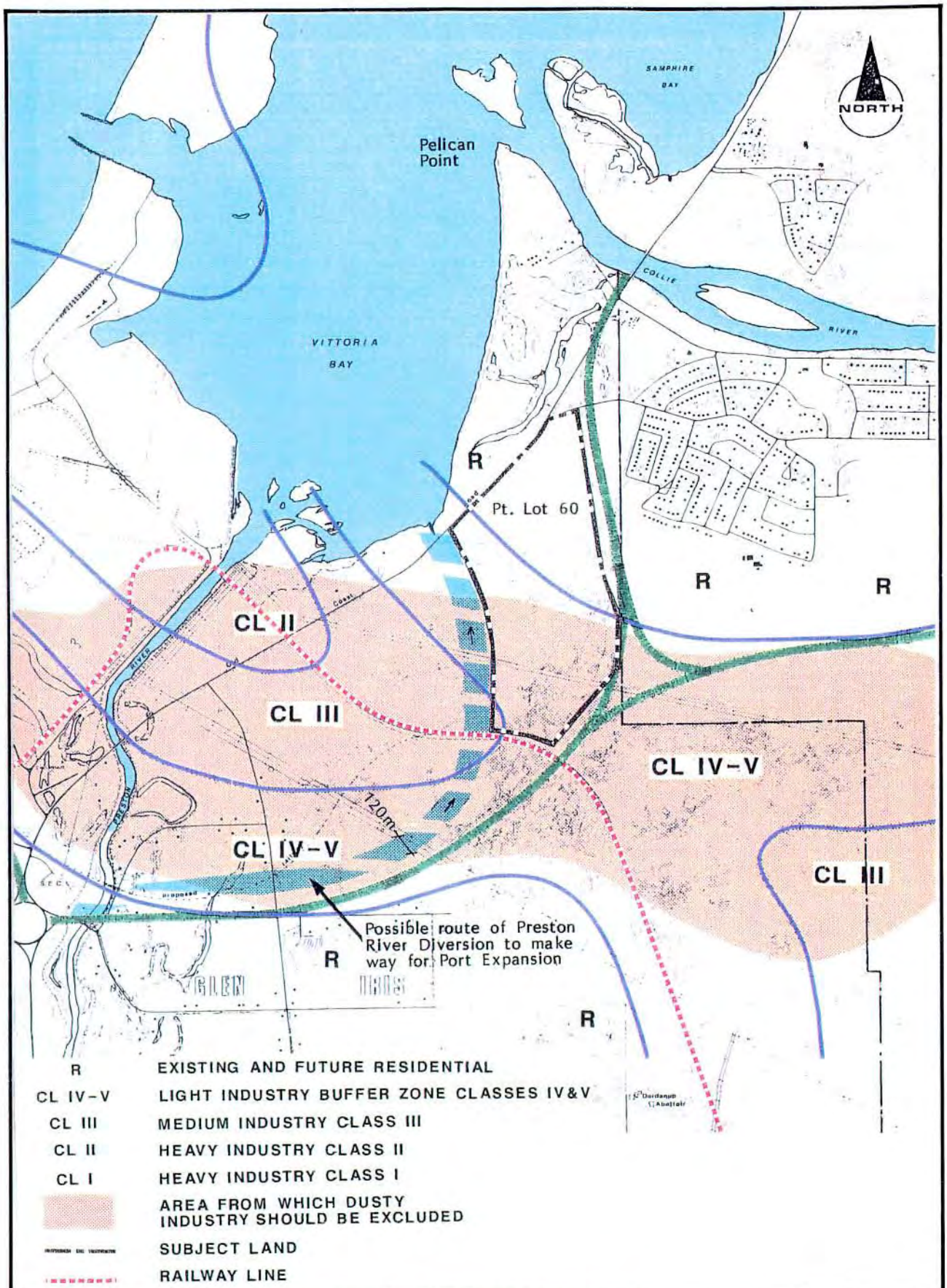
PELICAN POINT BUNBURY

BUNBURY REGION PLAN

Source: State Planning Commission, 1986

Figure **6**



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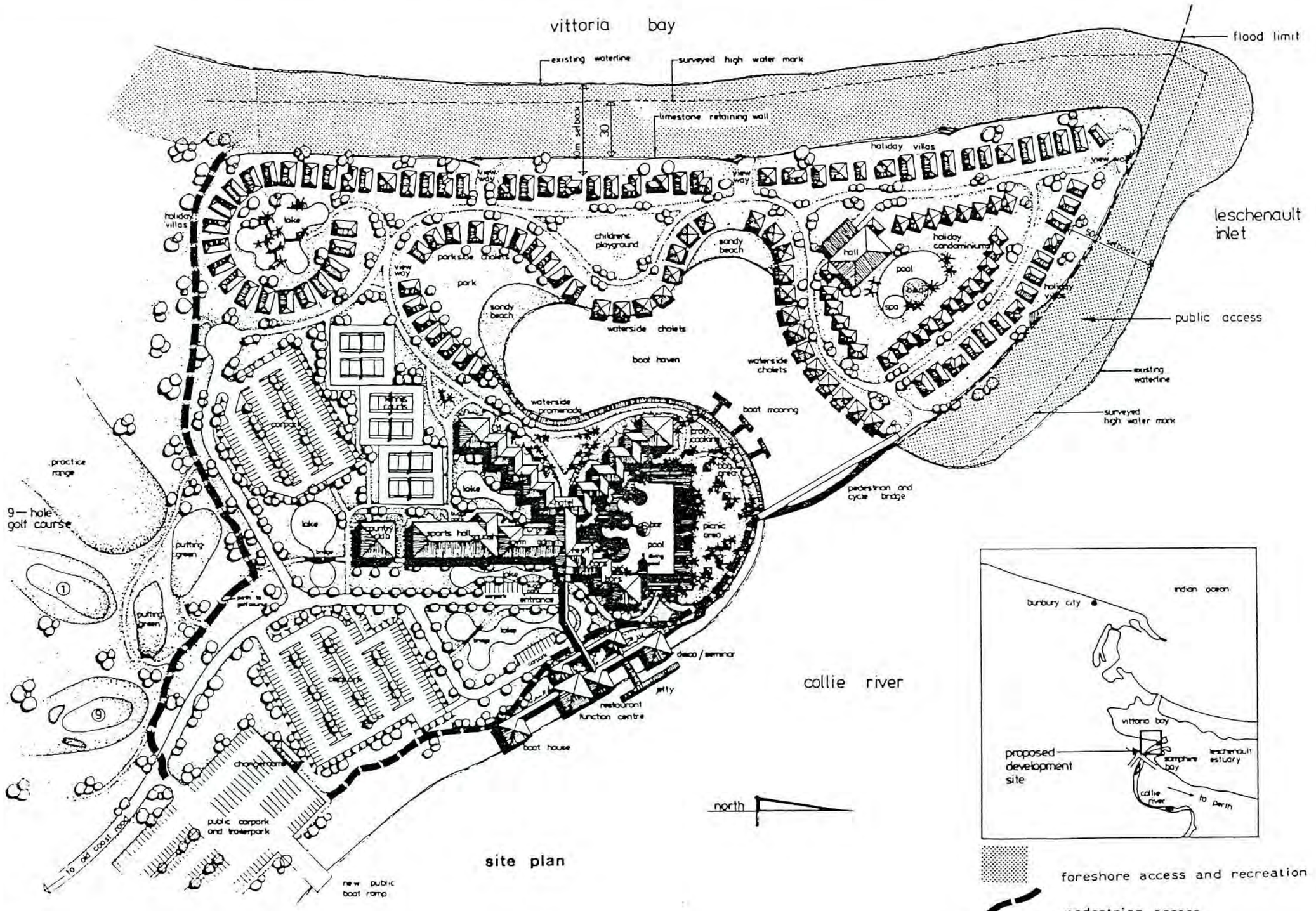
PELICAN POINT BUNBURY

