CORAL COAST RESORT
MAUDS LANDING

PUBLIC ENVIRONMENTAL REVIEW

Coral Coast

MARINA DEVELOPMENT PTY LTD

INVITATION

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

The Public Environmental Review (PER) proposes the rezoning of land and the development of an inland Marina Complex in the Shire of Carnarvon. In accordance with the Environmental Protection Act, a PER has been prepared which describes this proposal and its likely effects on the environment. The PER is available for a public review period of 8 weeks from **6 February 1995** closing on **31 March 1995** .

Comments from government agencies and from the public will assist the EPA to prepare an assessment report in which it will make recommendations to government.

Why write a submission?

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

All submissions received by the EPA will be acknowledged. Submissions will be treated as a public document unless specifically marked confidential, and may be quoted in full or in part of 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, safeguards or alternatives.

Points to keep in mind

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

- attempt to list points so that 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 may wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:

- your name,
- address,
- date; and
- whether you want your submission to be confidential.

The closing date for submissions is: **31 March 1995**

Submissions should be addressed to:

Environmental Protection Authority
Westralia Square
141 St George's Terrace
PERTH WA 6000

Attention: Ms Eve Bunbury

PUBLIC ENVIRONMENTAL REVIEW

CORAL COAST RESORT - MAUD'S LANDING

February, 1995

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PUBLIC ENVIRONMENTAL REVIEW
CORAL COAST RESORT, MAUDS LANDING

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1.0 INTRODUCTION

1.1 The Land and Summary of the Proposal

Coral Coast Marina Development Pty Ltd proposes the establishment of a marina and resort at Mauds Landing, a gazetted townsite located near Coral Bay on the North West Cape of Western Australia. The site is located approximately 1200km north of Perth, 250km north of Carnarvon, and 150km south of Exmouth within the Shire of Carnarvon (Figure 1.1).

Mauds Landing was gazetted as a townsite in the late 1800's, and has remained as vacant Crown land. The townsite, which lies some 3km north of the existing Coral Bay (Bills Bay) townsite, has an area of approximately 250ha .

Mauds Landing has played an important role in the settlement and development in the North-West of the State since the late 19th Century. In 1886, tenders were called by the Public Works Department of Western Australia for the construction of a jetty, woolshed and well at Mauds Landing to serve the settlers and pastoralists of the region. The works were completed in late 1897 and in 1898 tenders were called for the lease of the jetty and on-jetty tramway loading system and the wool sheds.

Until its closure as a coastal port in 1947, Mauds Landing served many local pastoralists both in the provision of supplies and in the outward shipment of various goods, notably wool. During this time, Mauds Landing handled various shipping traffic of up to four vessels at a time. In 1907 the township boundary was re-surveyed, and in 1908 Reserve 5313 was established around the jetty site, although it was not gazetted until 1923. In 1913, sixteen 0.1 ha town lots were created at the original reserve, and in 1915 Mauds Landing was declared an official townsite.

The name "Mauds Landing" originates from the name of the schooner "Maud", the captain of which was the first European to discover the location.

The tourism and recreational values of Coral Bay have long been recognised. Public utilisation of these opportunities was facilitated in 1967 with the commencement of formal settlement at Bills Bay. The potential of the Mauds Landing townsite for major tourism development has

only recently been addressed, with the calling for expressions of interest by the Department of Land Administration (DOLA) in late 1988.

Recognition of the potential of Mauds Landing townsite for tourism development has been largely driven by the impacts of the adjoining Bills Bay Settlement on the Ningaloo Marine Park, which was declared to protect the high conservation values of the Ningaloo reef system and to enhance the recreational use of its resources. The Ningaloo Marine Park Management Plan (May *et al.*, 1989) recognises that the existing settlement at Bills Bay, which comprises two caravan parks, a hotel and several sub-leases for chalets, has resulted in problems due to lack of planning, infrastructure and rapidly increasing use of the area for recreational purposes. The Management Plan also recognises the potential of Mauds Landing for a marina-based development that would provide valuable resources for visitors to the Ningaloo Marine Park as well as reducing the environmental and recreational pressures and conflicts generated at Bills Bay.

The Coral Coast Resort project is a resort town development proposal which has the complementing and supporting of the management of the Ningaloo Marine Park as one of its objectives. It proposes an inland marina to enable relocation of public boating activity and anchorage from the Maud Sanctuary Zone of Bills Bay, together with a broad range of tourist, commercial, entertainment, residential and recreational facilities. The location of the proposal in a local context is shown in Figure 1.2, with the Master Plan presented as Figure 1.3 contained in a pocket at the rear of this document. An artistic impression of the completed development relevant to the surrounding landscape is shown in Figure 1.4.

The project is intended to cater for the expanding tourism and residential/retirement market in the Gascoyne and Pilbara regions, and has been carefully planned and designed from inception to provide environmentally sensitive and sustainable development. Strategic management of the Coral Coast Resort will ensure that high standards are achieved and maintained, and that the objectives of the Ningaloo Marine Park Management Plan are fulfilled.

Development of the Coral Coast Resort is proposed to be staged over a period of 15 to 20 years and will comprise the following principal elements:

- An inland marina and associated facilities;
- Tourist resort facilities;

- An 18-hole golf course; and
- Residential accommodation.

The proposed development is described in detail in Section 3.

The development is expected to provide:

- Appropriate environmental management and orderly development of the coastal land adjoining the Ningaloo Marine Park, resulting in controlled access for tourists and boats to the waters;
- Promotion of an understanding and respect for the marine and terrestrial environments of the area, together with facilities enabling relevant Authorities to undertake valuable research and education regarding the Ningaloo Marine Park;
- Active management of recreational fishing and the provision of safe boating facilities;
- Relief by decreasing environmental and recreational pressures placed on the unique Maud Sanctuary Zone in Bills Bay by absorbing these pressures within a new inland marina and serviced recreational resort; and
- Provision of recreational opportunities and tourist facilities which will maximise the Ningaloo reef experience for the inevitable increase in the number of visitors to the region, and yet be sympathetic to the existing environment.

1.2 The Proponent

The proponent for the proposed Coral Coast Marina and Resort development is Coral Coast Marina Development Pty Ltd (CCMD). The company is privately owned, and was formed in October 1987 with the specific purpose of developing the Mauds Landing townsite.

Coral Coast Marina Development Pty Ltd has the resources and capacity to both develop and manage Mauds Landing in an orderly and proper manner, in accordance with government requirements for appropriate management of the adjacent marine and terrestrial environments.

Most importantly, the Company is committed to achieving an outstanding development which will be of great benefit to both the region and the preservation of the unique environment of the Ningaloo Marine Park.

1.3 Rationale for the Development

In August 1987, a founding Director of Coral Coast Marina Development Pty Ltd entered into discussions with officers of the Department of Conservation and Land Management (CALM) and the (then) Environmental Protection Authority, in respect to the degradation of the marine environment as a consequence of development pressures at the existing Bills Bay settlement.

In February 1988, the Company was granted Right of Entry to the Mauds Landing townsite by the DOLA to conduct preliminary site and feasibility investigations for the development of a resort town at Mauds Landing. The investigations confirmed that Mauds Landing could be developed in empathy with both the marine and terrestrial environments, and in late 1988 DOLA called for expressions of interest in a marina/tourist development at the site.

The Brief issued by DOLA for the Registration of Interest required potential developers to submit conceptual plans for the proposed development incorporating a marina concept in order to assist the Department in determining whether formal release of the land should proceed.

In May 1989, State Cabinet approved in principle the proposal by Coral Coast Marina Development Pty Ltd to develop Mauds landing townsite on the understanding that the Company met the requirements of the State Planning Commission, the (then) Environmental Protection Authority, and CALM. Preliminary site investigations were commenced, but as a consequence of the global economic downturn the project was postponed. However, in late 1993 Coral Coast Marina Development Pty Ltd was able to secure substantial financial backing for the project, and requested re-affirmation by the current State Government of its support for the project. This request for re-confirmation culminated in a Heads of Agreement between the Western Australian Government and Coral Coast Marina Development Pty Ltd, enabling the project to proceed, subject to the necessary approvals (including planning and environmental approvals), with the objective of commencing construction in 1995.

The proposed Coral Coast Resort is driven a demand for appropriate tourist facilities of international standard adjacent to the Ningaloo Marine Park to accommodate rapidly increasing visitor numbers to the region, and more particularly to the Park itself. The Parks' scenery,

abundant marine and terrestrial wildlife, and the accessibility of coral reefs are already gaining both national and international recognition. Appropriate protection and management of these natural attributes is a prerequisite applicable to any development proposal in the region.

The existing townsite at Bills Bay, which is situated adjacent to the Maud Sanctuary Zone within the Ningaloo Marine Park (Figure 1.5), has neither the physical nor environmental capacity to sustain a significant increase in visitor numbers, or to provide facilities of the required standard. At the very least, the existing settlement is in need of substantial and immediate physical and environmental management.

Coral Coast Resort at Mauds Landing is expected to provide environmentally and ecologically sustainable opportunities to provide both quality facilities and experiences outside of the Maud Sanctuary Zone. More importantly, the Mauds Landing proposal provides the opportunity and resources to effectively manage both existing and future visitor pressure in a location that has demonstrably preferable environmental features; viz a constructed inland marina which does not impact on and a nearshore zone free of substantial coral formations, in comparison to the unique Bills Bay.

The focussing of the future growth and recreational uses within a locality which already has substantial levels of usage but within a new facility which can facilitate and optimise the effectiveness of environmental management is a key benefit offered by the proposal.

Finally, development of Mauds Landing will provide the service infrastructure, particularly for the treatment, management and disposal of waste water, with the potential for future connection of the existing Bills Bay townsite which is presently operating on conventional septic systems and low performance infiltration/evaporation pond systems close to the coast.

In November 1994 the State Planning Commission released a draft report entitled "Gascoyne Coast Regional Strategy" for public comment. The Gascoyne Coast Regional Strategy seeks to promote a co-ordinated approach to regional development, which aims to maximise the region's economic advantages based on the sensible management of its natural resources. The Strategy recognises that tourism is a significant growth industry in the region and that the high demand for tourism facilities and problems with current servicing arrangements outside of the existing centres of Carnarvon and Exmouth has necessitated the need for action.

Accordingly, the strategy seeks to develop the Gascoyne Coast into a tourism region of international significance focussing on its unique features. It seeks to achieve this in a manner that is ecologically sustainable, retains the sense of wilderness and provides local and regional economic and social benefits.

In respect of the township of Coral Bay, the Strategy recognises that the current situation is problematic due to a number of logistic factors, and that the "do nothing" development option is not acceptable. Development is required both to improve the environmental sustainability of the site and to take advantage of the economic potential offered by tourism. The Strategy proposes that Coral Bay be identified as a tourism development node and, subject to appropriate environmental controls and management, supports the establishment of major tourism facilities at Mauds Landing to service the international and interstate and intrastate markets.

In respect of residential development at Mauds Landing, the Strategy adopts a more conservative approach, its principle area of concern being to ensure that there will be no significant impacts on the reef ecosystem in the long term, which is addressed in this document. The Strategy recognises that the residential component of the proposed Coral Coast Resort is crucial to the viability of the project and that a "tourism only" development would require the injection of substantial Government funds in the provision of services and utilities. The Strategy also recognises that Mauds Landing is the most appropriate location for residential development within the study area, and that the form and function should complement the existing Coral Bay settlement.

1.4 The Statutory Environmental Approvals Process

A number of Government Authorities will be involved in the decision making process in the course of approving this proposal. These include:

- The Shire of Carnarvon;
- The State Planning Commission and the DPUD;
- The Department of Environmental Protection,
- The Department of Conservation and Land Management;
- The Water Authority of Western Australia,
- The Main Roads Department;
- State Energy Commission of Western Australia;

- The Department of Transport; and
- The Western Australian Museum.

The *Environmental Protection Act, 1986* requires that any development which has the potential to affect the environment must be assessed by the Environmental Protection Authority (EPA). One of four levels of assessment may be assigned to a proposal by the EPA. These are:

- Informal Review with Public Advice
- Consultative Environmental Review (CER)
- Public Environmental Review (PER)
- Environmental Review and Management Program (ERMP)

In view of the potential environmental impacts associated with the implementation of this proposal, the level of assessment was set under Part IV of the *Environmental Protection Act* as a Public Environmental Review. This document was prepared in accordance with guidelines which were originally issued by the EPA in January 1990, and subsequently revised in October 1994 (Appendix A).

Following acceptance of this document by the DEP as suitable for public release, this PER is made available for a period of 8 weeks during which submissions may be made by members of the public regarding the proposal. At the conclusion of the public review period the Department of Environmental Protection will consider the proposal together with any public submissions. The proponent will be asked to respond to issues raised by the public, prior to assessment of the project commencing.

When the assessment is completed, the EPA will prepare a report (Bulletin) which will summarise the principal environmental issues and conclude whether the project is considered to be environmentally acceptable, and under what conditions. Following the release of the EPA's assessment report, anyone can appeal against the recommendations of a EPA for a 2 week period.

Following consideration and determination of any appeals received against the EPA's report, the Minister for the Environment will set conditions which will reflect the appeal determinations and conclude whether the proposal is environmentally acceptable and under what conditions. These conditions are enforceable by law.

1.5 Timing and Schedules

This PER was released on 6 February 1995, and will be available for public comment for an 8 week period, closing 31 March 1995. Details on how to make a submission are included at the front of this document.

Public Information Days will be held at Carnarvon, Coral Bay and Exmouth, at which time members of the public can view detailed plans of the project, receive information regarding the proposal from the proponent, and make submissions to representatives of the Department of Environmental Protection.

The venue, date and time of the Public Information Days will be advertised in the Northern Guardian closer to the time of the events.

1.6 Purpose and Structure of the Public Environmental Review

This document has the purpose of describing the proposal, detailing the existing environmental characteristics of the site and surrounding area and any anticipated environmental impacts associated with the construction and operation of the proposal, and proposing environmental design and management strategies which will be required to mitigate any potential environmental impacts. The environmental commitments proposed by the proponent to minimise or avoid these impacts are listed in Section 9.

The Appendices, which are the basis for information summarised in the PER in relevant sections, are presented in full under separate volume. The Appendices are available upon request (at additional cost to the PER).

The document therefore brings together the information required to assist in the environmental assessment process.

2.0 PROJECT JUSTIFICATION

2.1 Regional Planning

2.1.1 Gascoyne Coast Regional Strategy

In November 1994, the State Planning Commission released a landuse strategy for the Gascoyne Coast entitled "Gascoyne Coast Regional Strategy" for public comment.

The Strategy was prepared to provide a clear framework to guide landuse within the Gascoyne Region over the next 20 years and involved consultation with the Shires of Carnarvon and Exmouth, key Government Agencies and the local community. The Strategy seeks to promote a co-ordinated approach to Regional development which aims to maximise the Region's economic advantages based on the sensible management of its natural resources.

More specifically, the Regional Strategy seeks to develop the Gascoyne Coast into a tourism region of international significance focussing on the unique natural features. It seeks to achieve this goal in a manner that is ecologically sustainable, retains a sense of wilderness and provides local and regional economic and social benefits. The Strategy clearly recognises the importance of tourism as a significant growth industry within the Region and further that the high demand for tourist facilities, particularly outside the existing townsites of Carnarvon and Exmouth, has necessitated the need for action.

The Regional Strategy proposes a settlement hierarchy in order to guide the future growth of key towns. The hierarchy recognises the existing roles in future development in respect of the existing townsites of Carnarvon and Exmouth, and proposes that they be consolidated as Regional Centres to the Gascoyne. In respect of Carnarvon, the largest town in the Region and the main administrative service centre, the Strategy proposes that it remains as the focal point for the surrounding pastoral and horticultural districts and that its function as a southern gateway into the Region be reinforced. The role of Carnarvon as a tourist stopover and destination is growing, and with proposed developments such as the Fascine has the potential for further development as well as reinforcing its role as the Regional centre. The role of Exmouth as a sub-regional centre serving the northern part of the Gascoyne is recognised, and it is intended that this be reinforced and that Exmouth should remain the service centre for tourism to the North-West Cape area. Development of the Exmouth Marina is seen as providing an

opportunity for promotion of further tourism development within Exmouth, as well as providing opportunities for other industry and the potential for residential growth.

Beyond the Regional centres of Carnarvon and Exmouth, the Strategy identifies that:

"There is enormous potential to broaden the tourist market of this area (Coral Bay)*by providing the necessary infrastructure and by marketing the region as an international destination"* (page 2.23).

The Strategy recognises that the area is a popular tourist destination but that the existing settlement at Coral Bay is suffering from overcrowding and poor servicing, which is contributing to environment degradation with growing evidence of damage to the coral systems in the Maud Sanctuary Zone in Bills Bay. The Strategy recognises that the "do nothing" option in respect of Coral Bay is unacceptable as a consequence of both the environment and social impacts of the current arrangements and concludes that the situation in respect of Coral Bay requires urgent attention.

The Regional Strategy considers the Coral Coast Resort proposal at Mauds Landing in considerable detail and evaluates it against a range of local regional and management issues. In conclusion, the Strategy supports the tourism development component at Mauds Landing but adopts a more conservative approach in respect to a residential component at the site. The Strategy recognises that if residential development is to occur outside of the existing centres of Carnarvon and Exmouth, then Mauds Landing is the most appropriate location within the study area. Additionally, the Strategy recognises that the residential component of Coral Coast Resort is crucial to the viability of the project, and in particular to the provision of key infrastructure which would otherwise have to be provided by Government. The Strategy also questions the viability of a resort at Mauds Landing based on tourism only because of the relative "obscurity" of Coral Bay as an international and interstate tourist destination at the current time, a situation that would require significant promotion to reverse. In this respect, the Strategy draws a parallel to the village at Yullara (Ayers Rock) which, it is significant to note, is reported to have a permanent residential population varying between 900 and 1100 persons. Additionally, it is believed that Yullara village, which required only the provision of basic utilities infrastructure, operated at a financial deficit for some 10 years.

The evaluation of the various options for Coral Bay conducted in the Strategy concluded that a "tourism only" project would fully or partially satisfy all of the criteria which were applied,

while the Coral Coast Resort would fully or partially satisfy all but two; the provision of administrative and community services by Government, and uncertainty regarding the potential for impact on regional tourism assets (Ningaloo Reef). The Strategy states that:

"a tourism only project would be the preferred option in the short term, although residential development may be appropriate in the future if it can be conclusively established that it will be sustainable and there will be no significant impacts on the reef ecosystem in the long term" (page 3.29).

On the assumption of a "tourism only" development at Coral Coast Resort, it is important to note that after allowing for a scale-down marina due to lower demand, CCMD estimates that the cost of providing a marina and core infrastructure at between $15-$20 million. The reduction of financial viability which would result from a "tourism only" development would need to be offset by Government funding in order for a private sector operator to be capable of carrying out the development. This Government funding would not comply with the assessment criteria applied in the Strategy.

The principal concern of the Strategy in respect of the residential component of the Coral Coast Resort is the potential impact of resident's boats on the Ningaloo Marine Park. In respect to these potential environmental impacts, it is anticipated that information presented within this document together with commitments given by the proponent, will ensure that environmental impacts, particularly on Ningaloo Reef, are minimised.

It is important to note that total estimated boat ownership within the Resort is 530 craft, including commercial charter vessels, of which it is likely that up to 200 could be in use at any one time. This level of usage compares with the existing settlement at Bills Bay where up to 120 boats may be moored in the Bay during peak periods. More importantly, Coral Coast Resort will provide the State Government through CALM not only with the facilities to manage recreational boating and fishing at a single focussed location in a marina environment free of constraint by coral communities, but also will provide CALM with substantial revenue from the proposed visitor and research centre to enable the Department to provide the required resources for appropriate Park management. These matters are further discussed subsequently in this document.

2.1.2 Coral Bay Planning Strategy

In 1992, the Department of Planning and Urban Development prepared the Coral Bay Planning Strategy (DPUD, 1992), with the overall objective of retaining the townsite for low-key tourist accommodation and recreational usage for the benefit of visitors to the area.

The Strategy recognised the stresses placed on the existing townsite by overcrowding, the lack of adequate services, and the risk of present effluent disposal methods leading to long term nutrient enrichment problems within Bills Bay.

The Strategy concluded that the existing settlement has severe limitations to its capacity to absorb expansion without causing environmental deterioration, and recommends against expansion until a satisfactory resolution of servicing issues, particularly effluent disposal, has been determined. The Strategy recognised that land already committed to tourist development contained substantial potential for expansion, and identified additional areas for potential tourism development as well as limited residential development.

In relation to Mauds Landing, the Strategy recognised the potential of a marina development at Mauds Landing to assist in the management of Bills Bay, particularly in respect of:

"• *Reducing boating congestion in Bills Bay;*

• *Allowing proper management of boating activities in the area;*

• *Reducing damage to the coral formations in Bills Bay; and*

• *Providing the increasing private and commercial boating sectors with safer anchorage.* "

As previously noted, the existing settlement at Bills Bay is to be the subject of a separate Town Planning Scheme to be prepared by the Shire of Carnarvon as a framework for future growth.

2.2 Local Planning

The Mauds Landing Townsite falls within the Municipality of the Shire of Carnarvon. Mauds Landing is not presently zoned under a Council Town Planning Scheme, but is subject to an Interim Development Order (No. 15) in the case of the Coral Coast Resort site. The existing

settlement at Bills Bay is the subject of a separate Interim Development Order (No. 14). The provisions of the Interim Development Order for Mauds Landing townsite requires that all development be the subject of Council approval.

Council of the Shire of Carnarvon is presently preparing a zoning scheme, being District Zoning Scheme No. 11, that will include that portion of Mauds Townsite forming the site of Coral Coast Resort. District Zoning Scheme No. 11 introduces development and landuse controls over the rural area of the Shire excluding that portion of the Maud Townsite comprising the existing settlement at Bills Bay, which will be the subject of its own separate Town Planning Scheme to be prepared by Council.

District Zoning Scheme No. 11, which has been adopted by Council and advertised for public submissions, proposes that Mauds Landing Townsite be zoned Rural. At the time of preparation of the Scheme, specific plans for the Resort had not been considered by Council and hence no specific zone was included in the Scheme to accommodate the Coral Coast Resort. The Scheme does however recognise the potential for large scale resort development and for the land to be zoned accordingly at the appropriate time.

2.3 Regional Tourism and Population Profiles

In assessing the justification for the proposed development at Mauds Landing, it is essential to consider regional tourism and population trends and projections in terms of both present and future market demand.

2.3.1 Tourism

The Western Australian Tourism Monitor - June 1992, indicates that a total of approximately 33.2 million visitor nights were spent in Western Australia in the financial year 1991-1992, of which approximately 13 million (40%) were spent in the Perth region. The Gascoyne region, incorporating Shark Bay, Carnarvon and Exmouth accounted for approximately 2.2 million visitor nights (7%), with the Pilbara and Kimberley regions each accounting for approximately 1.8 million visitor nights (5%).

Of the 2.2 million visitor nights spent in the Gascoyne region approximately 90% were by persons from WA, with a further 5% from the balance of Australia. The proportion of visitor nights spent in the Gascoyne region from persons within Western Australia is significant in that

it is one of the highest intrastate proportions for all tourism regions within the State. By comparison, the Kimberley region attracts some 24% of visitor nights from the balance of Australia with a further 4% from overseas, a factor which can largely be attributed to direct eastern states flight connections. The adjoining Pilbara Region itself attracts some 20% of total visitor nights from the balance of Australia with a further 2% of visitor nights from overseas. No estimate is available for overseas visitor nights in the Gascoyne region.

Australian Bureau of Statistics data regarding tourism trends within the Gascoyne region indicate an average growth in guest arrivals to commercial accommodation over the five year period to 1992-93 of approximately 6% per annum. Assuming this growth to be representative of the broader visitor spectrum, a 6% growth rate based on current origin of visitors equates to an annual increase compounding from 135,000 visitor nights per annum. Assuming the continuation of current growth rates, total visitor nights could reasonably be expected to be in the order of 3.5 million by the year 2000 (900,000 guest arrivals), an increase of 1.3 million on current levels.

If the Gascoyne region was able to achieve comparable Eastern States and overseas visitation levels as the Kimberley Region over the equivalent period via promotion and upgraded flight connections within Australia and from Asian destinations, it would not be unreasonable to expect the addition of 500,000 visitor nights (125,000 guest arrivals) per annum. This factor is further supported by the increasing awareness in Australian and overseas markets of the uniqueness, variety and quality of experiences available to visitors in the Gascoyne Region, particularly given the performance of adjacent north-west regions which are arguably less attractive.

In short, based on current growth rates together with the potential of the Gascoyne to attract interstate and overseas visitors, a doubling of total visitor nights to the Gascoyne is possible within the foreseeable future. This level of visitation is comparable to the "Maximum Carrying Capacity Scenario" presented in the "North West Cape Tourism Development Study" (Jones Lang Wootton, 1993).

The JLW Scenario represented a "top down" approach for conducting an environmentally sustainable tourism industry that reflected the carrying capacity of the North West Cape, beyond which tourism pressures were perceived to be unmanageable at a sustainable level. This Scenario proposed a trebling of present bedspaces within the North-West Cape to approximately 13,000, which converts to an estimated 3.5 million visitor nights in commercial accommodation only, based on Broome occupancy rates.

While the JLW Study envisaged this growth in bedspaces over a period of 15-20 years, it is clear that the broader Gascoyne Region not only has the potential but also the sustainable capacity to double visitation levels. Of this potential increase, up to half would use air travel, and therefore require some form of serviced accommodation, such as hotel, motel, serviced apartments or chalets/park homes.

The State Government, through the Western Australian Tourism Commission (WATC), is seeking to substantially expand tourism within Western Australia, particularly from the interstate and international markets. The Commission is seeking to increase international visitors to W.A. to in excess of 1 million guest arrivals by the year 2000, an increase of 500,000 guest arrivals over current levels. In respect of the interstate market, the Tourism Commission is seeking to increase visitation to W.A. to 890,000 guest arrivals by the year 2000, an increase of 390,000 guest arrivals on current levels. Assuming the Gascoyne only maintains its current share of total visitation to WA, achievement of WATC expectations would suggest an annual growth rate in the order of 6.5% over the next 5 years, which is marginally higher than the past 5 years.

The Gascoyne Region is well poised to capitalise on this growth as a result of several factors:

- The variety and quality of experiences available to visitors, including Shark Bay, Denham, Monkey Mia; Carnarvon District features (blowholes, plantations, Quobba coastline); close-shore reef opportunities and recreational fishing and diving opportunities of the Coral Bay area; the Cape Range National Park, recreational fishing and diving opportunities of the Exmouth Region; and the renowned gorge landscapes of the Karijini National Park.

- The greater depth and range of visitor experiences available in the Gascoyne region in comparison to the adjoining Pilbara and Kimberley regions;

- The comparative proximity of the Gascoyne Region to Perth relative to the Pilbara and more so the Kimberley; and

- Most importantly, the availability of existing facilities at Learmonth airport capable of handling large interstate and international-scale aircraft.

The greatest opportunities for growth in the International sector are in the immediate south-east Asian region, notably Singapore, Malaysia, and Indonesia which are within a three hour flight

from Learmonth and within the same timezone. Indeed, Learmonth Airport and the Gascoyne Region have the capacity to become the gateway to the north-west, the Asian gateway to Western Australia, and the third northern gateway to Australia after Darwin and Cairns.

The average length of stay in W.A. by overseas visitors is presently in the order of 19 nights. Based on discussions with in-bound tour operators, including those who have recently brought in international charter tours to the Gascoyne Region, it would not be unreasonable to anticipate visitors may spend between 5-7 days in the region divided approximately 60% at a major resort with access to Ningaloo Reef, with the balance of visitor nights to the region being spent in surrounding locations.

The Gascoyne Region is well positioned for substantial tourist growth from the intrastate market, and more importantly from the interstate and international markets. In order to capitalise upon that growth there is a need to significantly expand the range and quality of facilities available to visitors, notably at the principle destinations of Shark Bay, Carnarvon, Coral Bay and Exmouth. Irrespective of the way in which tourism trends and projections are interpreted, a doubling of total visitation to the Gascoyne Region is considered to be achievable, particularly within the timeframe of the Coral Coast Resort. Such an increase in visitation equates to a minimum additional direct injection of some $120 million per annum into the regional economy, more than doubling present tourist expenditure. Indirectly, such an increase in tourist expenditure in the region could reasonably be expected to generate up to a further 25% in allied services together with the opportunities for growth within the export sectors as a consequence of higher airline traffic and particularly outward bound international traffic to the Asian region and beyond.

2.3.2 Population

The following regional population profile concentrates on the Central and Pilbara Statistical Divisions of the State of Western Australia, which in general terms extend from Dongara in the south to Port Hedland in the north, and eastwards to include the towns of Newman and Meekatharra. It is anticipated that the service work force for Coral Coast Resort will be drawn substantially from these Divisions and any potential impacts of the Coral Coast Resort complex are most likely to affect these two Divisions, more particularly the Towns of Carnarvon and Exmouth. It is, however, significant to note that while this profile concentrates on the Central and Pilbara Divisions, a proportion of both the service workforce to Coral Coast Resort and the

potential residential population may be drawn from other Statistical Divisions within the State, particularly the lower south-west divisions including the Perth Statistical Division.

Projections presented in this profile are those in the Department of Planning and Urban Development's 1988-2021 Series, and are supported where appropriate by the observations of property agents active within the Region. Additionally, the projections presented in this section are only for the period to the Year 2010, based on the assumption that Coral Coast Resort townsite will be substantially developed (greater than 75%) within a 15 year period, with construction commencing in 1995.

Since Federation in 1901, Western Australia's share of the national population has increased from 5% to 9.5% in 1989, and the indications are that by 2021 Western Australia will comprise some 12% of the national population. Western Australia's annual population growth rate is nearly double that of the national growth rate, and is second only to Queensland. By 2010 it is projected that Western Australia will have a total population of approximately 2.3 million, 1.7 million of which will be resident within the Perth Statistical Division.

During the period to 2010, the resident population of the Central and Pilbara Statistical Divisions is projected to increase by some 28,000 persons over a 1994 base of 120,000 persons. The Central Division, which extends from Dongara to Exmouth, is projected to have a resident population by 2010 of approximately 83,000 persons, an increase of 16,000 compared to the current (1994) base of approximately 67,000 persons. The Pilbara Division which extends from Exmouth, north beyond Port Hedland is projected to have a population of 66,000 persons over a 1994 base of 54,000 persons, an increase of 12,000.

The Central Statistical Division has exhibited steady population growth based on an economy dominated by farming, fishing and mining. More recent population growth has been due to an upsurge in mining activity, and it is projected that population growth within this Division will continue at a steady pace, remaining the third largest in the State. The Pilbara Division exhibited strong population growth during the 1960's and 70's but in more recent years has seen a decline reflecting the changing nature of the workforce in the region, and the decrease in construction activities. Additionally, a portion of the workforce within the area resides within the Perth Statistical Division working on a "fly in-fly out" basis. Generally, a continuing balanced growth is forecast for the Pilbara Division.

The projections for both the Central and Pilbara Division appear, at best, to be based on maintenance of the status quo and in particular, the percentage population share compared to that of the State. Given that base population ratios and assumptions applying to population distribution within the State are based on a period of relatively low economic activity, it is possible that the resident population projections for both the Central and Pilbara Divisions are underestimated. There is the likelihood of substantial growth in the mining sector and more importantly, secondary refinement of minerals at or near source which seems likely to result in increased growth rates. Further underestimation will also become evident if substantial tourism growth occurs in the Central and Pilbara Divisions, as projected, due to the direct and indirect service workforce requirements.

Of particular importance in the Central and Pilbara Divisions is the issue of age profile of the population. Whilst it is expected that the number of persons under 40 years of age will remain relatively constant for both Divisions, it is projected that the number of persons over 40 will "explode" in comparison to present levels. Only the south-eastern Statistical Division (Kalgoorlie/Esperance region) displays a comparable increase in the over 40 age bracket.

The projected substantial increase in the Central and Pilbara Divisions in the over 40 age groups is typical of a maturing residential population that has developed roots in the district and seeks to retain residency in the same area on a permanent basis. The Central, and more particularly the Pilbara Divisions, have clearly matured beyond the position of being mobile workforces to the mining industry, to the point where generations are being born and bred in the district and seek to remain in the location that has formed a substantial portion of their life. Large projected increases in persons over 40 are significant not only in that they show a maturity of the resident population base, but also indicate the probability of increasing demand for "retirement based" accommodation in the region, together with the probability for a greater demand for holiday-based accommodation as a consequence of the typically higher disposable income available to households in these age brackets.

As in the rest of Western Australia, occupancy rates (number of persons per dwelling) in the Central and Pilbara Divisions are decreasing. It is projected that dwelling occupancy rates as a proportion of total private dwellings will reduce from a present mean of 3.15 persons in the Central and Pilbara Divisions to 2.85 persons by 2010. Accordingly, a population increase of some 28,000 persons over this period translates to a requirement for an increase in total dwelling stocks of some 10,000 units which on present occupancy patterns represents a ratio of approximately 2:1 between single houses and medium density. Any significant increase in

mining activities or secondary refinement within either Divisions will further increase this requirement. A projected requirement for an additional 10,000 dwellings over this 15 year period is significant in its own right. The projected rapid increase in population numbers in the over 40's age groups, combined with the relative stability of the below 40 age groups, will result in the bulk of the additional 10,000 dwelling unit requirement being directed to retirement based accommodation, with an additional requirement for holiday-based accommodation. It is conceivable that the demand for retirement-based accommodation, particularly in the northern-Central and Pilbara Divisions, is underestimated.

Discussions with property agents operating in the Region indicate that a high proportion of the population presently in the over 40 age bracket are purchasing properties in the lower south-west of the State, notably the Perth and Mandurah Regions, because of the absence of suitable accommodation in locations closer to home that also present a more pleasant climate. Coral Bay, with its attractive climate and accessibility to major facilities and services at both Exmouth and Carnarvon, presents a unique opportunity for arresting a significant portion of leakage in retirement based accommodation demand to the lower southern Statistical Divisions.

Whilst the projected increase in dwelling demand will be directed to the principal townsites of Geraldton, Carnarvon, Exmouth and Karratha/Hedland, Coral Coast Resort needs only to capture less than 10% of the projected requirements to sustain a permanent dwelling stock, without taking into consideration demand projections from other Statistical Divisions and notably the Perth and lower South-West Divisions.

Labour force projections for the Central and Pilbara Statistical Divisions indicate an increase of 15,000 persons (aged 15 years and over), comprising 6000 males and 9000 females. The male to female labour force ratios are presently in the order of 2:1, and are projected to tighten to a ratio of 3:2 indicating a significant proportional increase in females in the future labour force. Whilst growth in the agricultural, aquacultural, mining and tertiary sectors will provide increasing employment opportunities within the Central and Pilbara Statistical Divisions, significant growth in tourism has the propensity to significantly increase employment opportunities; both directly and indirectly in the service and allied sectors. Coral Coast Resort will contribute significantly, both directly and indirectly, in providing increased employment opportunities within the broader regions.

2.4 Benefits of the Project

Section 2.6 evaluates the merits of Mauds Landing as a preferred location for a major resort facility servicing the Ningaloo Marine Park, relative to other potential locations within the Gascoyne Region. Beyond the obvious benefits accruing to Mauds Landing as a preferred site, there are a broad range of benefits to the greater Gascoyne Region that will derive from the proposed Coral Coast Resort.

Paramount amongst these is the impact that the development and operation of the Coral Coast Resort will have on the "critical mass" of the Gascoyne Region, and more particularly its ability for economic, social and cultural expansion. The development of Coral Coast Resort will present a major achievement for the Gascoyne and is widely perceived and acknowledged as providing a major catalyst for tourism and economic development of the Region. The catalytic effect of Coral Coast Resort is widely agreed in the communities of both Carnarvon and Exmouth and accordingly has received broad-scale support from the business community because of the potential direct and indirect economic and social benefits it will bring to the Region.

The following is an outline of the expected regional benefits of the Coral Coast Resort:

- Total construction expenditure for Coral Coast Resort over the life of the project is presently estimated at approximately $200 million inclusive of major tourist developments (eg. Club Resort and Resort hotel) but exclusive of domestic residential construction. Domestic residential construction is estimated to contribute a further $225 million over the life of the project, at current values. The Coral Coast Resort will provide both a significant and long-term contribution to the construction industry within the Gascoyne, generating not only direct employment and supply opportunities, but also indirect opportunities as a consequence of the multiplier effects due to capital injection into the local construction industry. The Gascoyne Regional Profile (Department of Regional Development, 1988) indicates a multiplier effect for the construction industry of up to 1.6. CCMD is committed, as far as practical, to sourcing both labour and materials locally and in this respect has already embarked on investigations and discussions with potential suppliers in the Region. The multiplier effects and the projected construction expenditure for the Region are significant;

- The level and continuity of projected construction expenditure for the Coral Coast Resort provides the Gascoyne Region with the unique opportunity to establish new construction-related industries not presently viable within the Region. Beyond the more obvious opportunities in materials handling and supply, the opportunity exists for both the expansion and creation of major new construction industries such as brick and block making, door and window fabrication, steel fabrication, joinery and equipment hire. Continuity of demand presented by the Coral Coast Resort would enable the progressive development and expansion of such industries within the Gascoyne, thereby not only ensuring retention of a greater percentage of construction income within the Region itself, but also as a consequence, significantly improving the multiplier effect of construction expenditure in the Region. More importantly, the positioning of the Gascoyne relative to the Kimberley, Pilbara and mid-West Regions provides the opportunity for such industries to become, over time, major suppliers to construction industries in adjoining Regions;

- Greater self-sufficiency within the Gascoyne construction industries can only lead to greater consumer choice within the Region as a consequence of increased competition. Additionally, it seems more than likely that a high level of self sufficiency is likely to result in a reduction in relative construction costs within the Gascoyne and adjoining Regions, largely as a consequence of the reduction in transport costs of materials and services, particularly from Perth;

- Projections for Coral Coast Resort indicate a total visitation level at completion of some 750,000 visitor nights per annum to commercial accommodation, or approximately 40% of the projected growth for the Gascoyne Region. Assuming comparable levels of expenditure to the adjoining Pilbara and Kimberley Regions, Coral Coast Resort alone will result in the injection of some $45 million per annum of tourist expenditure to the Gascoyne. More importantly, the projected increases in total visitation to the Gascoyne Region estimate that up to an additional 1.5 million visitor nights per annum would be spent in the balance of the Gascoyne Region, notably Shark Bay, the Carnarvon and Exmouth districts. An additional 1.5 million visitor nights within the balance of the Region represents an increase in tourist expenditure of some $90 million per annum. Economic multipliers for the Gascoyne Region suggest a factor of up to 1.7 for the entertainment and recreation industries, of which tourism is a part. An annual increase in visitor expenditure by $135 million in the Region therefore equates to an effective

increase in income of in excess of $200 million, a significant proportion of which would remain wholly within the Region;

- Increasing interstate, and more particularly international visitation to the Region, would significantly reduce the seasonality of the present tourism market particularly during the off-peak through increased international visitors, and those escaping the northern winter. Because of the variety of attractions provided within a relatively short distance, the Region additionally has the potential to develop as an alternative destination for interstate tourists to places such as Queensland, far north Queensland and the Great Barrier Reef, further improving occupancy levels, particularly in the shoulder periods;

- Increased visitation and promotion of the Gascoyne Region will inevitably lead to greater interstate and international awareness of the Region, not only as a tourist destination, but also of the Region's produce, notably its horticulture and aquaculture. Increased awareness will inevitably also lead to increased interstate and international flights into the Region, substantially expanding present export opportunities (particularly in respect of fresh produce). It is anticipated that in the initial stages Coral Coast Resort will result in two Boeing 747 services to Learmonth per week, increasing to up to five 747 services per week at maximum development. Each flight would have a cargo capacity of between 10 and 15 tonnes representing an export capacity of between 20-30 tonnes per week in the initial stages, increasing to between 50-75 tonnes per week. Export opportunities presented to Gascoyne industries as a consequence of this increased export capacity is substantial in the context of both the national and international markets, particularly South-East Asia. The industries best poised to capitalise upon this capacity are the horticultural and aquacultural industries, particularly the export of fresh and live produce to South-East Asia. The opportunity is also presented for the development and expansion of new produce industries, notably meat and floraculture. The opportunities for expansion of primary produce industries within the Gascoyne are similarly substantial, leading to a broadening and stabilisation of the economic and employment base of the Region. With vision, opportunities would also be presented for the establishment of export-oriented manufacturing bases to establish in the Gascoyne;

- Increased construction activities and tourist visitation combined with increased residential opportunities within the Region will, from a longer term perspective, also substantially expand economic and employment opportunities and related service

industries, both directly as a consequence of increased structural and tourist expenditure, and indirectly by increased resident consumer expenditure. Opportunities therefore exist for substantial expansion in the services and trade sectors, broadening the economic and employment base of the Region;

- The resulting increase in overall economic activity will clearly benefit the residents of the Region through greater access to goods and services together with the ability for major suppliers to locate in the Region, resulting ultimately in better choice through competition and reduced living costs through reduced importation; and

- Collectively, the benefits that will accrue to the Gascoyne Region as a consequence of the catalytic effect of Coral Coast Resort provide the residents, not only in the Gascoyne but the North-West generally, with a greater opportunity to reside, recreate and retire in the Region.

Without doubt, Coral Coast Resort has the capacity to be a major catalyst to the economic development of the Gascoyne Region and as a consequence thereof to its social and cultural development. Increased economic activity through tourism, combined with reduced economic leakage to other Regions (notably Perth), will provide the foundation for broadly based balanced and sustained growth and, most importantly, achievement of a much higher level of economic, social and cultural self sufficiency.

2.5 Specific Benefits to Coral Bay and the Community

Many of the Regional benefits of establishing the Coral Coast Resort outlined in the previous section apply equally on a local basis. By virtue of its proximity, Exmouth is well positioned to capitalise upon the benefits of the Coral Coast Resort in terms of the expected stabilising and broadening of the local economic base, and as a consequence thereof, increasing support to recently proposed major developments in the town including the Exmouth Marina and Tourist Precinct.

Specific local benefits of the Coral Coast Resort can be divided into two broad categories; benefits relating to the existing Bills Bay Settlement, and benefits to the immediate district. In relation to the existing settlement at Bills Bay, the Coral Coast Resort provides the opportunity to mitigate existing problems including:

- Overcrowding during periods of peak visitor demand;

- Leaching of effluent-borne nutrients into Bills Bay and the Maud Sanctuary Zone, which is believed to be damaging the coral communities, by connection to the sewage treatment plant at some future time;

- The opportunity for the removal from Bills Bay of all boating activity other than coral viewing boats, and thus preventing further physical damage to the coral formations, significantly reducing the risk of fuel spills, and significantly increasing the safety of swimmers. This opportunity to substantially reduce boating activity in Bills Bay may be considered beneficial in regard to the increase in the passive character of recreational opportunities which are presented by the Bills Bay environment and landscape;

- A lack of any substantive community services or facilities; and

- Improved boating safety as a consequence of easier access to the "north passage" in preference to the more dangerous "south passage".

These benefits are recognised in the Coral Bay Planning Strategy (DPUD, 1992).

In terms of onshore development, the Ningaloo Marine Park Management Plan 1989-1999 (CALM, 1989) recognises that:

"Sites at Mauds Landing and Tantabiddi Creek offer potential for marine developments likely to provide valuable services to Park visitors. " (p.55),

subject to consideration of the merit of individual proposals, environmental assessment and the requirements of CALM.

Taylor (1994), in an assessment of the current threats to the Ningaloo reef, considered that a resort at Point Maud may be the saviour of Coral Bay, and that a good case exists for all future development to be at this site, well away from the corals at Bills Bay.

Local benefits of a broader nature include:

- The opportunity for the relevant authorities, notably the Department of Conservation and Land Management and the Department of Fisheries, to develop and institute more effective management controls on the Maud Sanctuary Zone and the Ningaloo Marine

Park as a consequence of a permanent on-site presence, better control of recreational fishing, adequate surveillance of recreational boats and the opportunity to restrict boat activity in Bills Bay, greater control of marine safety, substantially safer boat access and management, and substantially improved boat handling and launching facilities;

- Through the provision of a Visitor and Research Centre by CCMD, the opportunity for the Authorities, notably the Department of Conservation and Land Management, to undertake a much higher level of research into the Ningaloo Marine Park while at the same time increasing visitor awareness and education of the Ningaloo Marine Park and the marine ecosystem;

- The ability for the Department of Conservation and Land Management to substantially increase its revenue sources from the Ningaloo Marine Park through both entry fees to the visitor centre and increased and better control over tour and charter operators in the Marine Park;

- Significant improvements in the management of effluent, nutrients and waste disposal, reducing the potential impact of leachates on the marine environment;

- The provision of technically advanced utilities (power, potable water and effluent disposal) and enabling potential future connection of the existing Bills Bay settlement;

- The availability of significantly expanded and improved community services to residents, tourists, and local pastoralists;

- The establishment of a broad range of community facilities including public utilities in conjunction with State Government or Local Government;

- Elimination of the pressures for further expansion of Bills Bay to cater for increasing demand for both short and long-term accommodation and the relieving of present problems of overcrowding;

- Introduction of greater competition in the provision of goods, services and consumables;

- The construction of substantially improved airstrip facilities;

- Increased local employment opportunities, broadening and diversifying the local economic base and reducing present seasonality; and

- Substantially increased opportunities for the development of local businesses in the tourism, services, maintenance and retail sectors.