BUNBURY REGION PLAN - RIGDEN LINES

Figure **7**

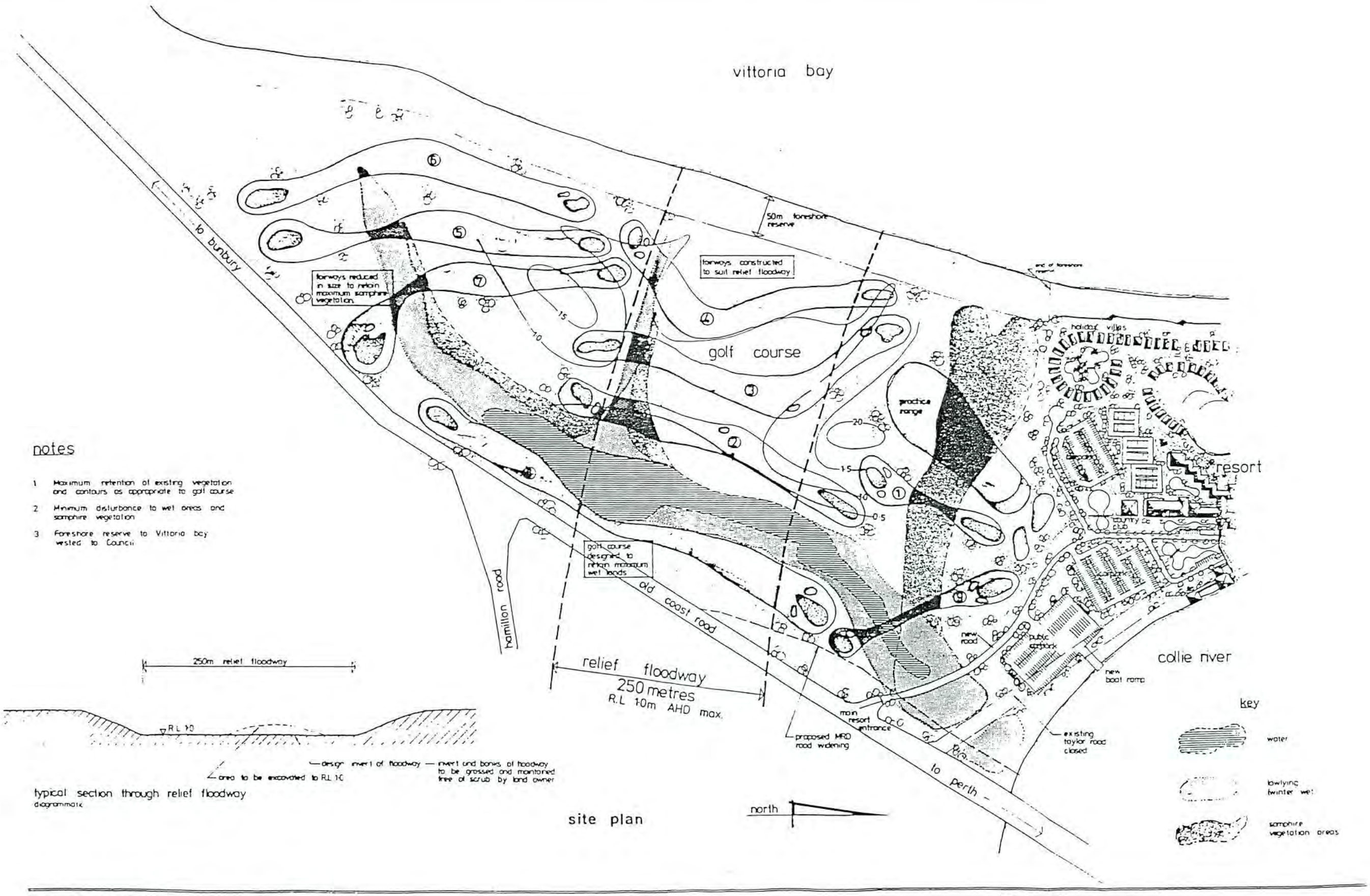
J186 R320



PELICAN POINT COUNTRY CLUB AND RESORT

Figure 8A
scale 1:2000
may 1986

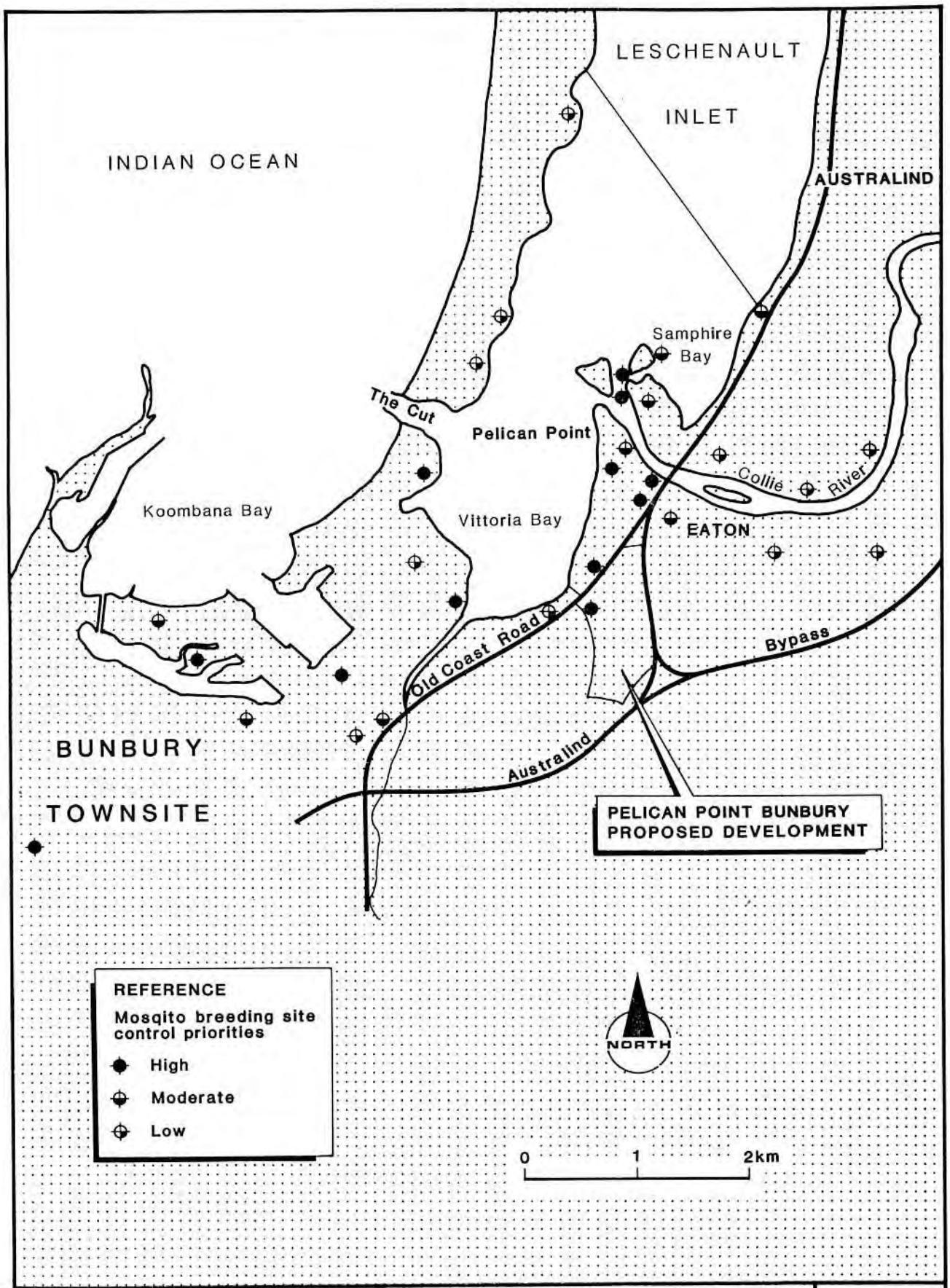
paul jones and associates pty ltd
9 havelock street. west perth (09) 322 4277



PELICAN POINT COUNTRY CLUB GOLF COURSE

Figure 8B
scale 1:4000
may 1986

paul jones and associates pty ltd
9 havelock street, west perth (09 322 4277



PELICAN POINT BUNBURY

MOSQUITO BREEDING SITES AND CONTROL PRIORITIES

Figure 9

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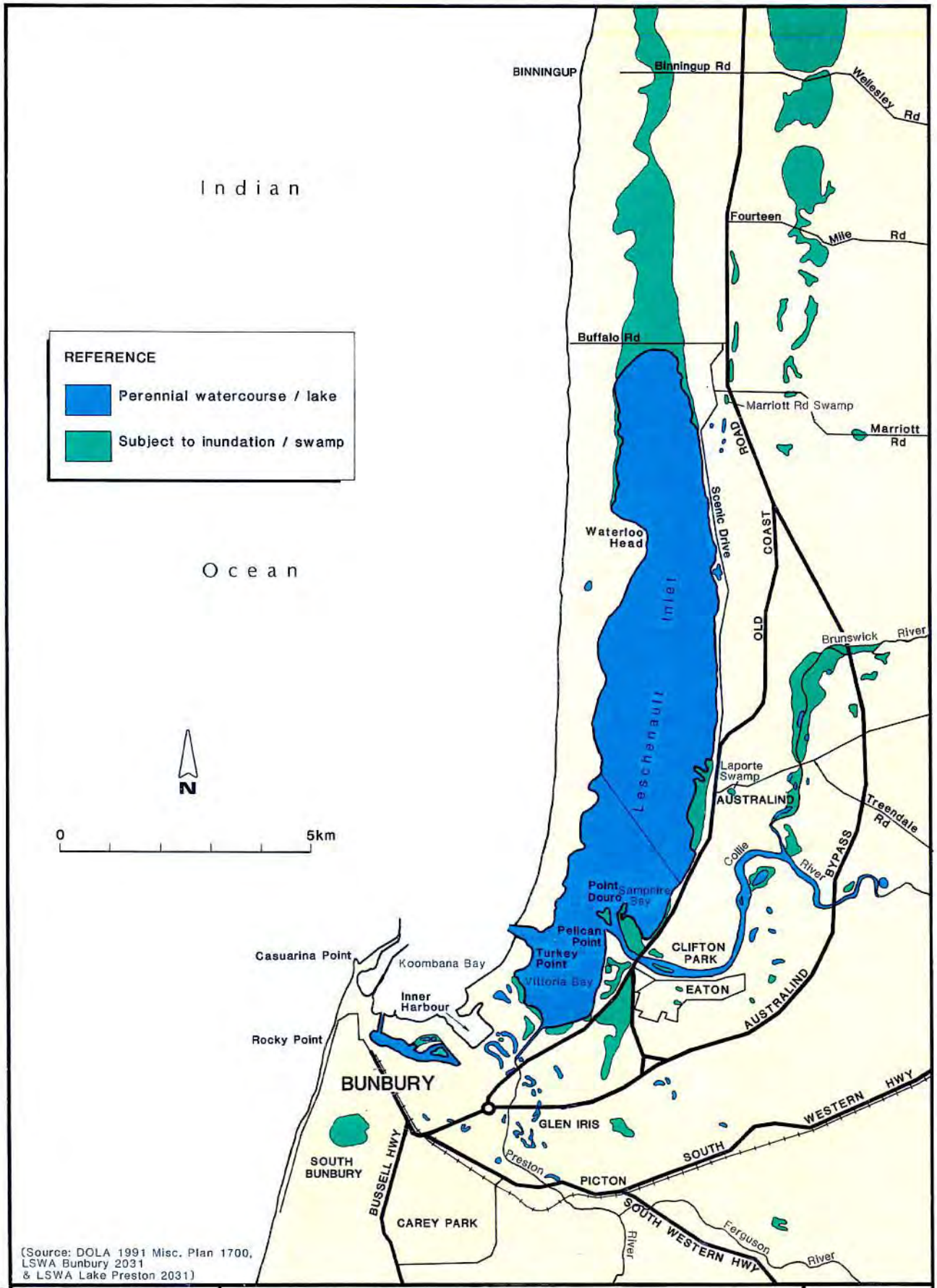