There is little doubt that the proposed Coral Coast Resort will substantially improve the present environmental and socio-economic status of Bills Bay to the ultimate benefit of the marine ecosystem, as well as providing the relevant Authorities with the opportunity to better manage and control the inevitable increase in tourist demand to this location.

More importantly, the Coral Coast Resort will provide a broad range of community infrastructure not presently available nor likely to be available within the foreseeable future, to the benefit of residents, pastoralists and visitors to the area. The involvement of the private sector in the establishment of this community infrastructure will significantly reduce the requirement for State and Local Government expenditure.

2.6 Evaluation of Alternatives

2.6.1 Coral Coast Resort Profile

The preceding sections demonstrate that the Gascoyne Region is entering a period of significant change in respect of demographic composition and tourism potential, and highlighted the major demands for tourist and residential accommodation in the Pilbara and Gascoyne Regions. The following information is presented to allow an evaluation of alternatives in context with the level of development proposed.

It is clear that the Gascoyne Region is on the brink of entering into a period of significant development, particularly in regard to its tourism potential. It is in this respect that the Coral Coast Resort is seen as a major catalyst to the realisation of the Region's potential, and in managing the inevitable influx of visitors in an environmentally appropriate manner.

The success of any major tourism development on the North-West Cape will rely upon attracting both interstate and international visitors through Learmonth Airport, particularly in the short to medium term. Learmonth is geographically better placed than any other Australian airport for attracting visitors from the Asian region, being typically within 3 hours flying time of major

South-East Asian destinations as well as being within the same timezone. Feeder time from Learmonth Airport to other major destinations in the Gascoyne Region are short, being 15 minutes by road to Exmouth; 1 hour by road to Mauds Landing and 1 hour by feeder airline to Carnarvon or Shark Bay. The importance and contribution of attracting interstate and international visitors is demonstrated by the experience of Broome which has only limited international airport facilities and, as a destination, is in CCMD's opinion substantially less attractive than Coral Bay/Mauds Landing and the broader Gascoyne Region.

It is expected that initially two Boeing 747 flights per week will be routed from Perth to Singapore via Learmonth and return. Loadings expected are about 150 passengers each from Perth and Singapore per flight with an additional cargo carrying capacity of 10-15 tonnes per flight. Ultimate development of Coral Coast Resort would see the number of flights into Learmonth increased to at least 3 and up to 5 flights per week.

The development of a major resort servicing Ningaloo Marine Park, together with the movement of international flights into Learmonth, is also likely to result in a significant increase in movement of domestic flights, both intrastate and interstate. The advent of interstate and international visitors to the Gascoyne Region would result in a significant impact on existing low hotel occupancy rates within the region, particularly during the summer months. Inbound tour operators have suggested that visitors would travel generally on 5-7 day packages spending up to four days at Coral Coast Resort, with the balance of the time travelling through the Gascoyne Region, notably Exmouth, Carnarvon and Shark Bay.

The ability of the Gascoyne Region and particularly the North-West Cape to attract substantial increases in interstate and international visitor numbers is demonstrated when one compares the attributes of the region with those of other major comparable established destinations in Australia and particularly, northern Queensland/Great Barrier Reef.

It is equally clear that a major resort townsite is needed to provide not only the catalyst but also to successfully manage this growth. It is considered that Coral Coast Resort at Mauds Landing provides the best opportunity to achieve these twin objectives.

As further discussed in Section 3 of this Report, it is proposed that Coral Coast Resort would comprise the following principal accommodation elements at full development:

- A Club Resort of 400 rooms;

- Resort Hotel / Convention Centre of 250 rooms;
- Caravan Park comprising 175 bays with an additional 75 chalets;
- Back-packers Hostel of 120 beds;
- 105 Serviced Apartments/Townhouses;
- Approximately 960 Single Residential lots; and
- Approximately 360 Strata Title townhouses/group units.

It is projected that up to 400 residential units would be occupied by the resort staff, as it is anticipated that total staffing requirements would be in the order of 450 to 500 persons. A portion of the remaining residential units would also be available for short-term occupancy when not occupied by the owners. However, it is difficult to estimate this proportion as there will be variation over time, and very likely a decrease towards the latter years of the project. It should be noted further that the total residential accommodation units proposed for the Coral Coast Resort are to be staged over a 15 to 20 year development period.

It is anticipated that at peak development the Coral Coast Resort will provide in the order of 2800 bed spaces representing (at optimum occupancy levels), some 750,000 visitor nights per annum to commercial accommodation or 40% of the projected total visitor night increase for the Gascoyne Region.

It is clear that Coral Coast Resort is a major development, particularly in the context of existing tourist infrastructure within the Gascoyne Region. It is equally clear that a strategically located major resort servicing the Ningaloo Marine Park will be required in order to attract and cope with projected tourist demand and further, for that major resort to be supported by additional tourist development within the existing townsites of Exmouth, Carnarvon and Shark Bay. Assuming the above parameters to be representative of an appropriate major resort, the following discussion identifies and evaluates the alternatives to development of a major resort townsite at Mauds Landing.

2.6.2 "Do Nothing"

Previous studies in respect of the Gascoyne Region, notably the North-West Cape Tourism Development Study (JLW, 1993), the Ningaloo Marine Park Management Plan (CALM, 1989) and the Coral Bay Planning Strategy (DPUD, 1992) all conclude that natural resources are, in some places, already under severe stress under current levels of visitation. On this basis it is reasonable to conclude that to "do nothing" to manage and control even present visitation levels would be detrimental to the environment, and would not provide adequate support to the existing investment in tourism presently within the Region.

Discussion of the regional tourism profile has indicated the present visitation levels are increasing annually by up to 6% to commercial accommodation, which if typical of the broader visitor spectrum would represent an annual increase of some 135,000 visitor nights per annum. Whilst that portion of visitation increase directed to the Carnarvon and Exmouth townsites could reasonably be accommodated by existing tourism infrastructure within those townsites in the shorter term, it is probable that:

- In the medium to longer term further expansion of existing tourism infrastructure will be required in existing key locations of Carnarvon, Exmouth and Shark Bay; and

- More importantly, significant environmental damage could occur to both the ocean-based and land-based resources of the Gascoyne Region; notably Ningaloo Marine Park and Cape Range National Park, as a consequence of inadequate accommodation and uncontrolled or poorly managed visitor activities in the area.

The North-West Cape Tourism Development Study concluded that:

- *"There is an immediate need for positive action to bring tourism demand and natural resource management into sustainable balance;*

- *There is an opportunity to develop a substantial tourism industry in the Region, of national/international standing, which is also sustainable in terms of the natural resources; and*

- *There is no viable "do nothing" policy as the growing tourism market will not be satisfied and the resource will be in danger of degradation."*

The minimum sustainable development scenario envisaged, in the short term, an increase in bed spaces within the North-West Cape of an additional 3,000 bed spaces. In the longer term the maximum development scenario proposed an increase of close on 10,000 bed spaces. In this context the "do nothing" option may be concluded to be both environmentally and economically untenable and impractical. It would not be possible, nor economically or socially desirable, to constrain present visitation to the Region.

There are a number of direct and indirect benefits accruing from the proposed Coral Coast Resort not only to the Region, but also to Coral Bay and the Ningaloo Marine Park that would not be realised by a "do nothing" approach. These benefits are discussed further, later in this Section.

2.6.3 Carnarvon

This alternative proposes the development of a major resort facility comparable to the Coral Coast within or adjoining the existing township of Carnarvon.

While the projected growth in tourism visitation to the Gascoyne Region will require expansion and upgrading of tourist infrastructure within Carnarvon, CCMD's research leads to the conclusion that Carnarvon would be unable to sustain a major resort development for the following reasons:

- The Gascoyne Coast Regional Strategy (Draft, November 1994) notes that the prime tourist attractions of the Gascoyne Region are located outside of Carnarvon and principally to the north - namely Ningaloo Marine Park/Coral Bay and Cape Range National Park. The Working Paper notes that growth in tourism in the Carnarvon townsite will stem from through-traffic to and from areas to the north and that it is unlikely that expansion of the North-West tourist market would produce large increases in tourist numbers to Carnarvon. The Working Paper also notes that better promotion of the attractions of Carnarvon, the development of a more distinctive tourist image and developments such as those proposed for the Fascine would improve the attractiveness of Carnarvon as a tourist centre enabling it, in essence, to capitalise on the broader regional tourism growth;

- Carnarvon Airport, whilst capable of handling intrastate domestic aircraft, does not have the engineering capability to accommodate international or interstate aircraft. As discussed previously, the success of any major tourism development on the north-west

will rely heavily upon attracting interstate and international flights. While it may be possible to shuttle interstate and international visitors from Learmonth to Carnarvon, Carnarvon's distance from the prime attractions continues to mitigate against its function as a major "staging post" for the broader region.

Accordingly, Carnarvon is not considered a viable alternative for the development of a major resort to service the Gascoyne Region. In addition, the much needed environmental management benefits which will accrue to the existing Coral Bay settlement, and for the future visitors to this area, as a result of the Coral Coast Resort proposal could not be realised in the event that Carnarvon was selected as an alternative location.

2.6.4 Exmouth

This alternative would comprise the development of a major resort facility comparable to Coral Coast Resort within or adjacent to the existing Exmouth Townsite.

In comparison to Carnarvon, Exmouth has a greater propensity for significant infrastructure development because of its proximity both to Learmonth Airport and Cape Range National Park. Additionally, its position relative to the Ningaloo Marine Park and as a springboard to the Muiron Islands has enabled the development of significant offshore tourism activities associated with the Marine Park, notably whale watching, diving and fishing.

However, two principle factors mitigate against the development of a major tourist resort at Exmouth, namely:

- Exmouth is approximately 1.5 hours by road from Coral Bay, which is recognised as a key tourist destination within the Region because of its unique marine environment and the ability of visitors to readily access and view coral formations and associated marine life. Whilst it would be feasible to operate day or overnight tours to Coral Bay using Exmouth as a staging-post, it is most unlikely that this approach could contain pressures for substantial expansion of tourist accommodation and infrastructure at Coral Bay; and

- The barrier effect of Cape Range results in Exmouth experiencing a more severe climate, particularly during its summer months, making it a less attractive location in comparison to the Mauds Landing site.

While it is expected that Exmouth will experience considerable growth in tourism and tourism infrastructure development as a consequence of Coral Coast Resort, it seems most unlikely that Exmouth could sustain a major resort development such as Coral Coast in its own right. However, it is envisaged that there would be significant growth in visitor numbers to Exmouth as a consequence of Coral Coast Resort. This will require the development of additional accommodation together with expansion of tourist services within Exmouth.

Finally, as for the Carnarvon alternative, an Exmouth location for a new resort would not yield the much needed environmental management benefits to the existing Coral Bay settlement, and for the future visitors to this area, which would be realised by utilising the Mauds Landing site.

2.6.5 Bills Bay

This alternative option would comprise the development of Coral Coast Resort at or adjoining the existing Coral Bay Settlement (Bills Bay).

The previously described pressures placed on Bills Bay by the existing settlement which have formed the basis for the proposed Coral Coast Resort at Mauds Landing. It would therefore be illogical to prefer a site at Bills Bay compared to Mauds Landing, as this would serve to intensify and exacerbate the environmental detriments occuring at present.

Beyond this obvious contradiction, there are a number of factors which mitigate against a proposal for extension of the existing Bills Bay townsite to accommodate Coral Coast Resort including:

- Coral Coast Resort development area encompasses approximately 200ha whilst the Bills Bay townsite area in total is approximately 115ha. Of this approximately 25% is occupied by existing freehold and leasehold developments. In effect, there is insufficient area within the existing townsite boundaries to accommodate the resort;

- The position, status and condition of the existing development at Bills Bay would present an incongruous and undesirable contrast against a new major resort, from both a design and aesthetic viewpoint;

- The existing development and landform would preclude the achievement of key objectives of the Coral Coast Resort including the removal of boat harbourage from

Bills Bay to inland marina facilities, the provision of adequate public swimming areas free from risk from boat movements, and the reduction of both physical and environmental pressures on the marine environment of Bills Bay.

These factors lead to the conclusion that the development of a major tourist resort at Bills Bay is neither a viable nor desirable option. This conclusion is supported by the Coral Bay Planning Strategy (DPUD 1992), which proposed only minor extensions which in turn are contingent upon adequate planning, management and the provision of appropriate service infrastructure. Accordingly, this alternative is discounted.

2.6.6 Mauds Landing

The evidence presented in this report identifies Mauds Landing as the most viable option for the development of a major tourist resort to service the Ningaloo Marine Park.

As a location adjoining the Ningaloo Marine Park, Mauds Landing is already experiencing significant tourist visitation and usage. The proposed site is acknowledged as having a comparatively very low bio-diversity as a result of previous grazing. The site is also provided with sealed road access to the Region. Accordingly, it obviates the need to disturb other more pristine locations which provide a comparable level of access to the features and resources of the Marine Park. Additionally it obviates the costs of providing the necessary infrastructure to achieve access to other Park locations.

Mauds Landing is situated outside of the Maud Sanctuary Zone, and provides the only practical alternative for the establishment of tourist accommodation to satisfy the projected growth. Mauds Landing is within easy travel distance of Learmonth Airport, which has the engineering specifications necessary to accommodate both interstate and international aircraft as well as being relatively centrally located to other major tourist destinations within the Region, notably Exmouth, Carnarvon, Shark Bay and Karijini National Park.

Most importantly, compared to all the alternatives Mauds Landing provides the opportunity for improving the present situation at Bills Bay through:

- removal of major expansionary pressures;

- provision of water, power and most importantly effluent disposal infrastructure to enable the potential for future connection of the existing Bills Bay settlement;

- removal of boat harbourage and associated boat movement from Bills Bay, activities which present risk of physical injury to visitors who swim in the bay and cause anchor damage to the coral reef formations;

- the provision of safe public swimming beaches which are located remote from coral formations;

- provision of safe boat passage to offshore water; and

- the opportunity to implement proper and more effective management controls within the sanctuary zone and within the southern end of Ningaloo Marine Park.

Coral Coast Resort will also provide both the Gascoyne Region and the more local districts with a number of other major benefits, both economic and social, which are discussed elsewhere in this Section. On the basis of the information presented here, the Mauds Landing site is concluded to be the most suitable location for the development of a major tourist resort to service Ningaloo Marine Park.

3.0 DESCRIPTION OF THE PROPOSAL

3.1 Overview

The Coral Coast Resort at Mauds Landing is proposed as a Resort townsite providing a broad and extensive range of short-stay, holiday and residential accommodation, together with sport, recreational, tourist and commercial services in a location which has an ideal climate and is becoming widely acknowledged as a premier tourist and recreational destination.

The need for Coral Coast Resort has been driven by the requirement to develop substantial tourist facilities of international standard adjacent to the Ningaloo Marine Park, and to accommodate rapidly expanding visitor numbers to the Region and its major attraction, the reef environment. The existing townsite at Bills Bay, which is situated adjacent to the Maud Sanctuary Zone (within the Ningaloo Marine Park), does not have the physical nor environmental capacity to sustain a significant increase in the visitor numbers nor to provide facilities at a national, or international standard. Coral Coast Resort provides the best opportunity and resources for effectively managing growth, whilst at the same time limiting the impacts of human pressures on the Park.

As a Resort townsite in a remote location, it is also incumbent on Coral Coast Resort to provide the necessary community services and infrastructure to support the proposed development. As a Resort townsite it is neither the intent nor desire of CCMD to create a conventional township which would compete with the existing townships of Carnarvon and Exmouth. The Coral Coast Resort is designed solely as a Resort townsite with its services and facilities selected and scaled to that purpose. The broader district and regional functions will continue to be provided from the existing regional centres of Carnarvon and Exmouth. In short, Coral Coast Resort at Mauds Landing is complementary to the regional hierarchy of the Gascoyne, and will provide the Region with a major catalyst for its economic and social development.

The following sections describe in detail the components of the Coral Coast Resort, the services and utilities necessary to sustain the townsite, the management and maintenance structures and responsibilities, and the potential impacts of the proposed development, together with appropriate and necessary management strategies and the proposed staging and implementation programme. Detailed engineering considerations are presented in Appendix B.

Table 3.1 provides a broad breakdown of the Coral Coast Resort project by its major landuse components.

TABLE 3.1
Coral Coast Resort - Breakdown of Broad Landuse Components

SITE AREA	
Maud's Landing Townsite	250 ha
Extended Area – Golf Course/Sports Ground	22 ha
Services/ Light Industrial	5 ha
Gross Area	277 ha

LAND USE	AREA (ha)	%
Dune Conservation	28.4 ha	10.3
Golf Course	65.0 ha	23.4
Country Club	3.1 ha	1.1
Marina	45.0 ha	16.2
Club Resort	10.9 ha	4.0
Resort Hotel & Convention Centre	5.5 ha	2.0
Caravan Park	8.0 ha	2.9
Chalet Park	3.0 ha	1.1
Backpackers Hostel	1.0 ha	0.4
Serviced Apartments	1.3 ha	0.5
Town Centre	4.0 ha	1.4
Service Station – Auto/Marine Rep	0.6 ha	0.2
Community/Emergency Services	2.3 ha	0.8
Schools Complex	2.0 ha	0.7
Administration	0.5 ha	0.2
Sports & Recreation Ground	8.0 ha	2.9
Neighbourhood Parks	1.0 ha	0.4
Major Roads & Parking	6.4 ha	2.3
Residential :		
West Marina Estate	31.0 ha	11.2
East Marina Estate	39.0 ha	14.0
Western Beach Estate	6.0 ha	2.2
Services/Light Industrial Area	5.0 ha	1.8
TOTAL	277 ha	100.0%

Figures 1.1 and 1.2 illustrate the regional location of the site and its local setting respectively. Figure 1.3 (in the rear pocket of this document) presents the Master Plan design concept of the proposal, whilst Figure 1.4 shows an artistic impression of the completed development in its surrounding landscape.

3.2 Project Components

3.2.1 Marina

A key element of Coral Coast Resort is the development of an inland marina forming the focal point to surrounding development and providing for safe boating and swimming facilities, while maximising the interface and potential enjoyment of the marine environment and adjoining landuses.

The marina will be linked to Bateman Bay by a 110m wide entrance channel, and will feature 3 associated breakwater structures extending for approximately 400m and situated about 750 metres north of the old Mauds Jetty. The marina has a total area of approximately of 45 hectares, and is proposed to be excavated to a minimum water depth of 3.5 metres so as to accommodate all recreational craft of reasonable draught under normal tidal variations.

The size of the inland marina and associated waterways is governed both by aesthetic factors and the need to generate sufficient earth-fill material in order to raise the surrounding development above cyclonic storm surge levels and cyclonic rainfall levels. The fetch or orientation of the marina has been designed to maximise wind mixing and circulation of contained waters.

The inland marina has been designed to maximise the interface between the waterways and the surrounding development area. From the main entrance channel it is proposed to create four major embayments around which the principal development components are focussed (Figure 1.3). The marina/development interface is for the most part proposed as beaches similar to those created within the Hillarys Boat Harbour. The horizontal width of beach sand areas will vary from approximately 10-30 metres under typical tidal conditions, and the principal embayments will be shark-netted to ensure safe swimming conditions. Private and commercial boating will be limited to the core marina area, either in pens or in the case of trailer-borne craft, to four boat launching ramps and associated boat trailer parking facilities situated to the immediate west of the Resort Town Centre.

Analysis of cyclonic storm events and cyclonic rainfall events indicate that development adjoining the marina will need to be set at a minimum building floor level of RL 2.7 metres AHD in order to provide an adequate safety factor from maximum sea levels arising from cyclonic storm surge. Extending outward from the marina interface, minimum building floor levels would be set at RL 2.3 metres AHD to provide an adequate safety factor against cyclonic rainfall effects. The need to fill development areas to safeguard against cyclonic storm and flood events requires that the existing landform is raised in elevation by between 1.5 and 2.0 metres, generating a total fill requirement in the order of 2 million cubic metres. This fill will be generated wholly from the excavation spoils from the construction of the marina and predominantly comprises fine to medium grain calcareous sands.

Projections of total recreational and commercial boat usage indicate a maximum of 530 craft within the Resort, comprising either trailer-borne craft or craft temporarily or permanently penned within the marina including commercial/charter vessels. These estimations are based on a ratio of boat ownership approximately 25% higher than that at Exmouth, about 7% higher than Mandurah, and three times the State average, and could therefore be considered to be generous. At full development a total of up to 200 public or commercial pens are proposed in the vicinity of the Town Centre, or private pens limited to the core area of the marina adjacent to areas of hard-walling. An additional 100m (approximately) of public jetty would also be supplied. It is estimated that at any one time, between 150-200 vessels may be in use, which is similar to existing boating activity at Bills Bay where up to 120 boats may be harboured during peak periods.

The entrance channel to the marina is expected to provide safe, all-weather access to the deeper waters of Bateman Bay. Given the littoral sand transportation and wave regimes, oceanographic engineering investigations indicate that minimal sedimentation is expected within the entrance channel and therefore little requirement is expected for sand by-passing at the entrance breakwater structures. Flushing of the marina waters will be achieved by a combination of wind and tidal action. Under normal conditions, it is expected that total water exchange would occur every three to four days. Oceanographic investigations in regard to the design and maintenance of the marina and entrance structures are described in more detail in Section 6.

The inland marina and associated waterways/embayments are a major feature of the Coral Coast Resort, providing a pleasant setting for the surrounding development as well as providing recreational opportunities. Extensive public beaches forming the interface between the marina and development areas will provide safe swimming for both visitors and residents, and will

reduce congestion at Bills Bay. Additionally, the marina will provide the opportunity for appropriate State Government authorities to relocate boating from Bills Bay, other than coral viewing boats, to the marina. Such action would arrest damage occurring to coral formations from boating, and free Bills Bay for passive water-based recreational activities. The marina also provides the opportunity for the appropriate Authorities to directly and effectively manage recreational boating, including marine safety and recreational fishing control, by observation and policing at the marina launch ramps and jetties. This management effort could be optimised for the whole area, if the appropriate authorities determine that launching and mooring in Bills Bay could not continue.