(Source: DOLA 1991 Misc. Plan 1700, LSWA Bunbury 2031 & LSWA Lake Preston 2031)

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PELICAN POINT BUNBURY

REGIONAL WETLAND DISTRIBUTION

Figure **10**

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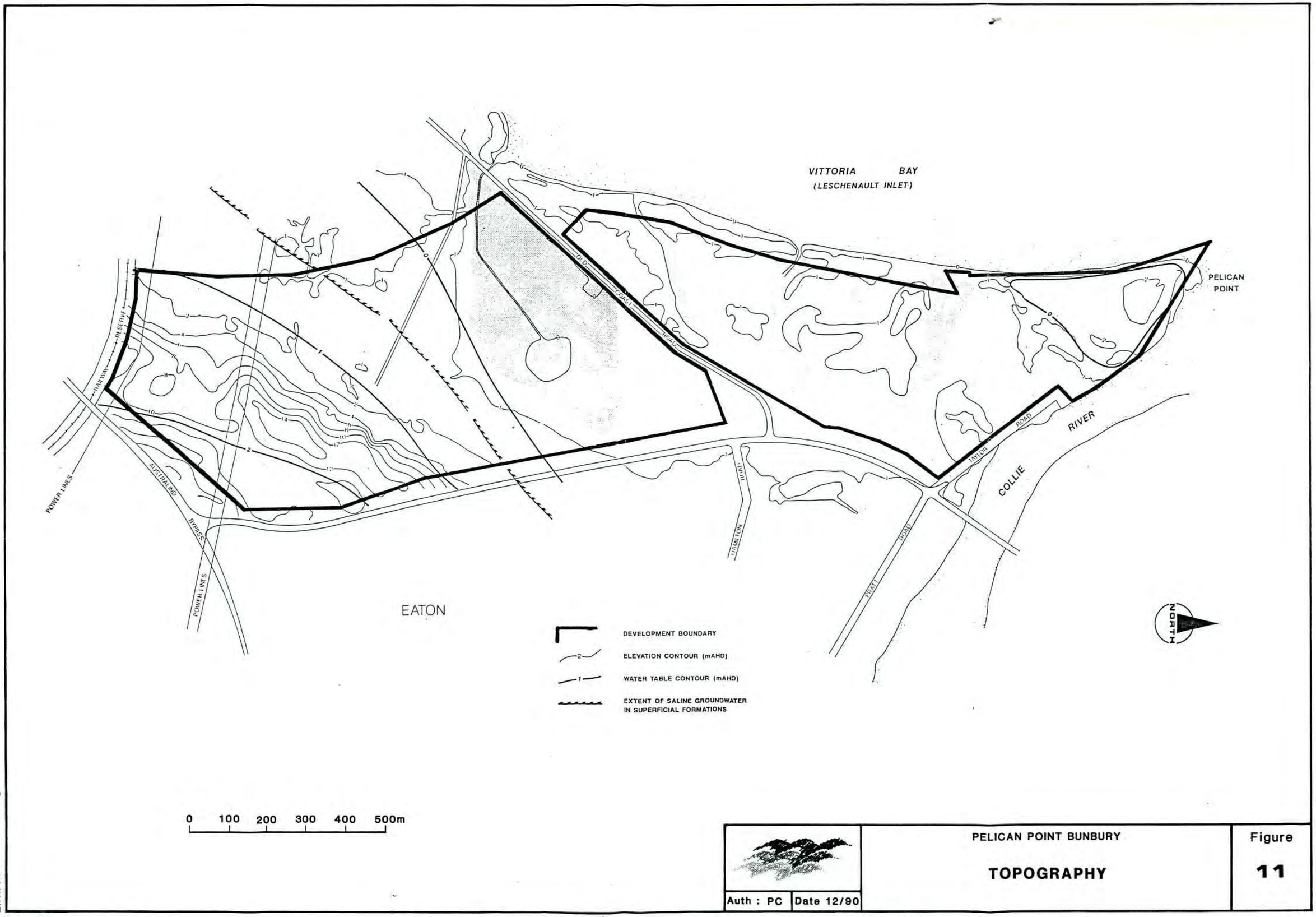

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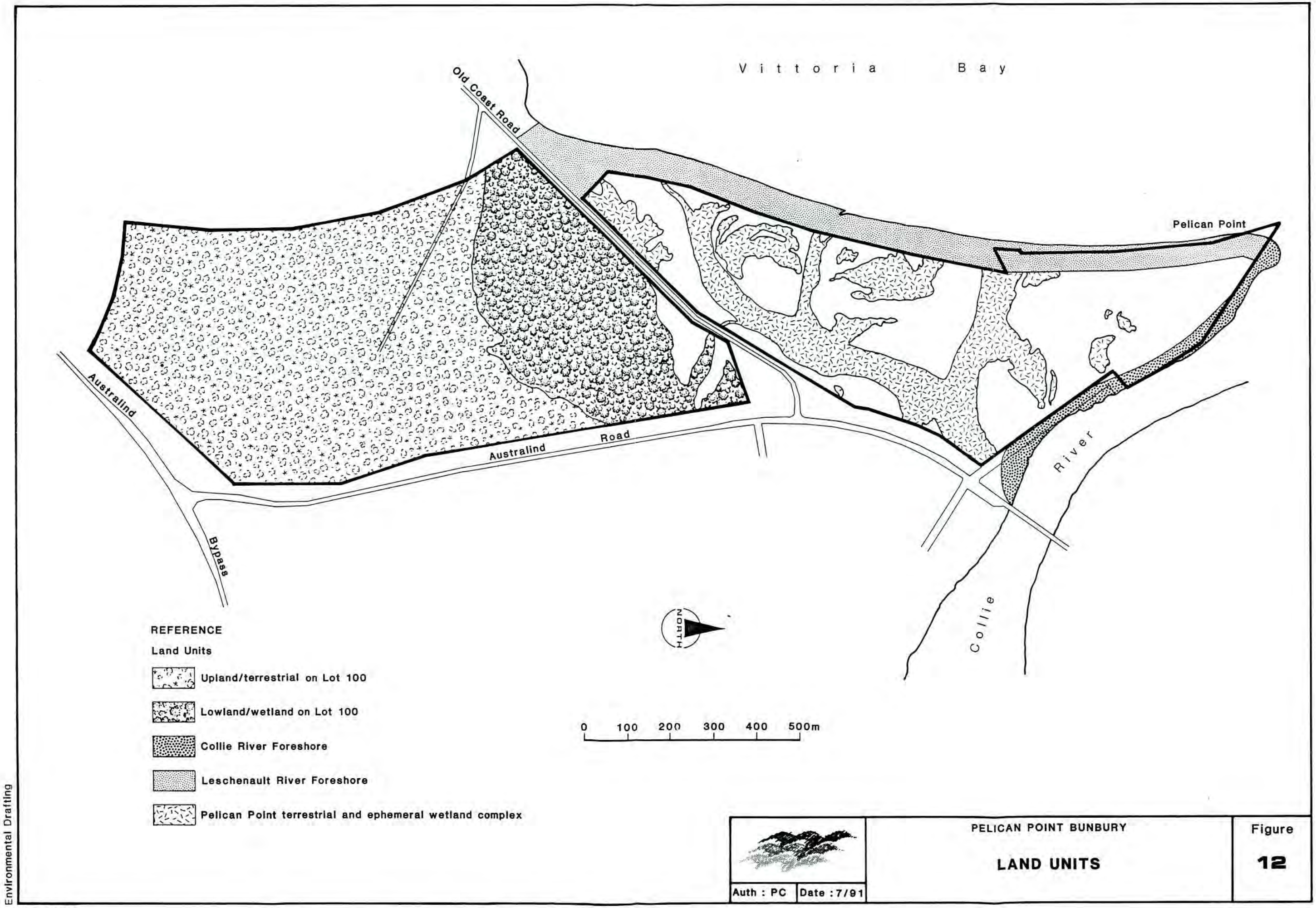
Auth : PC Date 12/90	PELICAN POINT BUNBURY **TOPOGRAPHY**	Figure **11**