A principal feature of the proposed marina is the creation of a "coral garden" adjoining Town Beach, the large swimming embayment to the immediate east of the Town Centre. It is intended to establish "a coral garden" within the embayment comprising both soft and hard corals adjoining the Ningaloo Marine Park Visitor and Research Centre, which will be situated within the adjoining Town Centre and operated by the Department of Conservation and Land Management. The establishment of coral formations within this embayment will provide CALM with the opportunity of more closely researching the development and management of coral ecosystems as well as providing visitors to the Resort with the opportunity to safely observe the coral formations, thereby further reducing the pressures on the Maud Sanctuary Zone. The successful maintenance of a coral community within the marina will require the highest level of water quality. Accordingly, the stormwater collection system for the project area around the marina will be designed to drain away from the marina for appropriate management onshore (see Section 6). Combined with marina design for optimum marina flushing, this segregation of potential contaminants will optimise water quality within the marina and will prevent direct entry of stormwater and entrained contaminants to Bateman Bay and Ningaloo Marine Park.

The design, construction and management approaches and procedures which will be employed to minimise the potential for environmental impact during the construction phase are detailed in Section 5. Water quality within the marina and nearshore environment will be monitored on a regular basis in accordance with a monitoring programme (see Section 7), as will sediment movement in the marina basin and areas adjacent to the breakwaters.

3.2.2 Tourist Accommodation

The Coral Coast Resort proposes a broad range of tourist accommodation to cater as fully as possible for the broad spectrum of tourist needs. In total, it is proposed to provide 1125

dedicated short-stay "sleeping-units" ranging from back-packers facilities through to an international-standard Resort hotel providing a cumulative total of approximately 2800 bed spaces at maximum development. Tourist accommodation sites total approximately 29.7ha and are focussed around the marina core and Town Centre areas. The specific components of the major tourist accommodation proposed within the Coral Coast Resort are described below.

3.2.2.1 Resort Hotel and Convention Centre

The Resort Hotel/Convention Centre will be developed in the second stage of the project program, and will be the highest standard accommodation available in the Resort, providing a range of room qualities from three to five star with typically three star service. The proposed Hotel will include:

- 250 rooms including executive suites;
- Licensed restaurants;
- All necessary supporting facilities;
- External pool/recreational courtyard areas extending to the beach;
- Conference and function facilities; and
- Car and coach parking.

The proposed Resort Hotel/Convention Centre site adjoining the marina core is a location which will ensure water views from virtually all rooms. The buildings will generally be low-rise of two to three storeys with central recreational facilities proposed on the south-western side of the site, providing a protected pool and courtyard area from the prevailing summer winds. The pool/courtyard area will also extend to the beach on the north-eastern side providing safe swimming in the eastern embayment.

A boardwalk link across the marina from the Resort Hotel site is proposed, with public circulation in the western part of the marina also via a boardwalk. This area will also provide docking facilities for charter boats.

The Resort Hotel will be situated in close walking distance from the Country Club, which is to be the focus of recreational and sporting activities for the Resort. Access to the Country Club from the Resort Hotel would be via a short, tree lined pedestrian link possibly with an underpass beneath the perimeter road.

3.2.2.2 Club Resort

The Club Resort is proposed to be developed in two phases, with the first phase of 250 rooms occurring as part of the first stage of development of Coral Coast Resort. The Club Resort will provide three to four star accommodation of international style and will be located between the Town Centre and Resort Hotel/Convention Centre with direct access to both and to the main town beach and Coral Garden. The Club Resort also has ready access to the Country Club via pedestrian linkages and an underpass beneath the perimeter road. It is proposed that the Club Resort be a maximum of two storeys with open pedestrian circulation through extensive and sympathetically landscaped grounds. The Club Resort complex will provide:

- Initially 250 rooms/bungalows with the capacity for future expansion to a total of 400 rooms/bungalows, predominantly oriented to family accommodation;
- Restaurants;
- Function room facilities;
- Swimming pool areas with direct access to Town Beach;
- All necessary supporting facilities; and
- Car and coach parking.

3.2.2.3 Serviced Apartments

It is proposed to incorporate two self-contained, serviced apartment complexes totalling 105 units within the Resort. The primary site is proposed to be located within the Town Centre to take advantage of this outstanding site and also to promote activity within the Town Centre. These units will be primarily in two storey format with some upper floor units extending over

ground floor commercial space. Internal courtyard facilities will provide localised recreation including a pool and a total of 75 units are proposed within the Town Centre complex.

A second complex of serviced apartments comprising a total of 30 two storey waterfront townhouses are proposed to the immediate west of the Town Centre adjoining the Caravan Park and beach, with direct access to the Caravan Park beach and swimming area, and will enjoy extensive views over the Town Centre and marina core area.

It is intended that construction of the Serviced Apartments will be undertaken progressively over the first stages of the Resort.

3.2.2.4 Caravan and Chalet Park

A Caravan Park of approximately 8ha is proposed to the immediate south-west of the Town Centre, supported by an independent but co-operated Chalet Park of approximately 3ha. The Caravan Park will directly adjoin its own safe swimming beach, and is proposed to comprise a total of 175 bays with supporting camping and coach camping areas. The Caravan Park will be intensely landscaped to provide extensive shade, and its central location to the Resort will promote a high level of pedestrian activity thereby minimising traffic generation in the Resort townsite. The adjoining Chalet Park comprises approximately 3ha and is proposed to provide a total of 75 chalets/park cabins. These chalets will vary in size from 60 to 90m^2 with a typical chalet being approximately 75m^2 of two bedroom configuration, fully self-contained and providing sleeping for four persons.

It is intended that construction of the Caravan and Chalet park be undertaken as part of the first stage of the Resort, and will form the main construction camp in the initial years of construction.

3.2.2.5 Back-Packers Hostel

A site of approximately 1ha is provided immediately adjoining the Town Centre and the main town beach for back-packers and youth accommodation. It is proposed that the back-packers Hostel provide a total of 120 beds and its location immediately adjoining the Town Centre will ensure a high level of convenience and access, thereby providing an ideal location for back-packers who typically do not have their own transport. It is proposed that the back-packers hostel be of varying one and two storey configuration, supported by necessary facilities including cooking and laundry.

Construction of the back-packers hostel is proposed in two phases in the first and middle stages of Resort development.

3.2.3 Residential Accommodation

The Coral Coast Resort is proposed to contain two principal residential precincts on the eastern and western margins of the marina, situated generally between the marina and the coastal beaches. It is proposed that the residential precincts be developed as innovative, small-lot villages catering for a broad spectrum of residential demand including holiday homes, retirement accommodation and permanent residences. The residential precincts will also cater for staff accommodation of up to 400 dwelling units at maximum development.

Population projections for the Gascoyne and Pilbara Regions indicate a requirement for an additional 10,000 dwelling units over the 15 year period to the year 2010, with the bulk of that demand being likely to be generated by the over 40's age groups, who will be principally seeking holiday and retirement-based accommodation. The Coral Coast Resort provides an ideal residential location because of its climate, broad recreational opportunities, and relatively easy accessibility both by road and air to the services and facilities of the Gascoyne, particularly the townships of Exmouth and Carnarvon.

The majority of lots proposed (55%) are in the range of 350m^2 to 375m^2 and typically 18 metres wide by 20 metres deep. Concessional setback provisions of the Residential Planning Codes will be applied to Residential development within Coral Coast Resort thereby enabling maximum and effective utilisation of the lot sizes proposed. Lot areas have been purposely constrained so as to minimise water requirements for outdoor/garden purposes, to reduce, if not eliminate, the need for application of fertilisers to lawn and garden areas, and to minimise external maintenance requirements.

Larger lots are proposed in specific areas, being typically either lots of 450m^2 (18 metres by 25 metres) fronting the marina, coastal beaches and golf course estate, together with limited pockets of lots up to 600m^2 (20 metres by 30 metres) adjoining the entrance channel, marina core area, the southernmost portions of the western waterway and the island estate. Private pens will be limited to the marina core area and principally the lots adjoining the entrance channel nodes. The vast majority of lots are within short and direct walking distance of the marina beaches and both the eastern and western marina residential precincts are serviced by "pocket parks" typically of approximately 4000m^2, also within short walking distance.

It is proposed through associations with major builders operating in the area, not only to achieve a style of housing most suited to the Resort but also to ensure continuity of design, style and colourings, thereby achieving a relatively homogenous and sympathetic residential environment. To further ensure a high level of sympathetic residential design it is proposed that CCMD, as the Resort Manager, vet all building designs and material schedules.

In addition to Single Residential lots, five Group Residential locations are proposed, three within the Western Marina Precinct and two within the Eastern Marina Precinct. Within the Western Marina Precinct, two group sites of terraced townhouses are proposed along the lower slopes of the existing dunes forming the western amphitheatre. These townhouses will be built into the slopes to accentuate the form of the amphitheatre and providing extensive views over both the Resort and Bateman Bay. It is estimated that these two Precincts would provide approximately 100 units. It is further proposed to develop two secluded cells of villas situated within the two large inter-dunal swales immediately west of the old jetty. These villas would be built along the lower slopes of the separating dune ridges whilst retaining a high level of natural vegetation within the cells and between residential clusters. It is anticipated that these two inter-dunal cells can accommodate up to a maximum of 200 units.

It is anticipated that residential development will concentrate in the West Marina Precinct during the early stages of the Resort with the Eastern Marina Precinct only being developed in the mid to later stages of development as demand requires.

Coastal setbacks to residential development have been determined by extensive investigations and examination of aerial photography for the period 1949 to 1981 (See Section 4). These investigations indicate that the shoreline of Bateman Bay has been accreting at rates varying between 0.1 and 2.6 metres per annum, varying by location, with most of the section of coast adjoining the development having advanced between 10m and 30m over that 32 year period. Accordingly, a minimum development setback of 100m to the vegetation line has been identified as being adequate to protect against the most severe storm events. Actual coastal setbacks vary from a minimum of 120m to residential property lines in the section between the old Mauds jetty and the entrance channel, increasing to between 120m and 160m further north along the coast from the entrance channel. The general line of development is marked by a prominent change in gradient between the foredune and the relict dune plain, and is considered to be the result of a past major erosional event prior to recorded history. Accordingly, all development has been situated within the relict dunal plain.

3.2.4 Commercial and Entertainment

The principal commercial and entertainment facilities will be located in the Town Centre, which is centrally positioned to the Resort and directly accessed from the Resort entry road. The Town Centre overlooks the marina core area and is also the location for main marine services and public boating pens.

At maximum development it is projected that the Town Centre will accommodate approximately 7500m^2 of retail floor space comprising a family supermarket of up to 3500m^2, support convenience retailing of approximately 1000m^2 (newsagency, butcher, delicatessen, liquor store etc), specialty tourist-based retailing of approximately 2000m^2 (clothing, jewellery, souvenirs, etc) and 1000m^2 of specialty services (tour operators, chandlery, personal and financial services etc). Additional to the retail floor spaces proposed, the Town Centre will also accommodate a range of food and entertainment services including a tavern/night club, restaurants/cafes/fast foods, with extensive outdoor seating areas and a variety of amusements. The focal point of the Town Centre is a large piazza situated in the north-east quadrant overlooking the entrance channel, marina core area and town beach, protected from the prevailing summer sea breezes by the principal Town Centre development. As previously noted, it will also contain serviced apartments to encourage and maintain continuity of activity through the Town Centre.

A major feature of the Town Centre is the Ningaloo Marine Park Visitor and Research Centre positioned at the entry and adjoining and overlooking the proposed Coral Garden within the Town Beach embayment. The Visitor/Research Centre will be constructed by CCMD and made available to CALM to operate as a major education and research facility for the Ningaloo Marine Park. With the adjoining Coral Garden, the Visitor/Research Centre will provide CALM with a significant facility, not only for further researching the marine ecosystems of Ningaloo Marine Park, but also providing extensive displays and education programmes for visitors to the Coral Coast Resort. The Centre will also provide CALM with a substantial income source from visitor entry fees, estimated in the order of $250,000 pa in the initial stages, and probably at least twice that amount by full development.

The Town Centre is supported by extensive landscaped parking areas catering for up to 350 vehicles together with tourist coaches. The Town Centre carpark is adjoined to the immediate west by a car/boat trailer carpark, servicing four boat launching ramps with parking capacity for up to 150 boat/trailer units. Provision is also made to the south of the Town Centre for a service station/auto services site of approximately 6000m^2 containing a service station with workshop areas for auto, caravan and marine repairs and services.

3.2.5 Country Club and Community Recreation Facilities

It is proposed that Coral Coast Resort provides a wide variety of recreational activities for visitors and residents, the focal point being a Country Club and an 18-hole public golf course. The Country Club, which is situated near the Town Centre and easily accessed by pedestrians and cyclists from all parts of the Resort, comprises a site of approximately 3.1ha and includes a club house with bars, restaurants, gymnasium, squash courts and saunas; and outdoors, a swimming pool, tennis courts and bowling greens.

The 18-hole golf course is proposed around the townsite perimeter and will be moulded into the existing landform, which together with the unique style of the course, will minimise the disturbance to the natural landform and vegetation and create a course of unique character. The style of course proposed is best suited both to the environment and to the objectives of minimising water use and nutrient management. The proposed layout of the golf course is shown in detail in Figure 1.3 (in the pocket at the rear of this document), and can be summarised as follows:

- 11 holes on the saline flats, some adjacent to (but not encroaching on) the predominantly dry saline lake;
- 5 holes on the relict plain in the north of the site; and
- 2 holes behind the beach ridge in a broad inter-dunal swale in the north of the site.

Public access to the beach will be maintained, formalised and managed in accordance with a Foreshore Management Plan (see Section 7).

Local soils, modified where appropriate, have been shown to produce an excellent growing environment for appropriate grasses when irrigated with artesian water. Fertiliser application to the course is expected to be minimal as analysis of the artesian water by the State Government Chemistry Centre of WA has shown that the mineral composition of the water is ideally suited as a slow release fertiliser.

The application of both water and fertilisers to the course (and other landscaped areas) will be the focus of a detailed Nutrient and Irrigation Management Plan prior to the establishment of the course (see Section 7). The combination of low fertiliser application and stringent nutrient

management, together with shallow groundwater quality monitoring, will minimise any risk of nutrient export to the waters of Bateman Bay.

In addition to the Country Club and 18-hole golf course, it is proposed to develop a large sports and recreation area of approximately 8ha adjoining the Resort main entry road. The recreation area will provide an oval and other grassed playing fields for residents and visitors to the townsite to participate in both formal and informal sporting activities, as well as providing a location for the conduct of special events such as District fairs/shows and concerts. The sports and recreation grounds and the adjoining holes of the golf course have been purposely designed, with the consent of the owner of Cardabia Station, to extend marginally southward of the townsite boundary so as to provide a pleasant entry statement and heighten the sense of arrival. Additionally, location of the sports and recreation grounds as far as possible from the marina serves to minimise the risk of any nutrient movement to the marina waters. The sports and recreation ground, while providing the principal area of open space to Coral Coast Resort, will also be supplemented by smaller strategically located "pocket parks" in the residential precincts and within the inter-dunal swale adjoining the beaches of Bateman Bay.

3.2.6 Community Services and Facilities

As previously noted, it is incumbent upon CCMD to provide the range of community services and facilities required to sustain a Resort Townsite of the nature proposed. In this respect, land for three community-based sites are provided, as described below.

3.2.6.1 Community Services

A community services site of 2.3ha is situated immediately adjoining the Town Centre at the junction of the Resort entry road and the perimeter road. Facilities within the Community Services site are intended to include:

- Emergency Services - Ambulance, Fire and Police;
- Medical consulting facilities for a General Practitioner together with support consulting rooms for visiting Medical Practitioners (eg. Dentist, Physiotherapist);
- Day/Child Care facilities primarily servicing residents of the Town and particularly the Town's workforce;

- An area suitable for the establishment of a Branch Library by the Shire of Carnarvon; and

- Multi-purpose Community Centre facilities incorporating a small hall and meeting/craft rooms.

3.2.6.2 Schools Site

A combined schools site of 2ha is provided adjoining the sports and recreation ground which is located centrally to the Resort on the south-west corner of the main entries to the site. It is intended that the initial level buildings be provided by CCMD for operation by the Education Department providing on-site education support to both Primary and High School students operating via or in conjunction with the School of the Air Programme and Distant Education Programme. The Resort's nature and population does not warrant full Primary School facilities and would not justify a High School. Accordingly, the Combined Schools provides support capacity to the Education Department's remote education programmes. It is intended that the site of 2ha be devoted solely to the provision of necessary building and support facilities as appropriate sport and recreation facilities will be provided on the abutting sports and recreation ground, thereby not only reducing duplication but also minimising water requirements.

3.2.6.3 Administration Centre

An Administration Centre site of 5000m^2 is provided in close proximity to the Town Centre situated on the north-west corner of the main entries to the site. It is intended that the site be developed as Administrative Offices for the purposes of town administration which initially will be undertaken by CCMD, with responsibility ultimately passing to the Shire of Carnarvon. Plant and equipment associated with administration and management functions will be located in a remote Services/Light Industrial Area which is discussed later in this Section.

It is intended that the three Community Services sites be developed in a manner and style sympathetic with the Town Centre and that the buildings be leased to the respective Authorities/Agencies.

3.2.7 Services / Light Industrial Area

The provision of utilities and support services to Coral Coast Resort requires the establishment

of a Services/Light Industrial Area (SLIA) which is proposed to be located approximately 4 kilometres south of the townsite with access from the existing Coral Bay Road. The SLIA occupies approximately 5ha and is situated 1.5 kilometres east of the existing Bills Bay settlement in an inter-dunal swale that is well screened from Coral Bay Road (Figure 1.2). The SLIA will comprise two components, specifically, a major utilities site for power, water and effluent disposal, as well as a secondary small cell of "Industrial" land for development of support and supply facilities including satellite maintenance and service workshops, cold and dry storage facilities for food and other goods and equipment required to sustain the townsite.

The entry road to the SLIA will also provide access to the waste disposal site, which is proposed to be re-located from its present location so as to eliminate the risk of nutrient/leachate movement into Bills Bay. Additionally, access to the re-located air strip will also be achieved from the same road. Re-location of the current air strip is described further in Section 3.11.3.

The location of the SLIA, the waste disposal site, and relocation of the air strip have been discussed with the owner of Cardabia Station, who is in agreement both with their location outside of the townsite boundary and the specific sites chosen.

3.2.8 Development Controls

To ensure that a high standard of development and visual amenity is maintained throughout the townsite, development controls will be imposed and ultimately reflected in Council's Town Planning Scheme. Additionally, all building plans will be required to be approved by CCMD prior to submission for Council for development and building approval.

Height restrictions, building forms and a palette of colours and materials will be nominated so as to ensure a reasonable extent of compatible forms and colours are maintained throughout the development.

Generally, roofs of nominated pitch and parapet forms will be the preferred style of development, with verandahs, colonnades and shade structures encouraged. Materials will be sourced locally, as far as possible, as raw material for re-constituted block work. Limestone extracted from existing quarries at Learmonth and Exmouth is anticipated to be the principal raw material and will become an economical base construction material for walling, retaining walls and primary fencing. Some forms of construction, such as corrugated iron fencing, will not be permitted within the townsite.

Development controls generally within the residential precincts will be as for the Residential Planning Codes with the principal variation being that of the reduced street setback standards provided for by the Codes. It is not intended, nor is it desirable from a long-term management perspective, to develop a detailed set of site planning requirements for residential development within the Resort. In respect of commercial and tourist based developments, it is proposed that developments generally be considered on their merits and that a high degree of flexibility in site design and building layout be allowed, consistent always with the requirements of the Building Code of Australia.

Though not intended as a specific development control, it is also the intention to encourage, particularly within the residential areas, landscaping that is consistent with the natural landform and vegetation and which conserves water use. Accordingly, it is proposed to develop residential landscaping guidelines identifying suitable species of grasses, shrubs and trees as well as identifying principles of residential landscape design that maximise building orientation and climate control.

3.3 Land Tenure

The Mauds Landing townsite is currently Vacant Crown Land and therefore under the control of the Minister for Lands. However as previously discussed, the site is the subject of a Heads of Agreement between the State Government (Minister for Planning and Minister for Lands) and Coral Coast Marina Development Pty Ltd.

3.4 Project Staging and Population Growth

As previously noted, the development of Coral Coast Resort is anticipated to occur over a 15-20 year timeframe. Table 3.2 provides the projected development staging of the various components of the Resort broken into stages of 5 years, together with the ultimate (complete) development scenario. Table 3.2 has been developed for the purposes of planning and extension of utility services, particularly water and effluent disposal, and will vary subject to actual market demand and final design details.

3.5 Stormwater and Storm Surge Management

Rainfall in the area of the site is generally low and inconsistent, with an average of 200mm falling in the May/June period, with erratic falls of high intensity and high volume occurring during cyclone events.

TABLE 3.2
Coral Coast Resort - Projected Development Staging

LAND USE	TOTAL	YR5	YR10	YR15	YR20
Club Resort	400 rooms	400			
Resort Hotel & Convention	250 rooms		250		
Caravan Park	175 bays	175			
Chalet Park	75 chalets	75			
Backpackers Hostel	120 beds	60	60		
Serviced Apartments	105 units	80	25		
Visitors	1980 persons	1440	540		
Town Centre :					
CALM Visitor Centre	500m2	500			
Coral Garden	O	O			
Retail – Conv & Special	7500m2	3000	2000	2500	
Food/Beverage/Ent	2500m2	500	500	1500	
Service Stn/Auto/Marine Rep	500m2	350	150		
Community/Emergency Serv	1500	600	450	450	
Schools Complex	600m2		300		300
Administration	400m2	150	100	150	
Country Club	1500m2	1500			
Golf Course	18 holes	18			
Sports & Rec'n Ground	8.0 ha	4.0		4.0	
Marina	45ha	45			
West Marina Estate :					
Single Residential lots	400 lots	350	50		
Single Dwellings	400 dwel's	110	140	90	60
Strata Dwellings	100 units	25	50	25	
East Marina Estate:					
Single Residential lots	555 lots		300	175	80
Single Dwellings	555 dwel's		130	135	290
Strata Dwellings	60 units			30	30
Western Beach Estate:					
Strata Dwellings	200 units			50	150
Residents	3150 persons	320	770	790	1270
Cumulative Population	5130 persons	1760	3070	3860	5130
Service/Light Industrial Area	5.0ha	2.0	1.5	1.5	
Utilities:					
Water (kl/annum)	2.2 million	1.64	1.97	2.14	2.2
Sewer (m3/day)	1900 m3	850	1500	1800	1900
Electricity (kVA)	8750 kVA	5000	7500	8750	8750

Following previous storm events, the low-lying area east of the development has been inundated for periods of several days or more, extending into the Mauds Landing Townsite. The salt lakes in the east of the site, which lie approximately at sea level and are usually dry, are thought to contain stormwater following rainfall events. Historic evidence exists from cyclone Elsie, a severe tropical cyclone which occurred in June 1967, that flood waters peaked at approximately R.L. 1.8m AHD (surveyed: Surveyor D. Shepherd, 1994). This data has been used to set final minimum building floor and road levels within and adjacent to the development of R.L. 2.3m AHD in the eastern part of the Resort, which allows a safety factor of 0.5 m above previously recorded severe storm events and flood effects. Drainage structures on the main access road will permit stormwater levels to equalise across the road.