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PELICAN POINT BUNBURY

LAND UNITS

Figure **12**

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PELICAN POINT BUNBURY

VEGETATION

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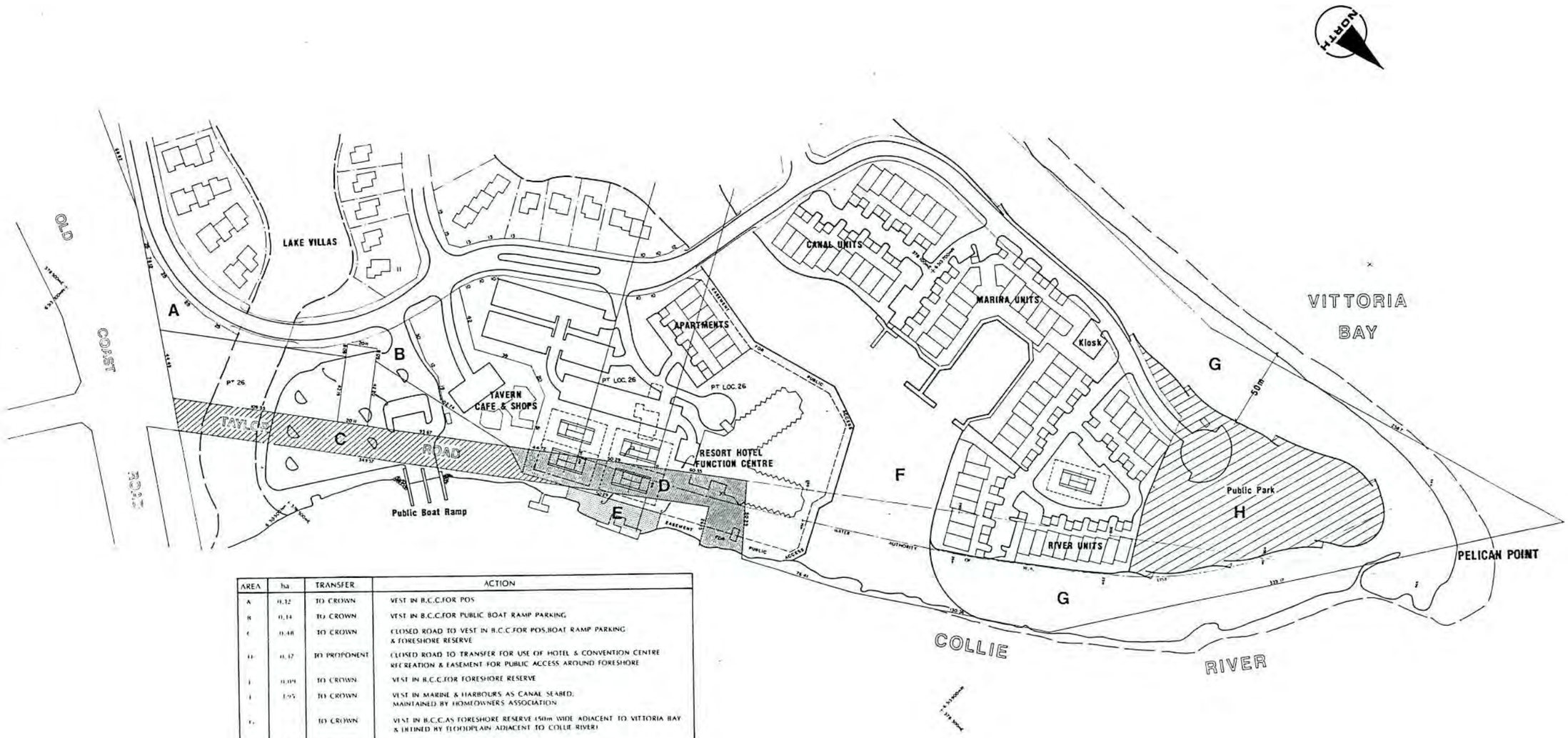
Figure **13**



AREA	ha	TRANSFER	ACTION
A	0.32	TO CROWN	VEST IN B.C.C.FOR POS
B	0.14	TO CROWN	VEST IN B.C.C.FOR PUBLIC BOAT RAMP PARKING
C	0.48	TO CROWN	CLOSED ROAD TO VEST IN B.C.C.FOR POS,BOAT RAMP PARKING & FORESHORE RESERVE
D	0.37	TO PROPONENT	CLOSED ROAD TO TRANSFER FOR USE OF HOTEL & CONVENTION CENTRE RECREATION & EASEMENT FOR PUBLIC ACCESS AROUND FORESHORE
E	0.09	TO CROWN	VEST IN B.C.C.FOR FORESHORE RESERVE
F	1.95	TO CROWN	VEST IN MARINE & HARBOURS AS CANAL SEABED, MAINTAINED BY HOMEOWNERS ASSOCIATION
G		TO CROWN	VEST IN B.C.C.AS FORESHORE RESERVE (50m WIDE ADJACENT TO VITTORIA BAY & DEFINED BY FLOODPLAIN ADJACENT TO COLLIE RIVER)
H	1.70	TO CROWN	VEST IN B.C.C.AS POS (DEFINED BY BASE OF WALL)

0 100 200 m

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PELICAN POINT BUNBURY

PROPERTY EXCHANGE

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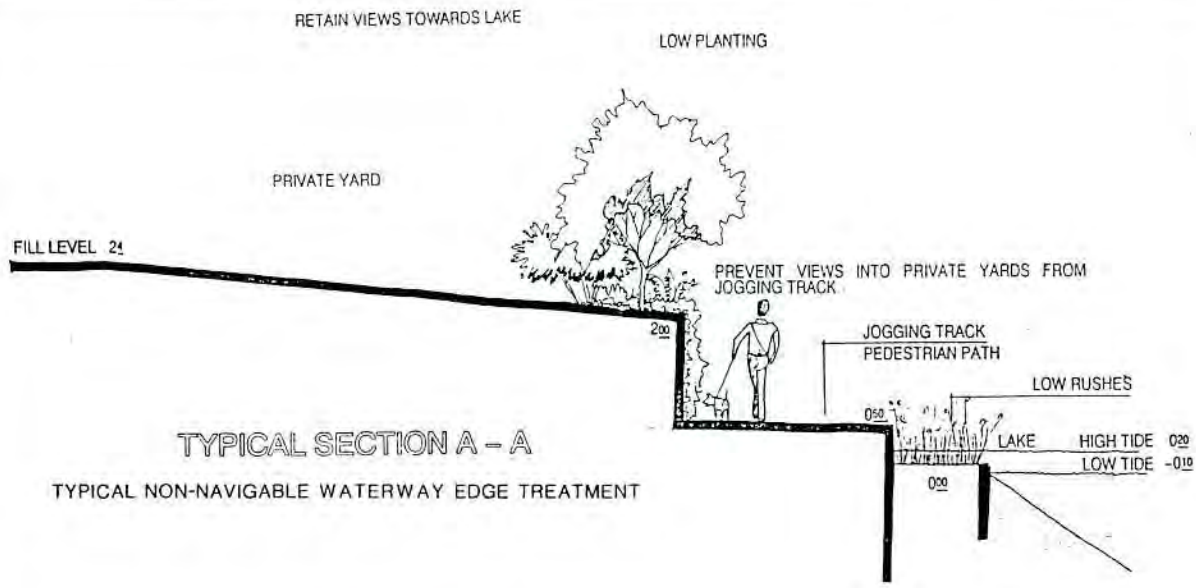
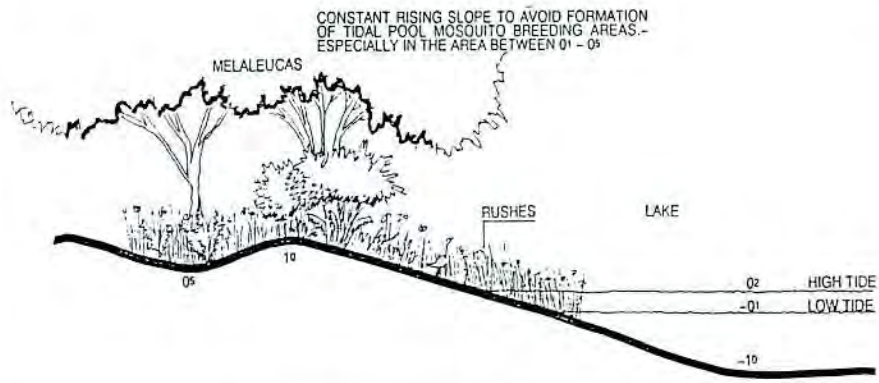
Figure **15**



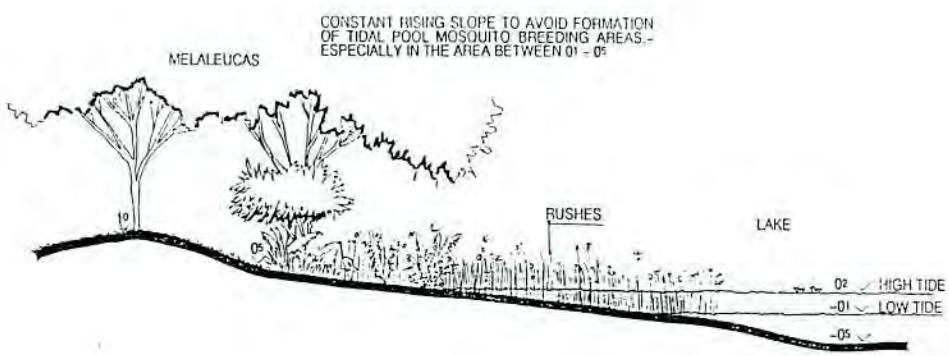
TYPICAL SECTION A – A

TYPICAL NON-NAVIGABLE WATERWAY EDGE TREATMENT



TYPICAL SECTION C – C

FLOODWAY SALT-WATER LAKE (Lower Reaches)