Plans from the Royal Australian Survey Corps (1982) indicate that landfill for the Resort development will reduce the area currently available for flooding (about 740 ha) by approximately 10%. This reduction would result in a rise of approximately 0.18m (18 cm) under a storm event similar to cyclone Elsie. The land fill proposed and associated reduction in available flood area should not have a significant effect on existing improvements at Cardabia Station north of the site.

Based on storm-surge modelling for the project (See Section 4), maximum predicted sea-water levels from cyclone events will necessitate that minimum building floor levels adjacent to the marina be set at RL. 2.7m AHD.

The primary design objective in determining final fill level and drainage structures has been to ensure that only major flood events will result in any discharge of stormwater towards the marina and consequently the ocean. Stormwater will generally be disposed by channelled overland flow, directed away from the marina towards the low-lying eastern and recreation areas, with local compensation areas where necessary. The stormwater run-off disposal strategy and anticipated direction of flow are shown in Figure 3.1. The minimum building and fill levels to be set from consideration of sea-water and flood water storm surge levels are consistent with this objective.

In severe storm events some stormwater discharge to the marina and ocean may also occur. It is important to recognise that under these conditions, natural drainages will discharge stormwater to the ocean throughout the region and this stormwater entry may be considered a natural process.

In order to minimise maintenance requirements, piped stormwater systems within Resort town road works will only be used where absolutely necessary.

3.6 Water Supplies

3.6.1 Potable Water Supply

Both the Coral Coast Resort at Mauds Landing and the existing residential and accommodation facilities at Coral Bay Townsite (and its proposed expansion), will necessitate the development of an adequate potable water supply of acceptable quality for all users.

Population trends and water demands for the existing Coral Bay Townsite were the subject of an extensive report prepared for the Water Authority of Western Australia by AGC Woodward Clyde in September 1993. Whilst the report did not specifically include Mauds Landing within its scope, the results are applicable to the area.

The median annual rain fall for Coral Bay which is indicated by records taken over some 14 years at Cardabia Station is approximately 200mm. The rainfall events are highly irregular and characterised by falls of up to 100mm over the May/June period, with the balance in irregular falls usually associated with cyclonic activity. These factors, together with the substantial evaporation losses in the area (up to 3000 mm per annum), lead to the conclusion that the provision of potable water supply based on storage of rainfall runoff is not viable.

Although freshwater to potable standards is not available locally, raw water for treatment to suitable standards is available from several sources:

- Unconfined aquifer groundwater supplies;
- Artesian aquifer groundwater supplies; and
- Sea-water.

Treatment of sea-water for drinking purposes is relatively expensive, therefore raw water sources considered were from the unconfined local aquifers and from the artesian Birdrong formation. These alternatives were examined by project hydrogeologists (Rockwater Pty Ltd 1994, Appendix C), which concluded that the Birdrong sand stone aquifer is the only practical

source for large supplies of groundwater in this region, and that the water will need to be desalinated for drinking and domestic water purposes.

The estimated potable water supply requirements for the Coral Coast Resort are presented in Table 3.3 below. These demands assume the growth of the Resort to be in accordance with the schedule presented in Section 3.4, with appropriate safety factor adjustments.

TABLE 3.3
Predicted Potable Water Requirements

Requirement	0-2 years	3-5 years	6-10 years	11-15 years	16-21 years
Peak Potable Output (m^3/day)	545	854	1476	1774	1890
Average Potable (m^3/pa)	99,000	156,000	269,000	324,000	345,000

The artesian water from the Birdrong formation flows at a temperature of approximately 60 degrees centigrade. Experience using this water (cooled) in the existing Coral Bay Townsite has shown that it is acceptable in its raw form for uses other than drinking, that is, the mix of mineralisation is such that the untreated water is acceptable for bathing, clothes washing, dishwashing and irrigation.

A number of options exist for the supply of water to the Resort, residential accommodation and other purposes, which will be the subject of detailed review as the project progresses. These options include :

- the supply of fresh water only throughout the resort;
- the supply of fresh water for drinking, and cooled raw artesian water for other household purposes; and
- supply of fresh water for drinking and other purposes, and cooled raw artesian water for landscape irrigation only.

For the purpose of this review, peak potable water demands have been assumed to be 250 litres per person per day, with an annual average of half that consumption.

Determination of the option to be implemented will be dependant on a number of factors such as:

- final planning and land use allocation;
- market evaluation of consumer demand; and
- economic analyses, including capital cost but with particular emphasis on operation and maintenance costs.

Options for treatment of the water have been considered (Hi-Tech Water (Australia) Pty Ltd 1994, Appendix D), which concluded that reverse osmosis is the most practical treatment method for the raw water from the Birdrong Formation. Subject to final design, an allowance of 50% system recovery has been allowed in determining source water volumes required throughout the growth of the Resort.

3.6.2 Storage and Reticulation of Potable Water

It is proposed that potable (and possibly cooled artesian) water will be reticulated by gravity to all lots and facilities within the development area. A gravity reticulation system would require a storage at an elevation of about R.L. 32m to ensure that water is supplied in accordance with Water Authority of WA pressure standards.

A suitable site exists to construct a ground level storage tank on Maud Hill adjacent to the resort development. The tank would have sufficient capacity to meet peak demands, with a major ground storage constructed elsewhere and water pump-transferred to the higher level gravity storage. The main storage will either be located at the SLIA, integrated within the development, or split between the two sites. The ultimate storage capacity required will be influenced by the demands of the Coral Bay Townsite.

3.6.3 Landscaping and Golf Course Supplies

Detailed records of average pan-evaporation are not available for the Mauds Landing site, however records maintained since 1975 at Learmonth indicate that average annual pan-

evaporation is expected to exceed 3,000mm. The average evaporation significantly exceeds the average rainfall for all months of the year. In order to ensure land stabilisation, enhance the landscape aesthetics of the Resort, and to ensure an appropriate micro-climate within the built environment, significant landscaping is proposed within the development area. In addition, it is proposed to develop a 18-hole golf course. Irrigation will therefore be required to maintain the landscaped and grassed areas.

By minimising lot and road reserve sizes and the areas to be grassed in the Golf Course, and by maximising use of appropriate paved surfaces, total water demand will be minimised. Nevertheless the Resort will ultimately require a substantial supply of water to satisfy landscaping requirements. The predicted cumulative water demand for the project is given in Table 3.4.

TABLE 3.4
Predicted Cumulative Water Demands for the Project

Cumulative Total Demands (m^3/a)	0-2 Years	3-5 Years	6-10 Years	11-15 Years	16-20 Years
Allow for treatment plant recovery-potable	198,000	312,000	538,000	648,000	690,000
Landscaping (untreated water)	245,000	325,000	430,000	485,000	500,000
Golf Course (untreated water)	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Cumulative Total Demand (m^3/a)	1,443,000	1,637,000	1,968,000	2,133,000	2,190,000

Investigations of the sustainable yield of the Birdrong indicate there is sufficient supply capacity to sustain these demands, and the abstraction volumes proposed for this project would not compromise the supply capacity of the aquifer.

Suitable grasses and vegetation have been shown to thrive at the existing Coral Bay Townsite when irrigated with Birdrong artesian water. Irrigation management techniques specific to this area are required to ensure satisfactory irrigation, however it is practical to irrigate appropriate grasses such as saltene couch, zoysia or similar directly with the artesian water.

It is desirable to reduce the level of soluble iron within the water and to reduce its temperature before irrigation to prevent staining and to minimise irrigation system maintenance. It is proposed that these objectives will be accomplished by passing raw artesian water along artificial stream beds incorporated within the landscaping, and storing irrigation water in sealed ponds strategically located throughout the development. Cooled aerated water will then be distributed throughout the Resort for irrigation as required.

Investigations by the Government Chemistry Centre of WA (1994, Appendix E) indicate that with appropriate management artesian water used in conjunction with the existing soils will provide an excellent growing medium for grasses.

3.6.4 General

Technology is available to allow development of efficient, readily maintained equipment for the supply of potable and irrigation water for the proposed Resort.

Three bores penetrating the Birdrong formation are likely to be required to service the ultimate needs of the development. Construction of two bores within the Mauds Townsite and a further bore near the SLIA would be adequate for the Resort, whilst maintaining appropriate spacing to minimise aquifer draw-down.

Construction of a bore near the SLIA site would provide standby capacity and would allow for the existing Coral Bay Townsite to connect into the Mauds Landing water supply. This is in compliance with the long term objective in the Coral Bay Planning Strategy (DPUD, 1992) to co-ordinate services for the two Townsites. Management techniques and patterns of usage for Coral Bay water supply will need to be well established to obtain maximum benefit from this service co-ordination.

3.7 Sewage Treatment and Disposal

All sewage generated within the development will be collected via a reticulated sewer system and transferred inland to a wastewater treatment plant constructed in the SLIA. The SLIA is located approximately 1.5km by road east of the Coral Bay townsite and about 3.5km south of the Coral Coast Resort site.

The collection method within the resort area may utilise either a gravity or vacuum based system, dependent on economic and maintenance factors. A pressure main will transfer sewage from the resort area to the treatment facility. Design of the reticulation and transfer system will meet Water Authority of WA specifications.

The treatment processes available and disposal considerations are described in a technical appraisal prepared by Hi-Tech Water (Australia) Pty Ltd (1994) and presented as Appendix D. The relatively slow increase in population within the Resort will mean that wastewater generation rate will also increase relatively slowly over the life of the development. It is currently proposed to utilise an extended aeration/activated sludge process which could be developed in a number of forms. These include oxidation ponds or ditches, or package plant format which could be developed in modules as demand grows.

Disposal of the treated effluent will be carried out in accordance with opportunities and constraints imposed by the volume of effluent generated, and with the key environmental management objective that no contamination of the nearshore waters must be allowed to occur in the short or long-term, either by direct (surface run-off) or indirect (groundwater discharge) processes. Shallow groundwater monitor bores will be located down-gradient of all proposed disposal areas in order to monitor and actively manage treated effluent disposal in accordance with this management objective (see Section 7).

Initially, treated effluent generation rates will be small, and will be disposed in the close vicinity of the treatment plant. This disposal may involve small-scale horticultural irrigation re-use to provide animal feed for pastoral uses, and enable nutrient management by plant uptake.

As volumes increase, it may become feasible to return the treated effluent to the resort or to the Coral Bay townsite for use in irrigation of landscaped areas or the proposed golf course.

Management of sewage treatment and disposal can be carried out taking full advantage of the large amount of land available for an acceptable disposal solution, the extremely high evaporation rates which can be utilised, the relatively small amount of treated effluent which will ultimately be generated, and the opportunity for long-term disposal to be conducted remote from the ocean. Early-warning monitoring systems can enable active management of disposal in order to prevent contaminant entry to ocean waters.

A sewage pump-out facility will be provided at a convenient and practical location on the service jetty within the marina for vessel discharge, and wastewater collected will be directed to the main reticulation system for treatment and disposal as previously discussed.

3.8 Power Generation and Transmission

It is currently proposed that energy requirements will be met using reticulated electricity augmented by gas.

Power supply within the Resort will be by underground cable to ensure reliability of supply and aesthetic appearance. A number of options for electricity supply were considered, and those options and staging of power generation installations are discussed in Appendix F by Bassett Consulting Engineers (1994). Following analysis of the options in regard to capital cost, practicality and maintenance, diesel powered generation is the preferred option at this time. The power generation plant will be located in the Services/Light Industrial Area.

The Perth-Dampier natural gas pipeline is located a large distance to the east of Coral Bay and Mauds Landing. Gas demand from even the combined Townsites is considered unlikely to warrant extension of the service from this facility in the foreseeable future. Nevertheless the electrical load projections based on the population schedule assume that cooking facilities will generally utilise gas to minimise electricity generation demands. The mix of electrical and gas powered facilities within the Resort will be subject to future economic analyses with particular reference to minimising maintenance and running costs. Options for gas supply include:

- supply by bottle gas to individual residences and components of the development;
- reticulation within the Townsite from a number of strategically located bottled gas storages; and
- reticulation of the complete Townsite at the time of development with storage at a location which can meet safety regulations and aesthetic objectives.

Recognising that establishment of power generation plant will be incremental and will occur over a twenty-year period, the economics and practicality of incorporating renewable energy sources, including solar and wind power, will remain under review.

3.9 Telecommunications

Telecommunications, telephone, television and radio services have been assessed in the report by Bassett Consulting Engineers (Appendix F). It is proposed to make available the most up to date technology possible in the area for provision of such services.

Installation and upgrading of the facilities will be carried out so as to maximise the opportunities for extension of the existing Coral Bay Townsite facilities.

3.10 Municipal Refuse Disposal

A number of methods for the disposal of solid wastes generated from the Resort and from the existing Coral Bay Townsite have been considered. Controlled landfill is presently considered the most appropriate method of solid waste disposal from both the Mauds Landing and the Coral Bay Townsite. A suitable site has been identified adjacent the SLIA and its progressive development should service the combined Townsites for many years. Allowing access to this tip by existing Coral Bay operators and residents will enable the potential for the existing tip, which is situated close to the existing Coral Bay Townsite, to be closed and the area restored to a more appropriate condition by others. As a result of its proximity to the ocean, the existing landfill site poses a significantly greater risk of leachate entry to the ocean than the site and disposal method proposed for the Coral Coast Resort disposal facility.

Consolidation of sites will enable appropriate management techniques to be used to ensure continuous compaction and fill. The opportunity exists to use some reject water from the nearby reverse osmosis potable water treatment units to assist with compaction and suppression of dust and airborne litter.

3.11 Transport

3.11.1 Road Access

The existing Bills Bay Townsite is serviced by Coral Bay Road which is of a good standard following reconstruction and upgrading in 1990. Coral Bay Road extends some 14km from the Learmonth to Minilya main road to the townsite. The turnoff is located 86km north of Minilya and about 140km south of Exmouth. Good road access is thus possible to the North West Cape and to the North West of the State by the Learmonth-Minilya Road and the recently upgraded

Burkett Road to the North West Coastal Highway. Areas to the south towards Carnarvon are accessible by North West Coastal Highway. The existing main road infrastructure is capable of handling the additional traffic generated by the Resort. Numerous 4WD tracks also traverse the coastal area between Coral Bay and Exmouth.

Main road access into Coral Coast Resort is proposed to intersect with the Bills Bay Road about 5km before Coral Bay Townsite and about 1km beyond the turnoff to Cardabia Station. This location has been chosen to minimise the effect of increased traffic close to the Bills Bay Townsite, to best suit the vertical and horizontal geometry of the existing road in addition to necessary sight distances at the intersection, and to make best use of the existing topography to minimise landfill and raise road levels to ensure all weather access into the Resort.

Internal public roads will be constructed in accordance with Shire of Carnarvon and relevant industry standards. Road reserve widths will be minimised whilst maintaining adequate area for the installation of services to reduce public land requiring stabilisation and landscaping. Common trenching practices will be employed wherever possible throughout the development.

Road pavement construction specifications will be developed to suit the needs of the locality, and will draw on the experience of the Shire of Carnarvon and the regional Main Roads WA officers. Road-making material will be obtained from quarries developed in local limestone ridges where possible. These supplies could be augmented from Trealla Limestone quarries to be developed or expanded to cater for the construction of marina breakwaters, walling, building materials and other uses within the Resort town.

Road construction techniques will need to recognise the constraints imposed by the salinity of waters available for compaction purposes. This will necessitate completion of construction in cooler months and particular attention being paid to bitumen and final aggregate application rates.

Road pavement materials will be selected based on a preference for colours which will blend with the natural and built environments. Sources of suitable final-seal aggregates have been confirmed to be available in adequate quantities from existing Exmouth quarry operations.

Road access within the Resort is provided primarily by a perimeter distributor road system fringing the development and thus ensuring a high level of pedestrian/vehicular segregation. More importantly, the perimeter distributor road serves to facilitate a high level of pedestrian and cyclist accessibility within the Resort as the key services and facilities are located centrally and

within a short walking distance of major tourist accommodation components and within a relatively easy walking/ cycling distance of the two main residential precincts. The high level of pedestrian and cyclist accessibility provided within the Resort will serve to minimise vehicular usage.

As development of Coral Coast Resort progresses into the later stages it is intended to develop and operate a public "transport" system based on the perimeter distributor road. The system is likely to take the form of a diesel driven open tram comprising a small prime mover and carriage, with the main terminal at the Town Centre. The system would be operated on a continual basis during daylight hours and could be expected to provide a 30 minute turn-around service at peak loadings.

3.11.2 Pedestrian/Cyclist Access

The Coral Coast Resort will provide a high level of pedestrian vehicular segregation, together with an extensive pedestrian/cyclist network.

The pedestrian cyclist systems proposed for the resort (Figure 1.3) are concentrated around the marina edge, forming an access promenade to the marina beaches and core resort components. A dual-use path typically of 2.5 metres width and constructed of local aggregates will form the core of the pedestrian/cyclist system expanding into boardwalks adjoining hard edges and into broader pathway systems in heavier traffic areas closer to the Town Centre.

3.11.3 Aircraft Landing Ground

The existing rough-formed landing strip which services Bills Bay is located approximately midway between the existing settlement and Mauds Landing, in the western extent of the low-lying flood-prone area. This landing ground is subject to occasional inundation, and the flight path for aircraft using this strip will be directly over the Coral Coast Resort. CCMD considers the current arrangements to be inappropriate and proposes the relocation of the airstrip to a location which can utilise more suitable ground and flight paths.

A suitable alternative site is to be developed south of the Coral Bay Road and about 1km west of the proposed SLIA site within Cardabia Station. This site would be serviced by an access road developed in conjunction with access to the SLIA. The air-strip will be constructed to gravel standard suitable for light commercial passenger aircraft. A small terminal reception building

and associated car and coach parking is also proposed to assist in passenger handling. It is proposed that the air-strip should be relocated in the early stages of development.

3.11.4 Transport Connections to Bills Bay

The existing Coral Bay Road together with the resort entry road will provide the sole means of vehicular access between Coral Coast Resort and Bills Bay. Additionally, a more direct pedestrian cyclist linkage will be provided between Coral Coast Resort and Bills Bay, generally following the alignment of the existing air strip. Should it be necessary, this linkage can be upgraded to also include a public transport system thereby minimising unnecessary vehicular movement into Bills Bay and between Coral Coast Resort and Bills Bay.

3.12 Townsite Management and Maintenance

CCMD has given an undertaking that infrastructure established as part of the Coral Coast Resort development will be operated and maintained for a minimum period of 5 years from construction or until the relevant Authorities, such as the Local Authority and Service Authorities, wish to take over responsibility for operation and maintenance of the facilities.

Accordingly, and until such time as management passes to the Shire of Carnarvon, it is proposed that a Management Corporation be established to administer and maintain the Coral Coast Resort town area. The Management Corporation will be responsible for the normal day to day services and maintenance of functions that would otherwise be provided by Council, and in particular would include maintenance of roads and pathways, parks and public landscape areas, waste collection and disposal, street and public place cleaning, and the provision of street lighting. The Management Corporation would also be responsible for maintenance of the marina. Whilst the Management Corporation will provide the facilities for the provision of community services, it is not the intent that the Management Corporation provide recreation and welfare services and these will need to be provided by the responsible Authority.

4.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

4.1 Physical Environment

4.1.1 Climate

The climate of the coastal Gascoyne Region is arid, characterised by hot summers and temperate winters. The mean (average) annual maximum temperature is 26.7°C (DCE, 1984) with summer daytime temperatures in the region ranging from the low 20's to low 30's (May *et al.*, 1989). February is the hottest month with a monthly average of 30°C (DCE, 1984). Average winter temperatures are approximately 5°C warmer than those recorded in Perth (DPUD, 1992). As a consequence of its location on the west coast, and in the south of this climatic zone, the climate at Coral Bay is more moderate than that experienced at Exmouth.

Annual rainfall is relatively low, with an average of approximately 200mm recorded at Cardabia Station (abutting the site) between 1976 and 1990. Rain is predominantly associated with cyclonic disturbances in February and March, and consequently rain-events are irregular but sometimes intense, with rainfall variation of 40% on averages from year to year (May *et al.*, 1989). More regular but less intense rainfall occurs in the winter period.

Mean annual evaporation is high (1700-3000mm), and generally exceeds precipitation throughout the year. Consequently, there is no water surplus and no permanent streams originate in the area (DCE, 1984).

Regionally, the synoptic wind patterns are dictated by the intensity and position of the east-west moving high pressure systems, which undergo a seasonal latitudinal migration. In winter they are located in more northerly latitudes (25°-30°S) and generate a south-easterly or easterly airflow, while in summer winds become more westerly or south-westerly as the high pressure cells move to the south and a sub-monsoonal depression forms over the north of the continent.

Storm winds of high intensity in the area are associated with the passage of cyclones, thunderstorms and pressure gradient intensifications. The latter are more prevalent in winter when they can produce easterly gales of two to three days duration. Strong winds from cyclones and thunderstorms may occur in summer and their direction and strength is highly variable and unpredictable.

In a local context, the wind climate of the area primarily results from the superposition of diurnal sea/land breezes over the prevailing synoptic winds. As a result, the prevailing winds in the area are from the south (DPUD, 1992) with brisk southerly sea-breezes occurring on approximately 70% of afternoons (May *et al.*, 1989).

4.1.2 Topography

The Mauds Landing Townsite consists of high parabolic dunes behind the Point Maud coast, low shore-parallel beach ridges behind the Bateman Bay coast terminating beyond the eastern site boundary at the seaward toe of Pleistocene dunes, with a large relict tidal flat behind the dunes and extending to the east. The relict tidal flat is relatively uniform in elevation, and is generally at sea level. The parabolic dune system within the western part of the site behind Point Maud reaches heights of up to 30m (Maud Hill), whilst the relict beach ridges parallel to the coast occurs at maximum elevation of approximately 9m at their southern extent, but are more typically 4-6m AHD. The development areas proposed focus predominantly on the flat land present within the relict tidal flat.