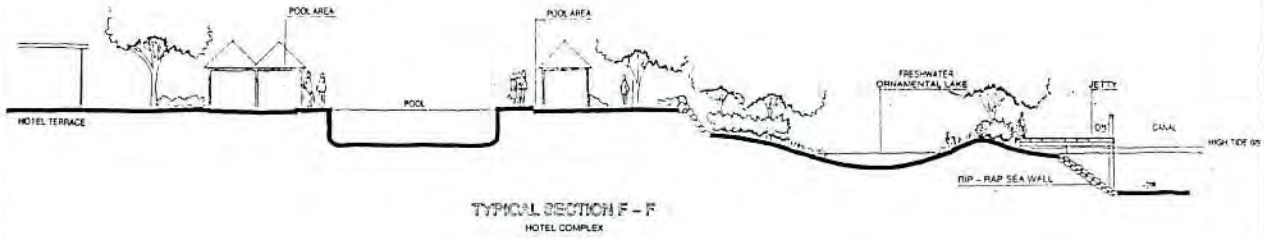
TYPICAL SECTION B – B

TYPICAL FLOODWAY LAKE TREATMENT (Upper reaches)

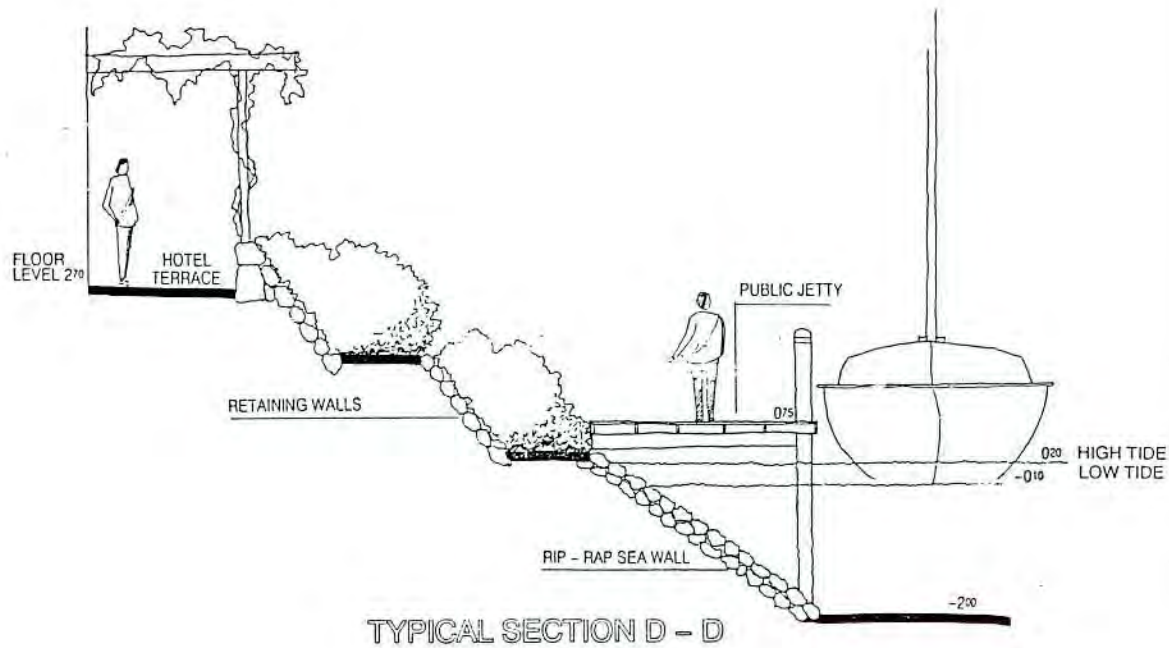
Auth : PC / Date : 7/91	PELICAN POINT BUNBURY **TYPICAL SECTIONS OF NON-NAVIGABLE WATERWAY AND WETLAND RESERVE**	Figure **16**

Environmental Drafting

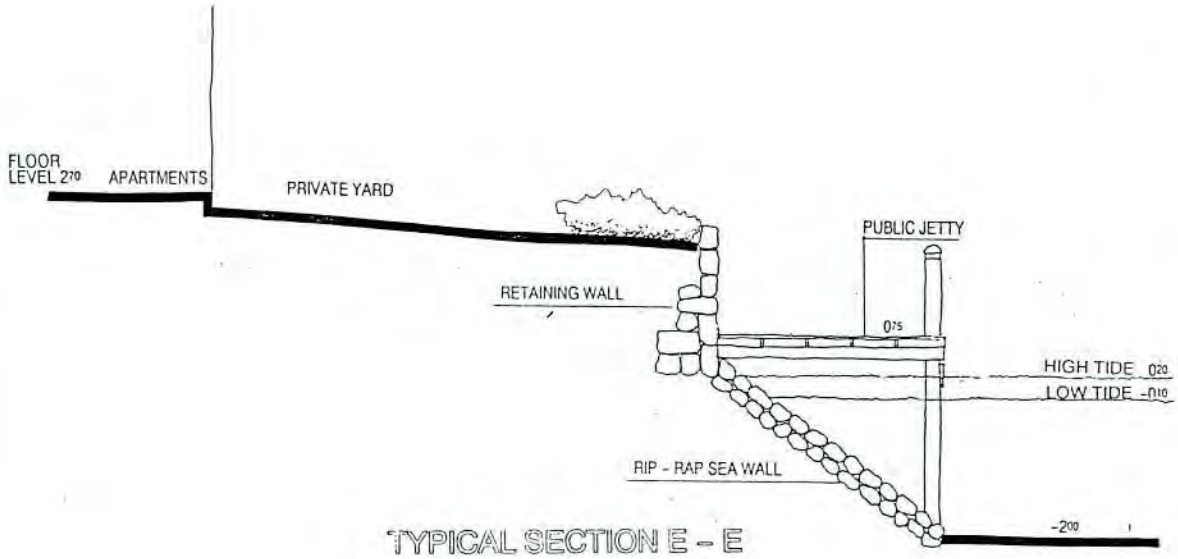
J186 R320



TYPICAL SECTION F - F
HOTEL COMPLEX



TYPICAL SECTION D - D
CANAL / HOTEL CONNECTION



TYPICAL SECTION E - E
CANAL / APARTMENTS CONNECTION

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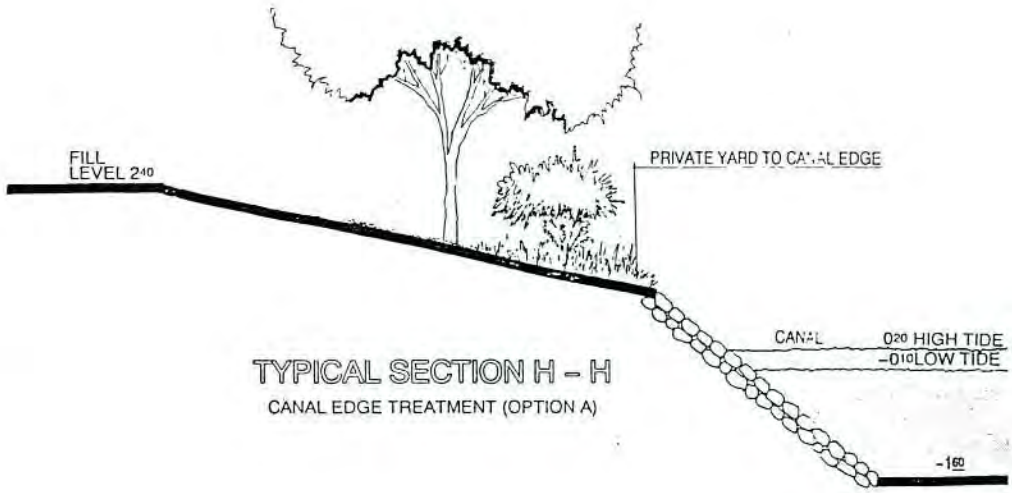
PELICAN POINT BUNBURY

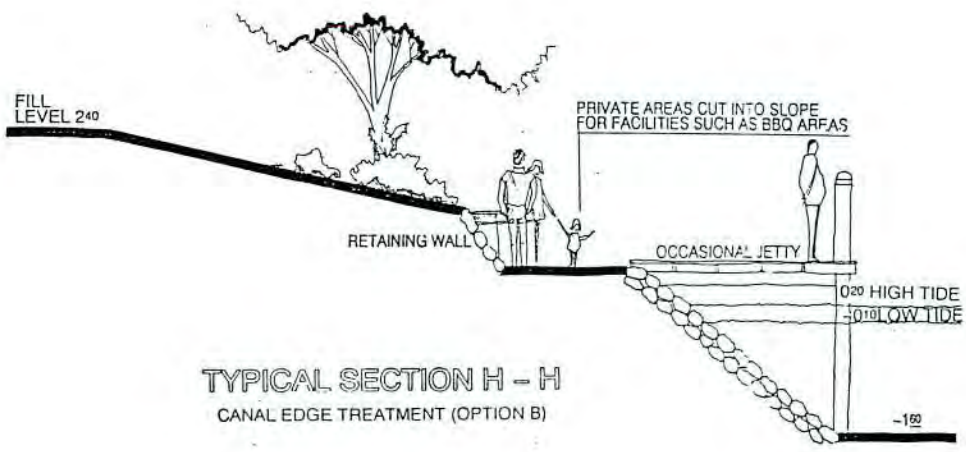
TYPICAL SECTION OF HOTEL CANAL EDGE

Figure **17**



TYPICAL SECTION H – H

CANAL EDGE TREATMENT (OPTION A)