4.1.3 Landforms and Soils

From North West Cape to Gnarraloo Bay the coastal geomorphology consists predominantly of Pleistocene limestones and Holocene sands. These are superimposed on the margin of an anticline of Miocene limestone, which outcrops at several locations as far south as Red Bluff (Wilson *et al.*, 1994).

Hesp (1986) considered Mauds Landing to be on the boundary of a geomorphological sub-region. This region was described as being dominated by parabolic Holocene dunes overlying Holocene relict tidal flats and Pleistocene coastal dunes, alluvial sediments, aeolian plains, dunes and coral terraces. Three large relict foredune plains occur in protected areas of the region.

The predominant landform of Mauds Landing is a relict foredune plain to the seaward side of an extensive relict tidal flat (Figure 4.1). When the sea level was higher than present, the topographic low between Pleistocene and Holocene terrains formed the large tidal flat and associated mangrove system, with an entrance opening near Mauds Landing. Once the sea level fell this became supratidal, and was probably rapidly closed off by foredune formation along Mauds Landing beach, eventually forming a relict feature. The original tidal entrance may be

seen where arcuate, east-west trending dune ridges are present. These ridges originally formed as spits on the margins of a flood tidal delta.

Point Maud itself lies on a prominent foreland, dominated by vegetated parabolic dunes and one active parabolic dune. These overlies relict tidal flats (as described above) and the southern margin of the Mauds Landing relict foredune plain (Hesp, 1986). The south-facing margin of Point Maud has a narrow fringe of foredunes which extend to the Point.

Holocene foredunes, with regular dune ridges, extend northwards along the coast behind a wide, moderate energy beach (DPUD, 1992). The eastern margin of the tidal flat consists of longitudinal desert dunes overlying Pleistocene sands and limestones.

The dominant soil type is a coastal calcareous sand overlying aeolian limestone. Small patches of calcareous loams variable coherency are dispersed throughout (Bethenay *et al.*, 1967). On-site investigation of soil types (Government Chemistry Centre 1994, Appendix E) confirmed this regional description, and identified strongly coherent loamy soils as being characteristic of the salt lakes.

4.1.4 Hydrology

4.1.4.1 Surface Drainage

Approximately 45% of the Mauds Townsite is comprised of sand dunes. Rainfall incident to this landform infiltrates directly into the dune soil profile with accumulation in localised low areas where water is dispersed by infiltration, evaporation, or taken up and transpired by vegetation.

The balance of the site east of the dunes is generally flat and low-lying and storm runoff drains to the south east generally towards the (usually dry) salt lake areas which form a large shallow basin. The capacity of this shallow basin and salt lake system is such that stormwater and runoff from major storm events is collected and stored before eventual dissipation by evaporation, with some infiltration into the shallow unconfined groundwater aquifer. This area collects all surface run-off from Mauds Landing and its hinterland, and has no outlet to the ocean.

4.1.4.2 Groundwater

The hydrogeology of the area is determined by the nature of the shallow strata, coastal features, and the deep strata of the Carnarvon Basin (Allen, 1987). There are two relevant aquifer levels, shallow unconfined aquifers and a deep confined aquifer known as the Birdrong Sandstone formation. Although a detailed hydrological study has never been undertaken in the specific area of the site, the Birdrong Sandstone artesian aquifer is known to be located at a depth of approximately 800m (DPUD 1992, Woodward-Clyde 1993).

Most of the shallow groundwater in the Mauds Landing-Coral Bay area is saline. Bores drilled to depths of 13-60m at distances up to 10km inland from Point Maud encountered water in the salinity range 10,000 to 14,000 mg/L total soluble salts (TSS). Salinities increase from east to west, and reach 35,000 mg/L at depth near the coast where a wedge of sea-salinity water underlies the less saline water. There is also believed to be a thin, shallow lens of fresher groundwater in the area, and an old well near Point Maud is reported to have been capable of supplying 900 L/d (Woodward-Clyde, 1993).

The shallow aquifers receive recharge at infrequent intervals by direct infiltration of rainfall and run-off from hills and ranges, such as the Giralia Range located 27 km inland from Point Maud. Apart from a small area west of Giralia Range and the shallowest water at Point Maud, all the unconfined groundwater in the area is saltier than 6,000 mg/L TSS, indicating that saline groundwater is being diluted very slowly, if at all (Rockwater, 1994).

Beneath the site, shallow groundwater flows from east to west towards the sea. The flat topography near sea level elevations and shallow groundwater depths observed beneath the salt lake flats indicate the water table is very flat and flow rates are likely to be extremely small.

The deeper, confined Birdrong aquifer extends throughout most of the Carnarvon Sedimentary Basin (Shark Bay to Onslow) and extends over approximately 77,000km^2 on-shore. This aquifer is the source for the Denham town water supply as well as for the salt mining operations at Lake MacLeod and Useless Loop (DPUD 1992, Woodward-Clyde 1993).

The two caravan parks at Coral Bay each have a bore which abstract from this aquifer, providing brackish water (around 5000 mg/L TDS) at approximately 60°C and at outflow rates of 1670 kL/day ('Bayview') and 2160 kL/day ('Peoples') (DPUD 1992, Woodward Clyde 1993).

An earlier (1907) bore installed into this aquifer at Point Maud had a yield of 2000 kL/day and a TDS of 5230 mg/L but is thought to be no longer functional (Woodward-Clyde, 1993).

The aquifer is considered to be a reliable water source (Woodward-Clyde, 1993) and is widely utilised for stock bores throughout the region (DPUD, 1992).

Groundwater recharge to the Birdrong Formation takes place along the eastern edge of the Cretaceous strata in the Carnarvon Basin, approximately 80 km east of Point Maud. Water infiltrates through outcrops, river beds or overlying superficial deposits. In some areas there appears to be discharge near-shore and on-shore (Exmouth, Lake MacLeod and Shark Bay) (Rockwater, 1994).

Investigations have indicated that the sustainable yield of the Birdrong formation will not be compromised by the abstraction required to supply the Coral Coast Resort (Rockwater 1994, Appendix C).

4.1.5 Oceanography

4.1.5.1 Tides

The oceanographic conditions vary markedly from the open ocean to the west of the Ningaloo Reef to the sheltered coastal waters east of the reef. The position and extent of the reef has a dominant influence on the nearshore currents and waves.

Point Maud is considered to be in the transitional zone between the small, primarily diurnal (one tidal cycle per day) tides of the south-west coast and the large semi-diurnal (two tidal cycles per day) tides of the North West Shelf (Hearn & Parker 1988, Simpson and Masini 1986). The Department of Transport has taken measurements within 5km of Mauds Landing which indicate that the mean spring (largest) tidal range to be about 0.9m, and about 0.4m during neap tides.

Highest ocean water levels would be caused by storm surge when severe cyclones pass through the area. Studies completed by Steedman Science and Engineering (1989) indicate that the peak storm surge during a 100 year return period cyclone would be about 1.9m. This would be in addition to the astronomical tides described above.

4.1.5.2 Sea Temperatures

Mean offshore water temperatures range from 22°C (July) to 26°C (January) (ANPWS, 1990). Within the lagoon more extreme temporal and spatial variations are likely to occur. Detailed

measurements for the lagoon (waters lying between the shore and the outer reef) off Mauds Landing are not available, however May *et al.* (1989) reported lagoonal water temperatures within Ningaloo Marine Park have seasonal averages ranging from 21°C in winter to 30°C in summer.

Simpson & Masini (1986) recorded mean temperatures over the Ningaloo Reef tract from 22.1°C (October) to 26.1°C (May) and suggested that areas of limited flushing may experience more extreme temperatures, with winter minima approaching ambient air temperatures (18-20°C). It was considered that quiescent lagoon waters may exhibit pronounced diurnal temperature variations consistent with insolar heating and night-time cooling.

4.1.5.3 Currents

Regionally, offshore water circulation is dominated by the Leeuwin Current, a southward flow of warm, relatively low-salinity water. This current is at its strongest from March to July and broadly follows the edge of the continental shelf. The Leeuwin current is coupled with a northward undercurrent, and is greatly attenuated by wind stress in summer (Holloway & Nye 1985, Hearne & Parker 1988).

Circulations within lagoons behind the outer reef are more complex, driven by the varying and interacting influences of wind, wave and tidal forces. These can be considerably modified by the local morphology of the coast and reef, particularly the location and size of passages through the reef system.

Generally, the consistent swells arriving from the south and south-west break against the reef and generate wave-driven circulation cells (May *et al.*, 1983). These involve oceanic water flowing over the reef into the lagoon and then moving parallel to the coast before exiting via the reef passages (Hearn & Parker, 1988).

Measurements reported in Hearn & Parker (1988) indicate that in Osprey Bay about 120km further north on the Ningaloo Reef, the lagoon has flushing times of less than 24 hours. The action of waves breaking onto the reef was shown to cause significant transfer of ocean water across the reef and then drive the currents along the lagoon to the north. In this location the wave-driven current is strongly modulated by tidal changes in water level.

Bateman Bay is generally wider and shallower than Osprey Bay. This will tend to reduce the relative importance of the wave-driven transport across the reef in the nearshore currents. Currents in Bateman Bay are believed to be controlled by the relative magnitude of the wind, tide and wave forcing.

The currents in the nearshore lagoon of Bateman Bay have been measured by a brief drogue tracking exercise carried out during flood and ebb spring tides. During the drogue tracking, the winds varied from 10 to 15 knots from the southwest. Drogues released near the proposed marina entrance during an ebb tide, travelled at about 0.1m/second (m/s) directly downwind. The drogues released during the flood tide and southwesterly winds showed little movement during the tracking exercise.

The largest currents in the southern portion of Bateman Bay are believed to be caused by the persistent and strong southerly winds and the mass transport of water over the Ningaloo Reef caused by wave breaking over the shallow reefs. It is estimated that mild currents would often be present in Bills Bay and the southern portion of Bateman Bay. They would be primarily driven by wave and wind forcing and modulated by tidal action. Figure 4.2 shows predominant water current patterns adjacent to Mauds Landing.

Typically the currents would be in the order of 0.1 to 0.2 m/s. Some of the water would flow out of the reef gaps in Bills Bay and the rest would continue north into Bateman Bay. It is reasonable to expect a localised increase in the current speed through the narrow channel near Point Maud. Rough estimates indicate that in this narrow channel, the currents may reach 0.5 m/s.

4.1.5.4 Waves

The wave climate offshore from the Ningaloo Reef is dominated by low, long swell waves from distant storms in the southern Indian Ocean and steep and choppy seas generated over local fetches by the sea-breezes.

The available data indicates that the swell approaches from the southwest in winter when wave heights are typically 2 to 3m and periods range from 10 to 16 seconds. During summer, there is a shift to a more southerly direction. The wave heights are slightly lower, typically 1 to 2m. The seas generated by the local sea-breeze would generally to be 1 to 2m in height, and have a 4 to 6 second period due to fetch limitations.

The most extreme wave conditions would be caused by tropical cyclones in the vicinity of the area. Steedman Science and Engineering (1989) completed numerical modelling of the waves generated by Tropical Cyclone Hazel. This storm was reckoned to create wave conditions representative of the 100 year return period condition for the Mauds Landing site. These were estimated to be characterised by significant wave heights of more than 6.2m immediately outside the reef line, and 3.7m in 7m of water near Mauds Landing in Bateman Bay.

This illustrates the effect of the reef-line in attenuating waves as they travel from the deep offshore waters towards the shore at Mauds Landing. The principal physical mechanisms include:

- refraction, due to variations in the bathymetry;
- diffraction through reef gaps;
- breaking on to reefs and in shallow water;
- reflection from submerged reef faces; and
- dissipation due to turbulence.

The reef-line also provides significant protection from the more usual wave conditions of southerly swell and seas. The 1 to 4m southerly swells would be refracted to the west-southwest, travel through the gap in the reef known as Cardabia Passage, and then be further refracted by the bathymetry in Bateman Bay before reaching the shore almost parallel to the beach. These waves would break near the shore having been reduced generally to 0.5 to 1m in height.

The beach near Mauds Landing is a north facing beach, and therefore the southerly sea-breeze seas would have little effect on the southern shores of Bateman Bay.

4.1.6 Marine Geomorphology

The coast from North West Cape in the north to Gnarraloo Bay in the south is formed mostly of Pleistocene (1.5 million to 10,000 years ago) limestones and Holocene (since the end of the last

ice age, about 10,000 years ago) sands superimposed on the margin of a Miocene (from 26 to 7 million years ago) limestone anticline (broad, raised stratified rock crest) (Wilson *et al.*, 1994).

The major marine geomorphological features are a gently sloping submarine shelf, underlain by Pleistocene limestone with a veneer of marine sediments and, interrupting this shelf, a fringing barrier reef system. The shelf in this region, known as the Dirk Hartog Shelf, is relatively narrow and within 40km of the coast just south of North West Cape (Wilson *et al.*, 1994). The shelf rises abruptly to the outer barrier reef, which consists of limestone and coral (DCE, 1984). The Ningaloo Reef omprises a partially dissected basement of Pleistocene marine or aeolian sediments, or Tertiary limestone covered by dead or living coral, the reef flat is on average several hundred metres wide (May *et al.*, 1983).

In the vicinity of the proposed development area the reef is discontinuous and there is a break or 'passage' directly offshore (Figure 4.2). Just north and south of Point Maud the reef is only 1 or 2 kms offshore (DCE, 1984), and plays a fundamental role in coastal processes. A more detailed description of the reef adjacent to the proposed development is given in Section 4.3.

Sediments in the lagoon are generally coarse calcareous sand with finer calcareous sand or silt in deeper basins and gutters (May *et al.*, 1989). These longshore drainage channels skirt the shoreward edge of the reef and may be up to 12m deep (May *et al.*, 1983). The underlying limestone may occasionally be exposed as bare pavement where the sand veneer has been swept away.

4.1.7 Coastal Processes and Marine Water Quality

The sandy beach in the southern portion of Bateman Bay is believed to be stable and in balance with the incoming, persistent low amplitude swell waves. The measured beach profiles are typically swell-built and there is expected to be little longshore transport of sediment under these usual conditions. The swell is believed to slowly feed the beach system with sediment produced in the nearby reefs.

Aerial photographs from 1949 and 1981, have been used to examine the longer term trends of shoreline movement. Using controlled photogrammetry, the vegetation line along the shore of the southern portion of Bateman Bay was plotted from both photographs. These shoreline movement plots indicated that from Mauds Landing to about 1.8 km northeast, the shore has been advancing over the 32 years between photographs. This accretion varies between 5 and

65m, which represent rates of between 0.1 and 2.0m/year. Most of this section of coast has advanced between 10 and 30m over the period between photographs which represent rates between 0.3 and 0.9m/year.

For the first 300m to the southwest of Mauds Landing the coast has also advanced at similar rates. Closer to Point Maud the coast has generally shown little change, although there are a few areas of recession. These are believed to be caused by mobile dune sand covering the foredune vegetation in the later photograph.

The shoreline movement plots also show that the tip of Point Maud itself has advanced seaward about 80m between 1949 and 1981. This is equivalent to a rate of 2m/year.

The largest movements of sand are believed to occur under the action of severe tropical cyclones. In work completed by Port & Harbour Consultants (1989) the longshore transport during an extreme cyclone was examined. This analysis indicated that during a very severe cyclone, there was significant transport of sand along the sandy beaches in the southern portion of Bateman Bay.

The direction of sand transport was to the south toward Point Maud, and varied from about 30,000m^3 opposite Cardabia Passage to about 10,000m^3 at the proposed Marina site, to a negligible amount at Point Maud.

The cross-shore transport during such a storm would also be significant. During a very rare, severe cyclone event the cross-shore sediment movement has been estimated to cause erosion of up to 50m from the present vegetation line during the 100 year return period event. In the months and years that follow such an extreme storm, the persistent, low-amplitude background swell would bring some of this eroded sand back onshore and naturally build up the beach (M.P. Rogers and Associates 1994, Appendix G). Available evidence indicates that these large erosional events on the Bateman Bay shore may be followed by a period of deposition which can recover the earlier shoreline position.

The waters of Bateman Bay are regularly flushed by the wind, tide and wave forced currents described in Section 4.1.5. Because of the wave-driven water transfer across the Ningaloo Reef and tidal flows through the reef gaps, the nearshore water will be regularly mixed and exchanged with new ocean water. Except for the possible influx of pollutants and nutrients from the waters

of Bills Bay, the water in Bateman Bay should be representative in composition to that of the nearby ocean.

4.2 Terrestrial Biological Environment

4.2.1 Vegetation and Flora

The Mauds Landing area is located within the Carnarvon Botanical District of the Eremaean Botanical Province, which extends from Shark Bay northwards to the Exmouth Gulf area.

To obtain site-specific information for this document and the assessment process, the vegetation and flora of the site were investigated by a specialist botanist in October 1994 (Trudgen, 1994), based on current aerial ortho-photography and site survey. A full account of the botanical survey methodology, together with results, is contained in Appendix H, whilst key features are summarised here.

4.2.1.1 Vegetation

The vegetation of the site can be broadly divided into two components; the foredunes and associated swales and low dunes in the west, and the saline-flat areas behind the dunes. Each component is discussed below, and mapped in Figure 4.3.

As is typical of many coastal areas with relatively young sediments, the vegetation of the dune areas is relatively low in diversity, and varies mainly in the proportion of the same predominant species.

The foredunes closest to the ocean near Point Maud are dominated by spinifex (*Spinifex longifolius*) hummock grassland over herbland (*Launea sarmentosa*), and in some areas similar vegetation extends into the swales, and low dunes behind the foredunes. In other areas the low dunes are dominated by tussock grassland (*Eulalia aurea*) over open herbland (*Carpobrontus "septentrionalis"/L. sarmentosa*).

The vegetation of the relict foredune plain in the coastal north of the site is dominated by *Acacia* spp., with the lower slopes similar in their vegetation to the aeolian flat/ridge, deflation basin and relict inland spits described below. The low sand drifts at the rear of the relict foredune plain

contains a thin, gently undulating layer of sand over salt-flat soils, reflected in vegetation of open shrubland over grassland.

The vegetation of the parabolic dunes varies with the location on the dune (crests, slopes, swales), although the proportional of the dominant species (*Acacia coriacea* ssp. *coriacea*) is generally similar, with variation in associated understorey species.

The vegetation on the aeolian flat/ridge, deflation basin and relict inland spits is controlled by underlying water relations, however they are all dominated or co-dominated by the shrub *Acacia tetragonophylla*.

The vegetation of saline-flats often has numerous units, although they have relatively few species. Within the study area, there are several smaller areas which have been isolated from the main saline flats due to the encroachment of the parabolic dunes and the relict foredune plain. The units in these areas are described in Appendix H.

The salt-pan in the south-east of the site was dry at the time of sampling, however dried and bleached fibrous material was recorded on the bed, and whilst unidentifiable is likely to be a species of the aquatic herb *Ruppia* spp. or similar. Based on the presence of seed and spore cases, there may also be an associated species such as *Chara* or a stonewort.

The variation in vegetation types from dune areas within the site are not considered significant from a local perspective ie. there is no unique vegetation type within any one area of the dunes. In a regional context, the dune system containing the site is relatively narrow, and therefore as a whole the system has some value. However, the area of dunes in the study area is a relatively small portion of the system, and consequently could be assessed as having moderate value (Trudgen 1994, Appendix H).

The relict saline flats within the site are part of a series found along the coastline between Carnarvon and Onslow. Beard (1975) maps the flat at Mauds Landing as one of three such features behind coastal dunes in the region (although only large flats were noted), and shows similar vegetation types adjoining Lake MacLeod approximately 60 km south of the site.

In a local context, there are many areas with similar vegetation types in the vicinity of the site, such as the dunes approximately 3km south of Coral Bay. Additionally, it should be noted that the whole of the Mauds Landing site will not be developed or disturbed. With the exception of

the entrance channel to the marina, development will largely be confined to the saline flat behind the dune system.

4.2.1.2 Flora

One hundred and six native flowering plant species from thirty-three plant families were recorded in the study area, including one aquatic species from the dry hypersaline pool. In addition, one introduced species, *Cenchrus ciliaris* (buffel grass), was recorded. This species was common, and in some areas abundant, on the sand dunes in the study area.

The species recorded are considered to represent approximately 85% of the flora of the site, with those species not being recorded being either present in very low numbers or being annuals not available at the time of the survey.

Given the relatively small size of the study area and the low number of habitat types, the number of species recorded seems to indicate an average diversity, that is, neither low nor high for an area on the coastline (Trudgen, 1994). In contrast, Kieghery and Gibson (1992) recorded six hundred and thirty taxa of vascular plants (in 86 families, excluding those with only weed and marine species) from the Cape Range peninsula, however from a larger area with more habitat types.

The plant families with the most species recorded for the study area were: Poaceae (grass family) 12 species; Chenopodiaceae (saltbush family) 15 species; Mimosaceae (wattle family) 7 species; Malvaceae (*Hibiscus* family) 5 species; Goodeniaceae (*Leschenaultia* family) 8 species and Asteraceae (daisy family) 12 species.

Poaceae, Malvaceae, Asteraceae and Mimosaceae are usually major components of floras in arid areas in Western Australia, and Chenopodiaceae in the floras of saline areas. The relative abundance of Goodeniaceae is a result of the presence of several coastal species, with the small size of the study area skewing their affect on the size of the family in the study area. Kieghery and Gibson (1992) had a similar list of families with many species, with differences (such as the inclusion of Myrtaceae and Papilionaceae) being readily explained by the small range of habitats in the study area of the current survey area.

The flora of the study area has groups of species that can be ascribed to different regions in their relationships. For example, species such as *Rhynchosia* cf. *minima* and *Launea sarmentosa* are

tropical in their relationships; species such as *Acanthocarpus preissii, Thryptomene baeckeacea* and *Pileanthus limacis* are south-western in their relationships, species such as *Spinifex longifolius, Scaevola spicigera, Acacia coriacea* ssp. *coriacea* and *Acacia rostellifera* are coastal in their distribution; and species such as *Sida* cf. *fibulifera, Abutilon* cf. *exoneum* are Eremaean in their relationships. In addition, there is a significant group of species, including the *Halosarcia* species and the *Atriplex* species that are associated with saline habitats.

Given the coastal nature of the study area, the latitude it occurs in and the presence of an extensive saline area, the biogeographical makeup of the flora recorded is as would be expected.

No Declared Rare Flora were recorded in the study area during the survey, however two Priority species were recorded. Gazetted rare species are protected by law. Priority species are not gazetted but are poorly known and in need of survey, or are adequately surveyed but are threatened and therefore in need of monitoring.

The priority species recorded are *Acacia ryaniana* and *Eremophila glabra* ssp. Dirk Hartog (M. Manning 6/9/64). Both are common in the study area, with populations generally found in the lower parts of the dunes, close to the saline flats, where the sand layer is thin. However the *Eremophila* was recorded at lower densities in some sites located further up in the dunes.

Acacia ryaniana and *Eremophila glabra* ssp. Dirk Hartog (M. Manning 6/9/64) are both Priority 2 species. Priority 2 taxa which are from one or a few (generally < 5) populations, at least some of which are not believed to be under immediate threat (ie. not currently endangered). Such taxa are under consideration for declaration as 'rare flora' but are in need of further regional survey.

Populations of species which are at the end of their recorded geographical range are generally considered important by biologists because they give information about the response of the species to its environment. Collections of four species during the survey significantly extended their known range to give them new northern limits. These species were:

- *Halosarcia peltata* - range extension, previous northern limit was at Shark Bay.
- *Acacia rostellifera* - range extension, previous northern limit was at the Zuytdorp Cliffs, Shark Bay.

- *Stipa elegantissima* - previous northern limit was near Carnarvon.

- *Podolepis microcephala* - previously only known from Shark Bay and the southern end of Lake MacLeod.

Another species worthy of comment found in the study area was *Launea sarmentosa*, a prostrate member of the daisy family with long creeping stems. This species was recorded in the foredunes next to the Mauds landing track, and is only known in Australia from a few records from beaches on the Pilbara coastline and from adjacent offshore islands (it has a wide distribution outside Australia on tropical islands).

There are in the order of 80 Priority and Declared Rare Flora species in the CALM Gascoyne region, however systematic checking of the CALM Declared Rare and Priority Flora List (Atkins, September 1994) indicates that it is unlikely that priority species other than those recorded would occur in the study area. The reason for this is the small range of habitat that occurs in the study area (saline flats and coastal dunes) and the fact that most of the declared rare and priority flora species are not from these habitats.

In terms of conservation value for flora, given the relatively small size of the site, the extensive distribution of many of the flora species and the limited degree of disturbance of much of their ranges, the overall conservation value for flora of the study area is considered to be low to moderate.

The value of the two Priority 2 species recorded may be considered higher, however it must also be noted that these species have not been specifically surveyed, and it is likely that they are more common than current herbarium collections suggest, as is supported by the geographical range extensions for some species due to this study as previously described.

4.2.2 Fauna and Habitats

The habitat types and potential fauna of the site were investigated for this document and assessment by a specialist fauna consultant, based on an assessment of current aerial ortho-photography, ground photography and extensive literature search (ecologia, 1994). The site was also ground-truthed by members of the study team in October 1994. A full account of the habitat and fauna assessment methodology, together with results including complete species list, is contained in Appendix I. Key features of the site are summarised here.

4.2.2.1 Habitat Types

The Mauds Landing project area encompasses four faunal habitat types (Figure 4.4);

1) sparsely vegetated beachfront;

2) coastal scrub-heath;

3) samphire flats; and

4) salt lake.

Based on previous capture records, known distributions and habitat preferences, as many as 189 different vertebrate species potentially occur in the project area. This total includes 18 mammal, 116 bird, 51 reptile and 4 amphibian species. However, it is unlikely that all potential species co-occur within the project area at any one time, due to spatial constraints and various temporal variations in the physical environment. Numerous nomadic or migratory species may only occur in the area after substantial rain, or at certain times of the year.

The beachfront habitat comprises three zones:

- the intertidal zone used for foraging by waders,
- the beach area used for roosting and nesting by birds and for foraging by foxes and varanids (monitor lizards), and
- bands of tidal debris, used for foraging by birds.

Thirty one species potentially occur in this habitat, including one mammal, four reptiles and 23 birds. The low species richness is attributable to the lack of significant vegetative cover and absence of any structural diversity.

The coastal scrub-heath habitat is the most structurally diverse habitat within the project area and as a consequence would exhibit the greatest species richness. A total of 108 species potentially occur in this habitat, comprising 18 mammalian, 62 avian and 47 reptilian species. The coastal dunes are the preferred habitat of the cryptozoic surface burrowing reptiles such as the legless

lizards while the accumulated leaf litter constitutes an important micro-habitat for fossorial species of reptiles. The relatively dense shrub and grass layer affords suitable shelter and a regular food supply for reptiles and for small mammals while tall shrubs and small trees are utilised by arboreal lizard species and small insectivorous birds.

The samphire flats habitat is structurally less complex than the surrounding coastal scrub-heath habitat and as such is expected to support fewer species. A total of 60 species potentially occur in this habitat; 15 mammalian, 27 avian, 14 reptilian and 4 amphibian species. Typically plant species of samphire flats grow to 0.5 m tall although some may grow to one metre. The resulting low, open habitat represents a suitable environment for Richard's Pipits *Anthus novaeseelandiae*, Orange Chats *Ephthianura aurifrons* and Crimson Chats *E. tricolor,* all of which forage amongst low vegetation for insects. Aerial species occurring over this habitat are generally those which are hawking insects. Unlike the loose sand layers of the coastal scrub-heath habitat, the soils of samphire flats are heavy textured and unsuitable for surface burrowing cryptozoic fauna species.

The saline conditions of salt lakes constitute a harsh environment that is generally devoid of vertebrate fauna when dry. However following heavy rains, such as those experienced during cyclones, it may support up to 26 species of birds, typically waders, gulls and terns. One of the lakes appears to hold water for some time as evidenced by the presence of Brine Shrimp *Artemia* spp. and algae. Such lakes would provide important food resources for both local and migratory species.

The samphire flats of *Arthrocnemum* sp. and associated salt lakes are widely distributed on a regional scale from Carnarvon in the south to Onslow in the North. The largest such area is to the south in the vicinity of Lake MacLeod. It is currently included in a mining lease with the option that once the mining lease becomes available, the ponds and adjacent areas of Lake MacLeod are to be vested with the National Parks and Nature Conservation Authority as a Class 'A' park.

The sparsely vegetated beach front and coastal heath/scrub habitats are also widely distributed on a regional scale, and are both encompassed by the Cape Range National Park.

4.2.2.2 Vertebrate Fauna

Fourteen native mammalian species from seven families potentially occur in the project area. Forty three percent are Eyrean in biogeographic affinities with the major proportion of their distributions in arid central Australia. The bats Western Cave Eptesicus *Eptesicus finlaysoni* and Yellow-bellied Sheath-tail Bat *Saccolaimus flaviventris* are near the southern limits of their range. Many of the remaining species, such as the Dingo *Canis familiaris dingo* and Gould's Wattled Bat *Chalinolobus gouldii* have Australia-wide distributions. Four species of introduced mammal potentially occur within the project area; the Cat *Felis catus*, the Fox *Vulpes vulpes*, the House Mouse *Mus domesticus* and the Rabbit *Oryctolagus cuniculus.* All 4 species are widely distributed over most of Australia and would undoubtedly occur within the project area.

Based on preferred habitat and distribution records, 116 species of birds from 45 families may occur in the project area. The majority of birds recorded or expected to occur have distributions which extend into all the zoogeographic sub-regions of Australia, including most of the migratory and highly nomadic species. For other species, the project area lies near the northernmost extension of their range, for example the Chestnut-rumped Thornbill *Acanthiza uropygialis*, or the southern limit such as the Beach Thick-knee *Burhinus neglectus*.

In terms of reptiles, the project area encompasses habitats suitable for, and is within the distributions of, 51 species from eight families. Particularly well represented are the skinks and geckos with 13 and 11 species respectively. In contrast the varanids (monitor lizards) are poorly represented with only one species expected in the area. Three species of marine turtles may use the beaches during their nesting season, October through to February. The largely arid Eyrean component of the mammal and bird faunas of the Murchison region is repeated in the terrestrial reptiles. Twenty one species (44%) have Eyrean biogeographic affinities only, while a further 21 species (44%) such as *Lerista meulleri* and Thorny Devil *Moloch horridus* have a predominantly arid distribution with range extension into the south-west of the State. Of the Eyrean species, 6% are endemic to the North West Cape, including the gecko *Diplodactylus rankini*, the skink *Lerista haroldi* and the legless lizard *Aprasia rostrata*. Five species including the Tree Dtella *Gehyra variegata*, Bynoe's Gecko *Heteronotia binoei* and Burton's Snake Lizard *Lialis burtonis* have Australia-wide distributions occurring mainly in arid and semi-arid habitats. Only one species, the Spotted Dragon *Ctenophorus maculatus* is mesic south-western in distribution, with the project area being on the northern limit of their range.

Four species of amphibians from 2 families potentially occur within the project area, and would largely be confined to the Samphire Flats habitat. Three of the 4 species, Main's Frog *Cyclorana maini*, Water Holding Frog *C. platycephala* and Tawny Trilling Frog *Neobatrachus fulvus*, have entirely Eyrean biogeographic affinities. The fourth species, the Shoemaker Frog *Neobatrachus sutor*, has most of its range within the arid zone of Western Australia but also extends into the South West. All species with the exception of *Neobatrachus fulvus* are widely distributed. The distribution of *Neobatrachus fulvus* includes the area of the central west coast from Wooramel River, near Shark Bay, to North West Cape.

The Coral Coast Marina project area is expected to contain fauna species which are generally widespread and abundant in similar habitats throughout the region. Based upon the current study, the project area is not expected to contain regional endemics or locally restricted species.

4.2.3 Rare or Endangered Species

No species of rare or endangered flora have been recorded from the site, however two Priority 2 species were commonly identified, *Acacia ryaniana* and *Eremophila glabra* ssp. Priority 2 species are not protected by law, but are those which CALM considers are not currently under threat but may need to be protected in the future following adequate survey.

There are in the order of 80 priority and declared rare flora species in the CALM Gascoyne region, however systematic checking of the CALM Declared Rare and Priority Flora List (Atkins, September 1994) indicates that it is unlikely that priority species other than those recorded would occur in the study area. The reason for this is the small range of habitat that occurs in the study area (saline flats and younger coastal dunes), and the fact that most of the declared rare and priority flora species are not from these habitats.

Fauna species which have been formally recognised as rare, threatened with extinction or as having high conservation value are protected by law under the Western Australian *Wildlife Conservation Act 1950* and the China & Australia Migratory Bird Agreement (CAMBA). In addition fauna are covered under the April 1991 Australian & New Zealand Environment & Conservation Council (ANZECC) convention.

Under the *Wildlife Conservation Act 1950*, three Schedule 1 vertebrate taxa potentially occur within the project area. These are the Red-tailed Tropic-bird *Phaethon rubicauda,* Grey Falcon *Falco hypoleucos* and Loggerhead Turtle *Caretta caretta.* Additionally one Schedule 4 species,

the Peregrine Falcon *Falco peregrinus*, may occur in the project area. All are mobile species which do not rely on the habitat of the site for survival.

Historically a further three gazetted rare and currently extant species may have occurred in the area. The Western Barred Bandicoot *Perameles bougainville,* Bilby *Macrotis lagotis* and the Burrowing Bettong *Bettongia lesueur* are now considered to be extinct in the region.

The China & Australia Migratory Bird Agreement between the Federal Government of Australia and the government of the Peoples Republic of China binds the signatory governments to the protection of migratory birds and their environment. Fifteen species of transequatorial migratory bird which potentially occur in the project area are listed under the annex of CAMBA (Appendix I).

The ANZECC convention lists fauna as "Endangered - Species in danger of extinction and who's survival is unlikely if the causal factors continue to operate" and "Vulnerable - species believed likely to move into the "Endangered" category in the near future if the causal factors continue to operate." Three species of marine turtle, Loggerhead Turtle *Caretta caretta,* Green turtle *Chelonia mydas* and Hawksbill Turtle *Eretmochelys imbricata* listed under the ANZECC convention potentially occur adjacent to the Coral Coast Marina project area.

The primary conservation significance of the sparsely vegetated beachfront habitat is as potential nesting locations for marine turtles, particularly the Loggerhead Turtle *Caretta caretta* which is listed as Schedule 1 Fauna. Significantly though, no records exist of marine turtle species nesting in the Coral Bay area. Additionally, the habitat provides temporary feeding grounds and resting sites for migratory birds protected under the CAMBA and JAMBA agreements.

4.3 Marine Biological Environment

4.3.1 Habitat Types

The marine environment near to Mauds Landing contains a diverse range of habitats and communities. Directly offshore for 7km to the north-east, 6.5km to the north and 2km to the west, bare sand substrate is the dominant habitat. Further offshore and to the north and south (Bills Bay), habitats include coral reefs, seagrass communities, macroalgae dominated communities, and mixed communities on hard pavements. Figure 4.5 shows marine habitats in the vicinity of Mauds Landing, compiled from aerial photography and confirmed by survey.

These habitats, and the deeper waters of Stanley Pool and offshore Ningaloo Reef, support a rich and highly diverse fauna of fishes and invertebrates and several species of marine mammals and reptiles, as described in the following sections.

4.3.1.1 Coral Communities

There are no substantial coral communities in very close proximity to the proposed development site at Mauds Landing. However, large, diverse and regionally significant coral communities are characteristic of the Ningaloo Marine Park. Local examples of important coral communities include:

- the extensive lagoonal coral community south of Point Maud in Bills Bay;
- the shallow backreef of Ningaloo Reef 2km to the west; and
- a highly diverse coral community located 9km north of Mauds Landing on the edge of Stanley Pool.

The lagoon at Bills Bay is generally 3m deep and supports an extensive coral community dominated by aborescent (branching) *Acropora* and tabular (flat) *Montipora* species. This community is the largest lagoonal coral assemblage along the Ningaloo Reef tract. Its importance has long been recognised, and most of the community has been designated a marine reserve for over 20 years. Severe mortalities occurred to the corals in 1989 due to anoxic conditions which followed the coral spawning in March of that year (Simpson *et al.*, 1993). Surveys conducted for this report in June 1994 indicate that differential recoveries to the coral communities have occurred, with only limited signs of recruitment being found in those areas most affected.

The Ningaloo Reef backreef is generally very shallow, with live corals often becoming emergent on extreme low tides. This is an energetic zone and is usually dominated by digitate and corymbose *Acropora* spp., with secondary corals being massive faviids and poritids, encrusting *Montipora* spp, and ramose *Pocillopora*. The backreef community throughout the Ningaloo Reef tract has been extensively affected by the coralliverous muricid gastropod *Drupella cornus*, with up to 98% mortality to corals reported in some areas (Forde, 1994). The backreef near Mauds Landing has been significantly affected, with high mortalities to corals in some areas, but very limited effects in others. Predation of corals by *D. cornus* is an on-going phenomena in

this area and based on recent research further reductions in live coral abundance on the backreef appear likely.

The coral reef on the inner edge of Stanley Pool, 9km north of Mauds Landing, is possibly unique on the Ningaloo Reef tract. It is a lagoonal community varying in depth from about 5m to 10m in depth, with a highly diverse coral fauna. The most notable coral formations are massive *Porites* colonies over 6m in height. Other genera observed in recent surveys include *Acropora, Montipora, Galaxea, Pocillopora, Mycedium, Astreopora, Hydnophora, Merulina, Serriatopora, Stylophora, Echinopyllia, Pavona, Pectinia, Fungia, Goniopora, Lobophyllia, Symphyllia* and most of the genera of the family Faviidae. No one genera is dominant and the diversity occurs over a relatively small area, with the total area of the community estimated as less than 8ha.

4.3.1.2 Seagrass Communities

Seagrasses in the Mauds Landing area are restricted to a discreet area containing patches of *Posidonia coriacea* and to more dispersed occurrences of sparse *Halophila ovalis*. The *P. coriacea* patches are located at depths of 5-10m along 1.5km of shoreline and extending some 600m out to sea, commencing 4km northeast of Mauds Landing. *Posidonea* is a temperate genera and the community near Mauds Landing is the most northerly meadows of *P. coreacea* presently identified. Similar isolated communities are suspected to occur on other areas of Ningaloo Reef, based on leaves of the species washed up on various beaches. However, this is the only *P. coriacea* community that has been positively identified to date, and as such can be considered as regionally significant (Kirkman pers. comm., 1994).

Halophila ovalis is a tropical species and is widespread throughout the Ningaloo Reef and Rowley Shelf region. Its representation near Mauds Landing is restricted to sparse and patchy occurrences, usually in shallow sediments overlying limestone. These areas include a small macroalgae-dominated area near Point Maud, and limestone pavements northwest of Mauds Landing. *Halophila* is eaten by Dugong *(Dugong dugon)* and although not a visually impressive plant, it is therefore ecologically important. The sparse occurrences of *H. ovalis* near Mauds Landing, its seasonal and itinerant nature, and its ubiquitous nature throughout the region, suggest that the communities occurring in the study area are of limited regional significance.

4.3.1.3 Macroalgal communities

Macroalgal communities are not well represented in the Mauds Landing area. Small areas of sparse macroalgae occur near the western end of Point Maud, while sparse, stunted macroalgal - mixed corals - filter feeder communities occur on the fringing shoreline platform located approximately 4km northeast of Mauds Landing. *Sargassum* is the dominant genera in each of these areas.

Well-developed macroalgal communities also occur extensively along the Ningaloo Reef tract. The nearest backreef algal community to the Mauds Landing occurs on the backreef immediately north of Mauds Entrance (Cardabia Passage), approximately 7km to the northwest. Although these communities are ecologically important, being highly productive and providing food for green turtles *(Chelonia mydas)*, the limited examples in the Mauds Landing area are not considered to be regionally significant.

The nearshore area of Bills Bay where coral mortality was most severe following the 1989 coral spawning, presently supports large amounts of *Sargassum*, with individual plants up to 2m in length. These plants are larger than otherwise occur in the area, and may be a result of the nutrient enrichment suspected to be occurring from the Coral Bay settlement.

4.3.1.4 Pavement Communities

Localised areas of low-profile limestone pavements occur near Point Maud, and to the northeast of Mauds Landing. The area near Point Maud supports the shallow, mixed macroalgal and *Halophila* community, as discussed above. The platforms to the north-east of Mauds Landing occur in two forms:

- An extensive area of exposed calcarenite platforms and boulders located 5.5km northeast of Mauds Landing.

- An exposed beach rock and coastal platform on the shoreline which mirrors the subtidal geomorphology at this location.

The pavement gently slopes from the shoreline to about 10m depth, and extends parallel to the shore for about 4km. At its southern extent the platform supports occasional sponges, corals (*Turbinaria* sp), macroalgae (*Sargassum* spp.) and turf algae. Coral density increases

northwards along the pavement, culminating in the previously described high-diversity coral reef located at the edge of Stanley Pool, approximately 9km north from Mauds Landing.

There are also exposed pavements located approximately 3km to the north-east of Mauds Landing, which consist of isolated, low-relief outcrops. These pavements are virtually bare of attached fauna however one area is completely covered by mussels. Of these platform areas those having only low-relief, which are depauperate of sessile organisms, would probably be periodically inundated by sand. The more permanently exposed pavements provide a habitat for reef fishes, including a large community dominated by parrot fish (Family Scaridae), which feed upon the turf algae.

Although locally significant, pavement communities occur extensively along the inner lagoon on the Ningaloo Reef tract (May *et al.*, 1983).

4.3.1.5 Sand Communities

All of the marine substrates near to Mauds Landing are bare sands. The nearest hard substrates to Mauds Landing are sparse outcrops of calcarenite with macroalgae coverings, approximately 1.2km west of the proposed site. The sand substrates are slightly undulating and vary subtly in shade, suggesting variations in age and mobility. This is consistent with the geomorphology of Point Maud, which is an accretionary cusp, whereas the limestone cliffs further to the north indicate an eroding coastline.

Investigations of sand substrates in the vicinity of Mauds Landing found little evidence of bioturbation and minimal attached fauna or flora. Sandy substrates occur regularly throughout the Ningaloo Reef tract and those near Mauds Landing would not appear to be regionally significant.

4.3.2 Fish and Sharks

The Ningaloo Reef tract supports extremely diverse populations of reef fishes, including many tropical species which are at the southern limits of their range and subtropical species which do not extend further north.

Point Cloates is considered to be the northern extent of the subtropical fishes distribution (Allen and Swainston, 1988). An example of this is the Baldchin Grouper *(Choerodon reubescens)*,

which is prolific at the Houtman Abrolhos, common on the reef flats and deeper slopes south of Point Cloates, but very rare north of Point Cloates.

One factor believed to be responsible for the high diversity of reef fishes occurring along the Ningaloo Reef is the proximity of the continental shelf and the influence of the Leeuwin Current. The continental shelf is closest to mainland Western Australia along the Ningaloo Reef, and the reef communities are directly affected by the south-flowing Leeuwin Current. Numerous fish occur at both the Rowley Shoals and Ningaloo Reef which have not been found at other inshore tropical locations of Western Australia, which suggests that fish populations at Ningaloo Reef are augmented by recruitment of fish larvae from the Rowley Shoals (Hutchins, 1994).

In the Mauds Landing area, fish numbers are greatest on the shallow energetic areas of the outer Ningaloo Reef. Large numbers of fish are also found in association with the shallow, coral environments of the Ningaloo Reef backreef, particularly at the diverse coral community 9km north of Mauds Landing. In these areas wrasse (Labridae) and the smaller reef fish such as damselfishes (Pomacentridae), gobies (Gobiidae) and cardinalfishes (Apogonidae) are the most common and diverse groups. The most common of the larger or more spectacular fishes include the parrotfishes (Scaridae), surgeonfishes (Acanthuridae) and butterflyfishes (Chaetodontidae).

The pavement habitats near Point Maud and north-east of Mauds Landing support a relatively impoverished fish fauna, with turf algae eating fishes such as parrotfishes and surgeonfishes being the most common. The bare sand substrates surrounding Mauds Landing have a very depauperate fish population, with occasional schools of pelagic fishes such as trevally (Carangidae) and mullet (Mugilidae) being the most frequently encountered.

The Ningaloo Reef tract also has a diverse and abundant shark and ray population. Sharks are most common on the seaward side of the Ningaloo Reef, where whalers such as the Grey Reef Shark *(Carcharhinus amblyrhynchos)* are often encountered on the shallow backreef. Small reef sharks such as the white tip shark *(Triaenodon obesus)* and black tip reef shark *(Carcharbhinus melanopterus)* are most common, although the large and harmless tawny nurse shark *(Nebrius ferrugineus)* is also often encountered.

The largest of the tropical sharks, the whale shark *(Rhiniodon typus)*, the tiger shark *(Galeocerdo cuvier)* and the hammerhead shark *(Sphyrna* spp.), are also present. The whale sharks occur seasonally along the Ningaloo Reef tract, between November and June, and are less common at Coral Bay than further north along the reef.