TYPICAL SECTION H – H

CANAL EDGE TREATMENT (OPTION B)

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	PELICAN POINT BUNBURY		Figure
	TYPICAL SECTIONS OF CANAL EDGE		18
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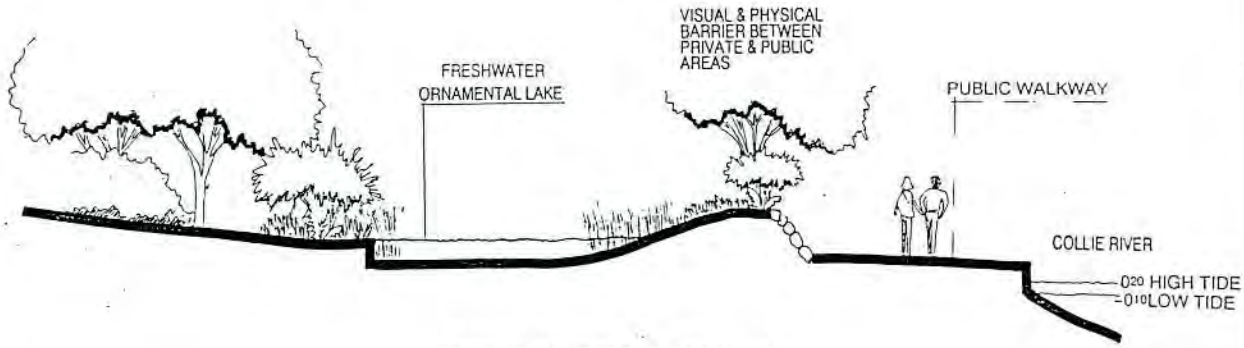
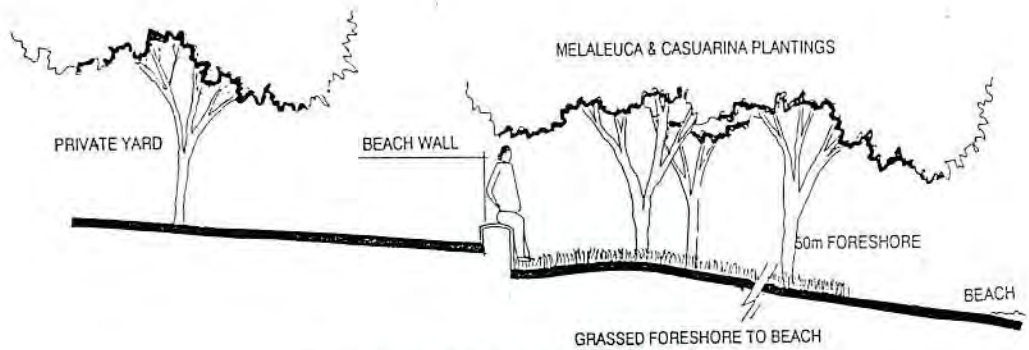


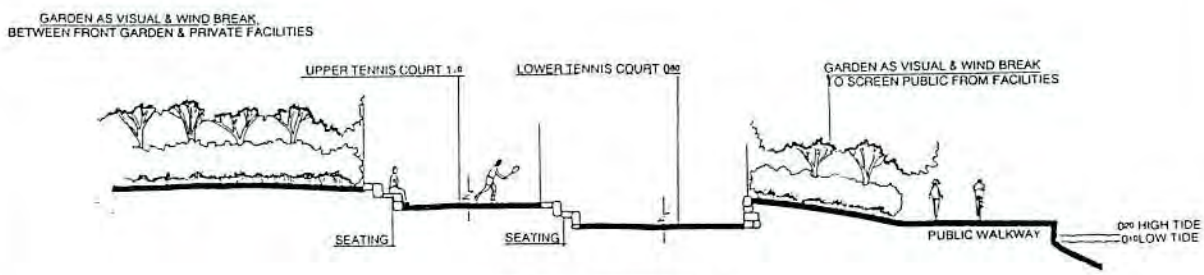
TYPICAL SECTION I – I

HOTEL / COLLIE RIVER CONNECTION



TYPICAL SECTION J – J

BEACH WALL / FORESHORE



TYPICAL SECTION G – G

TENNIS COURT

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Auth : PC / Date : 7/91	PELICAN POINT BUNBURY **TYPICAL SECTIONS OF COLLIE RIVER AND LESCHENAULT INLET FORESHORE**	Figure **19**

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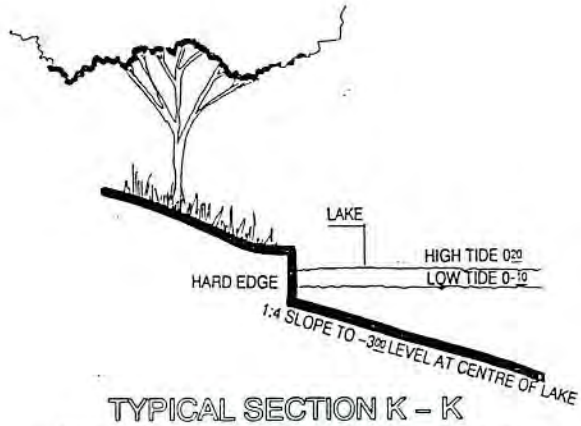
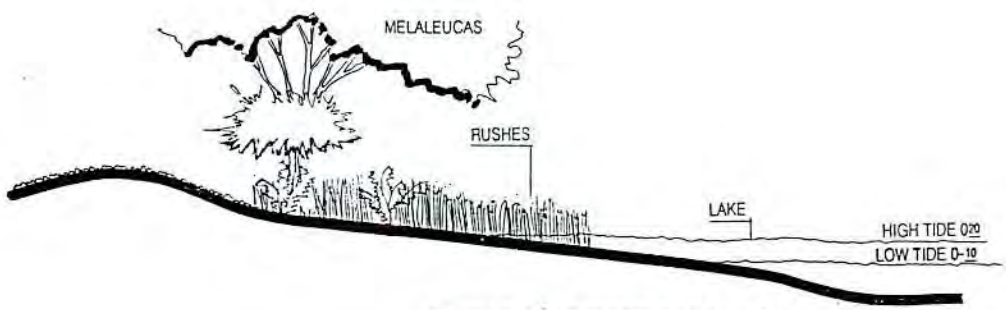


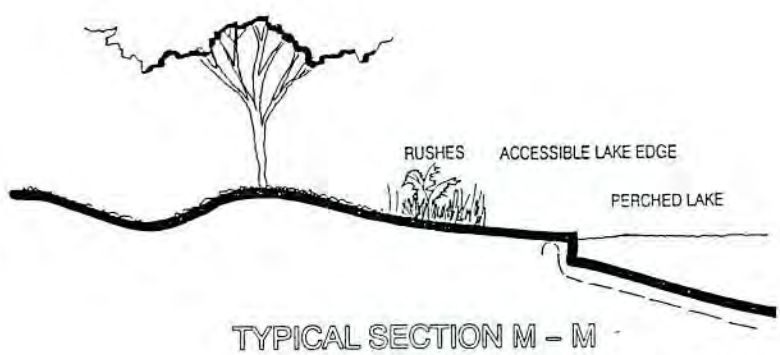
TYPICAL SECTION K – K

SALT-WATER LAKE DRIVING RANGE (Lower Reaches)



TYPICAL SECTION L – L

SALT-WATER LAKE DRIVING RANGE (Lower Reaches)



TYPICAL SECTION M – M

FRESHWATER IRRIGATION LAKE LAKE LINER

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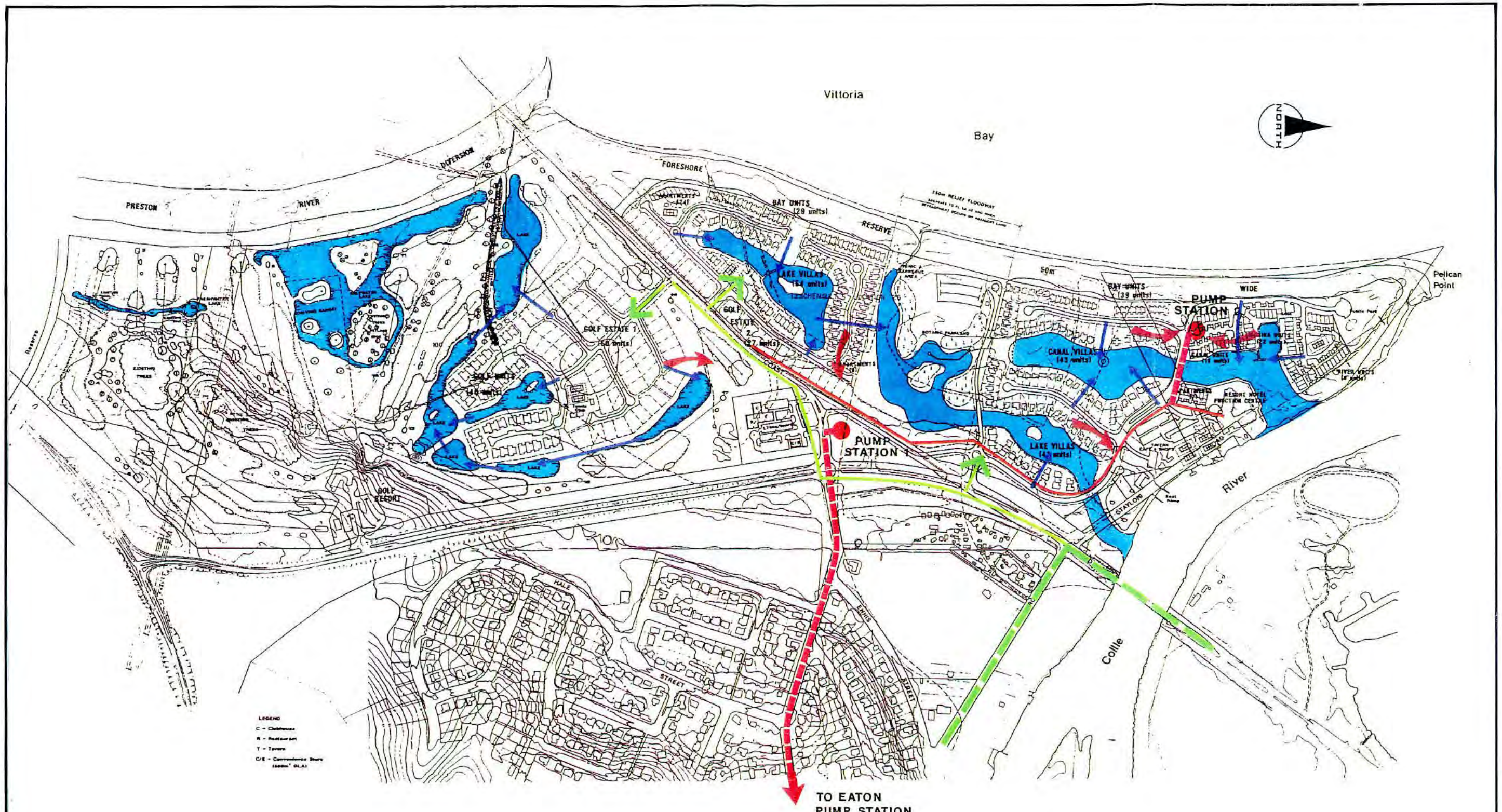
PELICAN POINT BUNBURY

TYPICAL SECTIONS OF GOLF COURSE LAKES

Figure **20**



PELICAN POINT BUNBURY

SERVICING

Figure **21**

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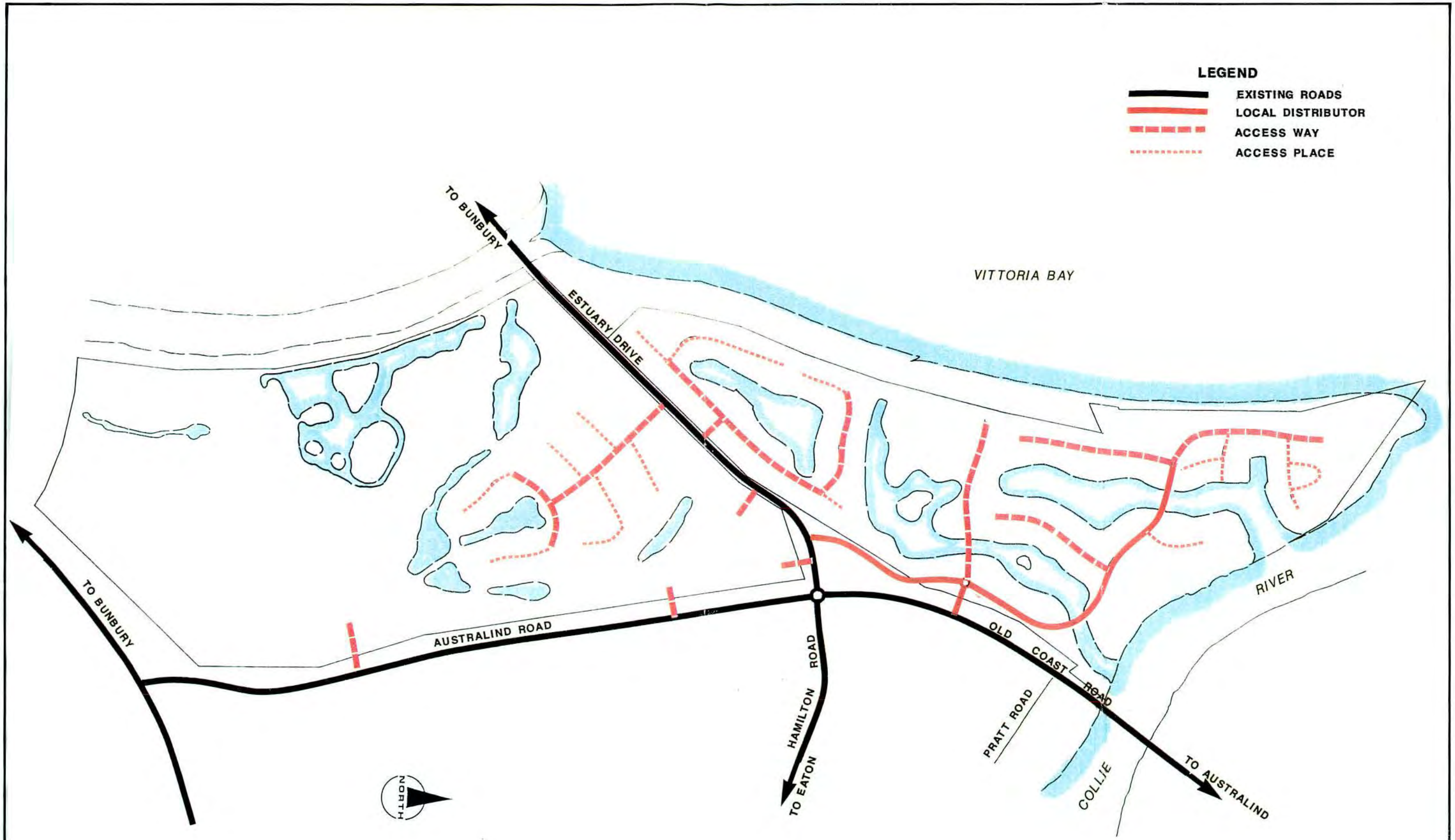

Environmental Drafting

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PELICAN POINT BUNBURY

PROPOSED ROAD TYPES

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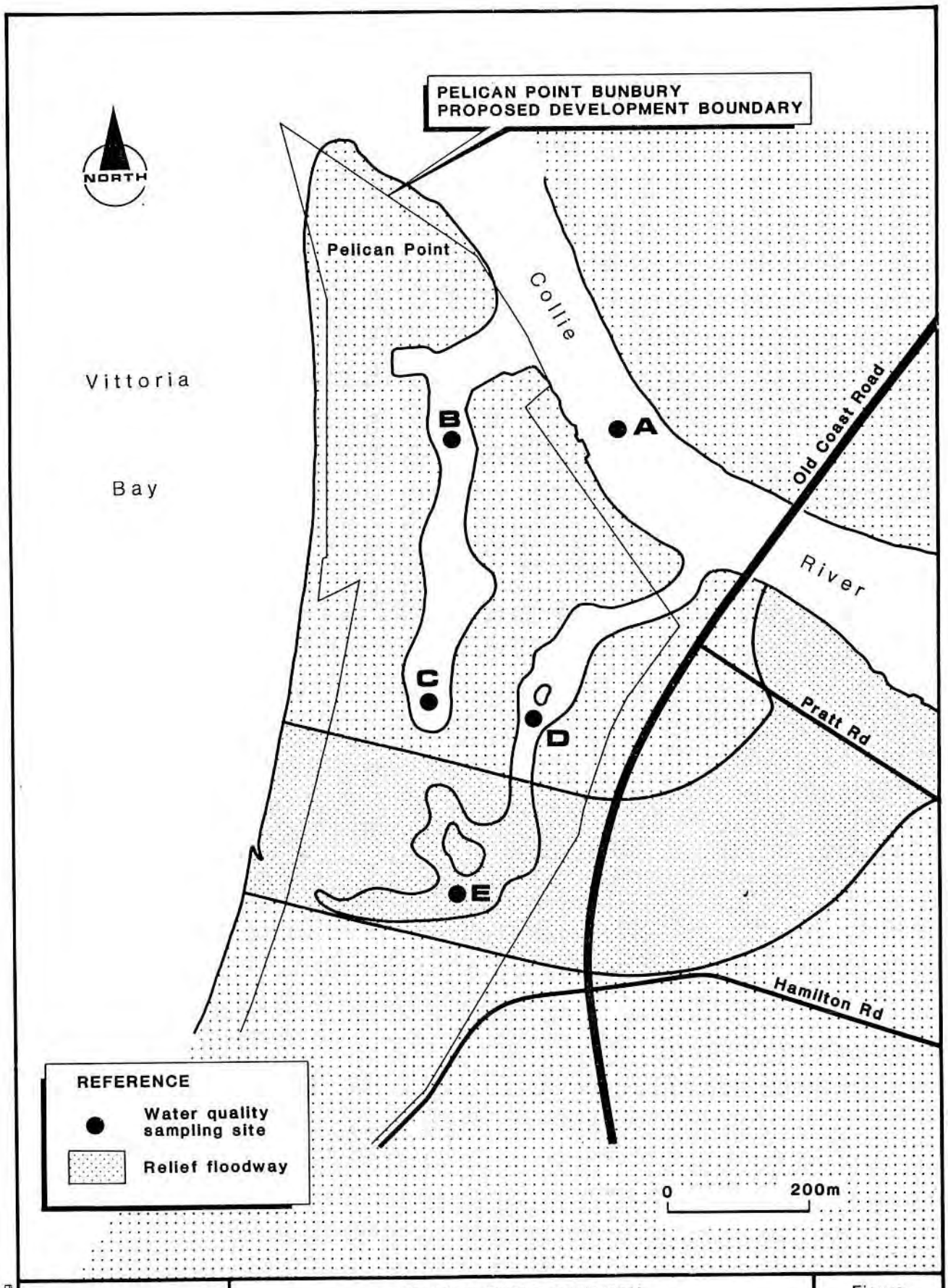
Figure **22**



Environmental Drafting

PELICAN POINT BUNBURY

WATER QUALITY MONITORING SITES

Figure **23**

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Plate 1: Aerial view of Pelican Point taken in winter, showing Leschenault Inlet shoreline (foreground), the Collie River and the Eaton residential area (right).

Plate 2: Pelican Point looking north-west across the Collie delta, Leschenault Inlet and Peninsula (background).

Plate 3: Lot 100 - view from northern end across pasture (foreground) and samphire-vegetated depression.

Plate 4: Lot 100 looking east from ridge across parkland-cleared pasture.

Plate 5: Collie River foreshore protected from erosion by log walling. Australind Bridge in background.

Plate 6: Collie River foreshore, showing eroded scalloped beach with remnant rushes (foreground) and *Casuarina* (background).

Plate 7: Leschenault Inlet grassy foreshore and sandy beach.

Plate 8: Leschenault Inlet intertidal zone adjacent to tidal channel connecting Pelican Point wetlands to Leschenault Inlet.

Plate 9: Pelican Point wetlands (in winter) with rushes and samphires in the foreground and *Eucalyptus rudis* in the background.

Plate 10: Pelican Point looking south-west towards Bunbury.

Pelican Point Pty Ltd

Pelican Point, Bunbury

Public Environmental Review

ANNEXURE A

GUIDELINES FOR PELICAN POINT, BUNBURY

PUBLIC ENVIRONMENTAL REVIEW

LEC Ref: J186/R320

GUIDELINES FOR PELICAN POINT, BUNBURY

PUBLIC ENVIRONMENTAL REVIEW

The following guidelines have been prepared for a Public Environmental Review (PER) on the development of a major tourist development featuring resort centre, golf course, lakeside villas and a residential canal, at a site at the mouth of the Collie River.

These guidelines are issued as a checklist of matters which the Environmental Protection Authority considers should be addressed in the PER. They are not exhaustive and other relevant issues may arise during the preparation of the document: these should also be included in the PER. Much of the information required has already been prepared and included in earlier documentation but will need to be collated in the PER. The relevance and requirements of EPA Bulletin 267 and subsequent EPA advice provided to the proponent in correspondence dated 23 May 1988 and 25 January 1990, should be appropriately discussed and referenced.

It should be noted that the guidelines are not intended to convey the Authority's wishes with respect to the format of the document. The format is a matter for the proponent and his consultant.

A copy of these guidelines should appear in the PER.

1 SUMMARY

The PER should include an explanation of the following:

- salient features of the proposal;
- alternatives considered;
- description of receiving environment and analysis of potential impacts and their significance;
- environmental monitoring, management and safeguards and commitments thereto;
- conclusions.

2 INTRODUCTION

The PER should include an explanation of the following:

- identification of proponent and responsible authorities;
- background and objectives of the proposal;
- brief details of, and timing of the proposal;
- relevant statutory requirements and approvals;
- scope, purpose and structure of the PER.

3 NEED FOR THE DEVELOPMENT

The PER should examine the justification for the project and projected costs and benefits (in the broad sense) at local and regional levels. Specific reference should be made to other relevant existing and proposed tourist developments in Australind/Bunbury.

4 EVALUATION OF ALTERNATIVES

The evaluation of alternatives is an important part of a PER. A discussion of alternatives to the proposal, including alternative sites as well as the "do nothing" option should be given. A comparison of these in the context of the stated objectives should be included as well as costs and benefits at both construction and operational stages. This discussion should also briefly consider various components of the project (e.g. the golf course, lakes and wetlands, residential canal), and their implications. In this way the rationale for not choosing certain alternatives should be clear as would the basis for choosing the preferred option.

5 DESCRIPTION OF PROPOSAL

The PER should include details of:

- overall concept;
- location and layout;
- proposed land uses, land tenures and a clear indication between boundaries of private and public land;
- infrastructure including any boating support facilities;
- number of employees;
- access;
- auxiliary services (e.g. power, water, sewerage);
- control and staging of project;
- operation during and after construction, including management of any boat facilities;
- projected life of the project;
- translocation and reinstatement of wetland bird habitat areas in terms of precise habitat value and management provision;
- all statutory requirements required for the project to proceed.

6 EXISTING ENVIRONMENT

The PER should provide an overall description of the environment and an appraisal of physical and ecological systems likely to be affected by it.

It should then concentrate on the significant aspects of the environment likely to be impacted by the development (i.e. in particular, the processes sustaining the system). Only

the processes, habitats, resources and potential resources which could be influenced should be defined. Detailed inventories should be placed in appendices to the PER.

Wherever possible in the discussion of physical and biological processes that are essential determinants in the maintenance of habitats and resources, conceptual models or diagrams should be used to illustrate and synthesise the interactions between the processes.

The following matters should be addressed:

6.1 PHYSICAL

- meteorology;
- oceanography of Leschenault Inlet/Collie River;
- geology and geomorphology;
- drainage;
- onshore hydrology and hydrogeology, including water quality;
- near shore water quality;
- wetlands.

6.2 BIOLOGICAL

- offshore and onshore biota (including wetlands) ecosystems;
- mosquitoes.

6.3 HUMAN

- land use, including past land uses, land tenure, zoning and reservation, conservation and recreational aspects;
- road systems and traffic;
- landscape;
- public access;
- adjacent sites affected by System 6 "Red Book" recommendations;
- historical, archaeological and ethnographic sites;
- adjacent urban developments;
- use of waters in vicinity of proposal;
- use of adjacent wetlands.

These issues need to be discussed in both a local and regional context. In addition, the PER should, where appropriate, take cognisance of any other similar developments proposed for the general area.

7 ENVIRONMENTAL IMPACTS

This is the most important part of the PER and the result should show the overall effect on the total ecosystem and social surroundings of the location during and after construction.

The objective is to take an overview of the elements of the system involved and the external factors with which they interact and to present them as a synthesis or conceptual model which can be used to predict system behaviour under these stresses likely to be encountered. This should include an assessment of the resilience of the systems identified in 6 to natural and man-induced pressures. Impacts should be quantified where possible. Criteria for making assessments of their significance should be outlined. Compliance with relevant standards should be demonstrated. In some cases there will be advantage in discussing construction and operational impacts separately.

It will be necessary to determine impacts on individual components of the environment before a final overall synthesis of potential impacts is made.

The following potential environmental impacts should be included:

- oceanography of Leschenault Inlet and Collie River;
- offshore and onshore biota (in particular wetlands ecosystems);
- risk analysis of storm events e.g. floods;
- contingency planning and safety;
- drainage;
- water quality (within the newly created, and modified wetlands and within the residential canal portion) and groundwater;
- land stability (with particular reference to all areas disturbed during construction, especially the batters of significantly filled areas, and the peripheral areas of wetlands);
- landscape;
- local and regional significance and ethnographic sites;
- any historical, archaeological and ethnographic sites;
- the adjacent System 6 areas;
- emissions (air, water, waste disposal, noise);
- land use including conservation and recreation aspects;
- access road systems and transport;
- effect on existing community and facilities;
- services (power, water sewerage);
- use of adjacent offshore waters;
- construction and operational workforce;
- use of wetlands by waterfowl;
- impacts of the environment of the project e.g. mosquitoes;
- the possible long-term impacts of Bunbury Port facility activities on the proposed tourism, residential uses of the development.

The final synthesis should include an assessment of the significance and timing of the various potential impacts identified.

8 ENVIRONMENTAL MANAGEMENT

An environmental management programme should be described on the basis of (and cross-referenced to) the synthesis of potential environmental impacts.

The purpose of the management programme is to demonstrate the manner in which potential environmental impacts can be ameliorated.

Authorities responsible for management should be clearly identified as should management administration, costs and funding including long-term financial contingency.

Elements of monitoring and the environmental management programme should include the impacts identified in 7.

Emphasis should be placed on the manner in which monitoring results will lead, where appropriate, to amendments to the management programme.

Procedures for reporting the results of monitoring and management to appropriate authorities should be give.

It is important that specific commitments are given to all components and procedures of the management programme.

9 SUMMARY OF COMMITMENTS BY PROPONENT

Where an environmental problem has the potential to occur, the proponent should cover this potential problem with a commitment to rectify it, and clearly articulate the financial capacity and provision to do so. Where appropriate the commitment should include: (a) who will do the work; (b) what the work is; (c) when the work will be carried out; and (d) to whose satisfaction the work will be carried out.

10 CONCLUSION

An assessment of the environmental acceptability of the project in terms of its overall environmental impact and in the context of the proposed management programme should be given.

11 REFERENCES

GLOSSARY (definitions of technical terms, abbreviations)

PER GUIDELINES

APPENDICES