The Ningaloo Reef tract also supports a diverse and abundant ray population. These include the giant manta ray *(Manta birostris)*, large black *(Dasyatis thetidis)* and black-blotched stingrays *(Taeninura melanospila)*, and small rays such as the blue spotted stingray *(D. kuhlii)* and the blue spotted fantail stingray *(T. lymma)*. Manta rays are most often encountered immediately outside the Ningaloo Reef, and appear to be more common in Autumn. Other rays occur throughout the Ningaloo Reef tract, from deep offshore waters to shallow nearshore waters.

The Mauds Landing area is of unknown importance to sharks, however one area close to shore on the southern side of Point Maud (ie. Bills Bay) has long been referred to as "Shark Alley", apparently because schooling sharks (possibly black tip sharks - *Carcharhinus limbatus)* are often found there. Schooling hammerhead sharks also occur in Stanley Pool in autumn (George King pers. comm., 1994).

Hammerhead sharks form breeding aggregations in coastal areas throughout the world, and those observed in Stanley Pool, could also be aggregated for breeding. Likewise the aggregation of sharks observed at "Shark Alley" could be related to breeding activity (Hutchins pers. comm., 1994).

4.3.3 Sea Birds

The Ningaloo Marine Park supports about 33 species of sea bird, 13 of which are residents, while the other 20 migrate through the area, or are occasional visitors (CALM records). The most abundant of these birds are the wedge-tailed shearwaters (*Puffinus pacificus*), which are common throughout the area during summer and autumn. These form rookeries of tens of thousands of nesting birds on the islands north of Ningaloo Reef on the Rowley Shelf, but feed on batifish over a large area, including the ocean offshore from Point Maud. Occasional visitors include southern species such as the petrels which are more often encountered during the winter months.

The thirteen types of resident sea birds include 5 species of tern (*Sterna spp.*), two cormorants (*Pholacrocorax spp.*), the frigate bird (*Fregata ariel*), silver gull (*Larus novaehollondiae novaehollondiae*), brown booby (*Sula leucogaster plotus*) and three species of fishing raptors. All three of the fishing raptors; the osprey (*Pandion haliatus cristatus*), the brahminy kite (*Haliastur indus girrenera*) and the white breasted sea-eagle (*haliaeetus leucogaster*), are common near Point Maud. Ospreys nest in the radio tower at Coral Bay and all three species roost in the cliffs north of Mauds Landing (M. Forde, pers. observ.).

Although none of the sea birds are known to breed on Point Maud, the area is an important roosting site. Fairy terns (*Sterna nereis*), with less numerous caspian terns (*S. caspia*) and occasional pelicans (*Pelecanus conspicillatus*), utilise the beach at the tip of Point Maud. The importance of this area has been recognised and was gazetted in 1992 as a No Vehicle Access, Bird Roosting Sanctuary under the Offroad Areas Act.

4.3.4 Marine Mammals

Marine mammals inhabiting the waters near Mauds Landing include Dugong *(Dugong dugon)*, common bottle-nose dolphins (*Tursiops truncatus*), Indo-Pacific humpback dolphins (*Sousa chinesis*) and a number of different whale species.

Dugong occur in small numbers along the entire length of the Ningaloo Reef tract. Recent research suggests that they usually reside within relatively confined areas rather than pursuing large migrations, although movement in relation to seawater temperature has also been reported (Prince pers. comm., 1994). A solitary Dugong was observed at Mauds Landing during the June 1994 survey, and individuals and cows with calves have regularly been sighted in the area. A small population probably incorporates the Mauds Landing area within their home range.

Bottle-nosed dolphins are common along Ningaloo Reef and are expected to regularly occur in the vicinity of Mauds Landing. Less common are humpback dolphins, which are a tropical species rarely sighted south of Exmouth Gulf. A small pod of humpback dolphins was identified 3km north of Mauds Landing during the June 1994 survey, however these could be considered as only occasional visitors to the area.

Humpback whales (*Megaptera novaeangliae*), Minke whales (*Balaenoptera acutorostruta*), Fin whales (*B. physalis*), Blue whales (*B. musculus*), Brides whales (*B. edeni*) and Killer whales (*Orca orca)* occur in the offshore waters westward of Ningaloo Reef (May *et al.*, 1983). Of these, humpback whales regularly pass along the reef during the northern and southern migrations, while the other species are less common.

4.3.5 Marine Reptiles

Marine reptiles utilising the waters adjacent to Mauds Landing may include four species of turtle and several species of sea snake. Green (*Chelonia mydas*), Hawksbill (*Eretnochelys imbricato*) and Loggerhead (*Carretta caretta*) turtles are common occupants of the area. The Leatherback turtle (*Dermochelys coriacea),* the largest of the turtle species, has the most widespread

distribution of any turtle. Although not reported from Ningaloo Reef, the area is within its assumed distribution and occasional individuals are expected to occur (May *et al.*, 1983).

Green turtles feed on macroalgae and are by far the most common turtle on Ningaloo Reef. Several Green Turtles were observed during the June 1994 survey browsing within the macroalgae communities near Point Maud.

Loggerhead turtles are carnivorous, feeding mainly on molluscs and crustaceans. They may utilise the mussel beds 3km north-east of Mauds Landing.

Hawksbill turtles feed mainly on sponges and are more often located in deeper water, seaward of Ningaloo Reef.

Beaches on the northern end of North-West Cape and on the islands of the Rowley Shelf are very important turtle nesting beaches, however only small numbers nest on beaches further south along the Ningaloo Reef tract, including Mauds Landing. The vast majority of turtles nesting near Mauds Landing are Green turtles (Prince pers. comm., 1994).

Sea snakes are not common inhabitants of Ningaloo Reef but occur as occasional visitors. Sea snakes are typically tropical and are much more common north of North West Cape. Nine species of marine seasnakes from 5 genera have distributions which include Exmouth Gulf or further south (Starr *et al.*, 1986). Any of these species could possibly be encountered near Point Maud, though usually in the offshore waters.

4.3.6 Marine Invertebrates

The Ningaloo Reef tract supports a very diverse range of marine invertebrates, the majority of which are tropical species. Molluscs are particularly abundant and the most investigated of the marine invertebrate groups. They occur in all the marine and intertidal habitats present near Mauds Landing, ranging from only occasionally inundated or splashed beach rock, to submerged sand plains and coral reefs.

Molluscs on the intertidal platforms include the periwinkles (Family Littorinoidea) and limpets (Families Acmaeicae and Patellidae) in the upper intertidal zones, and oysters (*Saccostrea* spp.) at the midtide level. The rock platforms 4km north of Mauds Landing have particularly well developed *Saccostrea* communities, hence the local name of "Three-Mile Oyster Reef". The

deeper pavements support numerous browsing and carnivorous molluscs, such as cerithids and mitras and at times filter feeding bivalves. The most notable such community is the mussel bed (*Brachidontes sp.*) located 3km from Mauds Landing.

Coral reefs provide a great range of habitats and support a varied molluscan fauna. These range from the large clams (*Tridacna maxima*) interspersed among the corals, to tiny muricids within the dead coral branches. The most ecologically important of the molluscs on coral reefs near Mauds Landing is the coral eating gastropod, *Drupella cornus*. As previously described, this snail has occurred in very large numbers on coral reefs throughout Ningaloo Reef, resulting in significant reductions in live coral cover. The marine substrates closest to Mauds Landing are bare sands, and molluscs are expected to be the dominant fauna of the submerged plains. Bivalves of the genus Donax are ubiquitous in lower intertidal beach sands and are expected to occur at Mauds Landing, along with polychaete worms.

Wells (1980) reports that about 433 species of mollusc had been identified along Ningaloo Reef prior to 1978. The range of habitats available for molluscs and the position of Ningaloo Reef as a biogeographic cut-off zone would suggest that this is a conservative count and many more species probably occur.

Crustaceans are a second important component of the invertebrate fauna of the Point Maud region. Most of those present are inconspicuous, being small and nocturnal. The most impressive of the crustaceans which occur in the vicinity of Mauds Landing are the Panulirid decapods, better known as crayfish. Three species occur near Mauds Landing; the red cray or western rock lobster (*Panulirus cygnus*) which is most common; the green cray or painted rock lobster (*P. versicolor*), which occurs sparsely in coral communities; and the painted cray or ornate rock lobster (*P. ornatus*) which is rare in the area.

The most common crustacean at Mauds Landing is the ghost crab (*Ocypode ceratophthalmia*) which inhabits the high intertidal beach zone. These crabs are nocturnal, and venture into the sand dunes to forage at night.

The third major group of mobile invertebrate found in the Mauds Landing area are echinoderms, which include the starfish (Asteroidea), sea urchins (Echinoidea), feather stars (Crinoidea), brittle stars (Ophiuroidea) and sea cucumbers (Holothurioidea). Ninety species of echinoderm, representing 56 genera, are reported as occurring along Ningaloo Reef (Marsh and Marshall, 1983). Like the molluscan fauna, these are mainly tropical species, many of which are near their

southern distribution limit. Common and conspicuous echinoderms found on the reefs near Mauds Landing include the blue starfish (*Linckia laevigata*) and the black holothurian (*Holothuria atra*). Echinoderms are common inhabitants of sandy substrates, and sand dollars (family Laganidae) and heart urchins (family Spatangidae) are expected to occur in the sand flats near Mauds Landing.

4.3.7 Rare or Protected Marine Fauna

The diverse marine fauna of the area includes a number of species which are gazetted as endangered or vulnerable. In addition, the majority of animals which occur within the Ningaloo Marine Park are protected, especially those in the sanctuary zones. The only marine animal gazetted as endangered under the *Endangered Species Protection Act (1992)* which utilises the waters adjacent to point Maud is the Loggerhead turtle. Other Schedule 1 species which occur in the region are the humpback whale, and possibly occasionally the blue whale.

Species listed as "vulnerable" in the area include the green, hawksbill and leathery (leatherback) turtles. All other native marine mammals, birds and reptiles are protected under the *Wildlife Protection Act (1950)*. All invertebrates are protected within the Ningaloo Marine Park except for those listed as food or bait species, such as the Panalid Rock Lobsters.

All organisms are protected within the designated Sanctuary Zones, such as Maud within Bills Bay, which extends to Mauds (Cardabia) Passage. In addition, two of the large seranids, commonly termed cod or groper, are protected under the *Fisheries Act*. These are the Potato Cod (*Epinephelus saillus*) and the Queensland Groper (*E. lanceolatus*).

The other protected animal of note is the dugong (Dugong dugon), which is a Specially Protected Species under the 4th schedule of the *Wildlife Conservation Act (1950)*.

4.4 Social Environment

4.4.1 Landscape

Viewed from Coral Bay Road, the site is approximately 1.5km away and visible in the distance. The view varys according to perspective, however three major existing landscape features are evident:

- the dunal ridges in the west of the site;
- the low coastal dunes behind the beach line; and
- the flat, open landscape of the samphire flat and salt lake in the south and east.

Views available from the site are also variable. The higher dunes in the west of the site allow views to the ocean and Ningaloo Reef, northward to include the coastline, and east over the salt flats to the distant ranges. Views to the south include the large expanse of saline flat. On the lower ground in the east of the site, views are limited to the dune system to the west and north, older dunes to the east, and a continuation of the salt flats to the south.

4.4.2 Land Uses

The 250ha of land which comprises the Mauds Landing Townsite is currently Vacant Crown Land which was gazetted as a townsite in the late 1800's. The land is undeveloped and though no longer part of the pastoral lease of Cardabia Station, has been used for grazing purposes until relatively recently. Until its closure in 1947 as a coastal port, Mauds Landing served many local pastoralists both in the provision of supplies and the shipment out of the area of various goods, predominantly wool. Little remains of the former Mauds Landing jetty, nor physical evidence of its former occupation in more recent times by commercial fishermen. A low-grade light aircraft strip is situated to the immediate south of the townsite boundary.

Unsealed, gravel roads presently provide access from the Coral Bay Road, both to the airstrip and beyond to Mauds Landing, with a small unsealed parking area in the location of the old jetty. The beaches at Mauds Landing are principally used for fishing and beach-walking, and access to the beach by four-wheel drive vehicle is unrestricted. The beaches from Point Maud northward are heavily used by four-wheel drive vehicles, largely for the purposes of access to preferred fishing locations. An access road, though supposedly closed, is also available to Maud Hill which is frequently scaled by visitors to the area.

4.4.3 National Parks

Two National Parks are located in the regional vicinity of the site; the Ningaloo Marine Park and Cape Range National Park (Figure 4.6). Mauds Landing is situated immediately adjacent to the Ningaloo Marine Park.

The Ningaloo Marine Park was established in 1987, and is currently managed by CALM in accordance with the Ningaloo Marine Park Management Plan 1989-1999 (CALM, 1989). The Park includes 260km of coastline from Bundegi Reef in Exmouth Gulf to Amherst Point on Gnarrloo Station in the south, an area of approximately 4,300km^2 (as of May, 1989). The Park therefore includes waters in Exmouth Gulf, protected lagoon waters inside the reef, and deep oceanic waters.

Approximately 224,000ha of inshore waters within the Park are controlled by the State government, with a Commonwealth government component of the Park comprising the outer portion which lies seaward of the State territorial waters. A strip of coastal land extending 40m from the High Water Mark between Winderabandi Point and Amherst Point is also included in the Park. Management of fisheries within the Park boundary are controlled by Federal and State Fisheries Departments.

The Park was established in order to protect the high conservation values of the coral reef system, and to enhance recreational use of its resources. The principal aim of the Park is to provide conservation for the marine environment with recreational use to the extent that it is compatible with conservation of the natural environment (CALM, 1989). Management of the Park is aimed at avoiding use conflicts via the implementation of management zones. Another management objective is to promote an appreciation and understanding of the marine environment by providing information and guidance and by conducting interpretation programmes.

A simple management zone framework has been adopted for the Park, and activities are defined and regulated within each zone. The nominated zones are:

- General Use Zone,
- Recreation Zone, and
- Sanctuary Zone.

Selection of the management zones has been based on the priority-order criteria of:

(i) Representativeness of the reef system for biological diversity and structural variability (Sanctuary Zone).

(ii) The degree of attractiveness and accessibility of the reef for recreational use (Recreation).

(iii) The potential for recreational and commercial use which is not in conflict with other uses or protection of conservation values (General Use Zone).

The broad uses for each zone are summarised as follows. A detailed description of these specifications can be found in the Ningaloo Marine Park Management Plan (CALM, 1989).

General Use Zone

Provides for commercial and recreational uses consistent with conservation of natural resources. Conservation implies fishing within the sustainable limits of the natural resources.

Recreation Zone

Provides for recreational uses consistent with conservation of natural resources. Commercial fishing is not permitted. Commercial concession operations for recreation activities may be provided where there is no conflict with other uses.

Sanctuary Zone

Provides for recreational uses consistent with conservation of natural resources. Commercial concession operations for recreation activities may be provided where there is no conflict with other uses.

The Mauds Landing Townsite lies principally adjacent to Recreation Zone within the Park, with the exception of the tip of Point Maud itself which is adjacent to Maud Sanctuary Zone (Figure 1.5). No development is proposed for Point Maud or Mauds Landing in this location, and therefore all development will lie adjacent to the multiple use recreation zone.

The southern boundary of the Cape Range National Park is located approximately 80km north of Mauds Landing. The Park encompasses an area of approximately 50,600ha (Figure 4.6). This Park was established in 1964 with the objective of conserving and managing the Cape Range terrestrial environment, which forms the spine of the Cape Range Peninsula. A management

plan for the Park has been formulated to take account of integrated management with Ningaloo Marine Park, and is current until 1997.

4.4.4 Commercial Fishing

The oceanic waters of the Park are open to commercial line fishing. Two vessels which operate as recreational charter boats from Coral bay are also licenced to fish commercially as well as carry tourists. There is also one wet-line commercial fisher and one commercial rock lobster diver.

4.4.5 Local and Regional Transport Systems

Coral Bay is presently well serviced by road access and specifically Coral Bay Road which is of good standard having been reconstructed and upgraded in 1990. It extends some 14km from the Learmonth to Minilya main road, the turnoff to Coral Bay being approximately 86km north of Minilya and approximately 140km south of Exmouth. Both the Coral Bay Road and the Learmonth/Minilya Road are sealed and provide all-weather access to the site (except after heavy rain events). Good road access is possible to the North-West Cape and to the North-West of the State as well as south towards Carnarvon via the North-West Coastal Highway which is also sealed.

Access to Mauds Landing townsite is presently via an informal gravel road intersecting with Coral Bay Road approximately 1km east of the townsite. The gravel road is accessible to two-wheel drive vehicles most of the year and leads to the beach at Bateman's Bay in the vicinity of the old jetty. Other four-wheel drive only access tracks also traverse the location providing access to Ningaloo coastal areas to the north.

4.4.6 Aboriginal Heritage

Extensive archaeological investigations have been conducted on the more northerly section of the Cape Range peninsula, but did not include the current site. Previous work indicates that Aboriginal people with a well-developed and diversified coastal economy lived in the Cape Range area intermittently from 25,000 years ago to modern times.

The area of the proposed development is within land traditionally occupied by people of the Baijunju linguistic unit. The Baijunju people inhabited an area roughly delineated by Point

Cloates north of the site to Point Quobba in the south, and inland to Mia Mia.

In 1989 the Department of Aboriginal Sites at the West Australian Museum was requested to arrange a survey of Aboriginal sites in the development area, which was subsequently undertaken by Morse and Wright (1989). The following sections summarise the findings and recommendations of the survey, which have been supported by the Department of Aboriginal Sites. The full archaeological and ethnographical report, including correspondence from the Department of Aboriginal Sites, is included as Appendix J.

4.4.6.1 Archaeology

Five archaelogical sites were recorded from within the study area at Mauds Landing, predominantly comprising of broken shells, stone or glass. The location of each site is shown in Appendix J.

Sites P6180, P6257, P6258, P6259 and isolated finds were assessed as adequately recorded and of low archaeological significance, and it was concluded that subject to approval under Section 18 of the *Aboriginal Heritage Act (1972-1980)* development could proceed. Site P5715 is a soak recorded during a 1985 survey, and it was recommended that the developers apply to the Department of Aboriginal Sites for permission to disturb the site prior to the commencement of earthworks in that area.

It is possible that further archaeological material will be discovered once earthworks begin. This issue is addressed in Section 5.

4.4.6.2 Ethnography

Based on the 1989 survey and an inspection of the site by a senior man of the Baijunju people, it was concluded that there did not appear to be any objections by relevant Aboriginal people to the proposed development.

The soak (Mulanda soak) did not appear to be of any great significance to Aboriginal people, except that it may have some sentimental attachment for those who used to camp at Mauds Landing.

However, the senior man expressed concern that the proposed development should not encroach upon the small dunes on the landward side of the main dunes to the north of the (then) proposed harbour entrance cut. The entrance channel currently proposed has been re-aligned approximately 400 metres to the north of that proposed in 1989, and two fairways of the golf course are proposed in a coastal location in the north of the site. It is therefore likely that the small north dunes will be impacted by the development, however earthworks will be conducted in accordance with the required procedure (see Section 7).

4.4.7 European Heritage

The history of Mauds Landing and Coral Bay is described in Section 1.1. The landing of the schooner 'Maud' in 1884 is the earliest recorded European activity in the region. In 1896 the townsite reserve was gazetted (No. 3699) to protect the site of an existing jetty and government goods shed. In 1915 the town was officially named Mauds Landing (DPUD, 1992). Only old piles from the jetty remain today.

Parts of the site behind the old jetty location have been utilised as a seasonal base by commercial fishermen in recent times, however these uses have not continued and there is only scant evidence of their earlier presence.

5.0 CONSTRUCTION PHASE ENVIRONMENTAL IMPACTS

This section of the document identifies environmental impacts which will occur as a result of constructing the resort and townsite, and identifies mitigation and management strategies to be implemented during the construction phase of the project.

It is intended that a Construction Management Plan (CMP) will be developed by the proponent to provide detailed procedures to be followed by contractors involved in the construction works. The CMP will include the following factors:

- Environmental responsibilities of all construction staff;
- The identification and marking of "no access" areas, including:
  - aboriginal site areas
  - salt lake areas
  - dune conservation areas
  - heavy vehicle and machinery access and "no traffic" areas
- Fuel storage and refuelling areas and associated management (including spill cleanup);
- Stockpiling and materials handling areas;
- Dewatering and product disposal (including a Dewatering Management Plan);
- Noise and dust suppression;
- Building rubble, construction spoil, and refuse disposal;
- Temporary effluent treatment and disposal;
- Wildlife protection and conservation areas; and
- Fire management and suppression.

As a component of the CMP, the proponent will conduct induction courses for all construction phase employees and contract personnel, which will include information regarding the environmental attributes of the region and their sensitivities, together with information defining total corporate and individual environmental responsibilities. All contractors and construction personnel will be legally bound to compliance with environmental management procedures. All contracts between the proponent and construction companies and their personnel will contain clauses specifying necessary procedures and conduct within the site and surrounding areas, and appropriate punitive measures in regard to non-compliance.

The purpose of the Construction Management Plan will be to prevent any unnecessary disturbance to the surrounding environment during the course of construction operations.

5.1 Vegetation, Flora and Fauna

Whilst impacts to vegetation caused by construction will be minimised by careful management of operations as specified in the Construction Management Plan, removal of the existing vegetation will be required in all areas proposed for built structures, for golf course fairways, and other formal passive recreation areas.

The significance of the vegetation losses may be assessed in the context of the findings of the vegetation, flora and fauna investigations presented in Section 4.0.

The key findings of these investigations were:

- The variation in vegetation types from dune areas within the site are not considered significant from a local perspective ie. there is no unique vegetation type within any one area of the dunes.

- In a regional context, the dune system containing the site is relatively narrow, and therefore as a whole the system has some value. However, the area of dunes in the proposed site is a relatively small portion of the system as a whole, and consequently would be assessed as having moderate value.

- The saline flats are part of a series found along the coastline between Carnarvon and Onslow. Beard (1975) maps the Mauds Landing saline flats as one of three such features behind coastal dunes in the region (although only large flats were noted), and

shows similar vegetation adjoining Lake MacLeod, approximately 60km south of the site.

- Of the approximate 800ha of saline flat vegetation which occurs in the Point Maud area, only a relatively small portion will be directly impacted by construction of the project. Drainage patterns in most of the area will remain unaffected.

- Site surveys carried out for this proposal found large areas of characteristic saline flat vegetation and landforms at Bruboodjoo Point and Point Cloates, whilst landform analysis reported in Hesp (1986) indicates a number of both large and small saline flats occur along the western coast of the North West Cape where typical saline flat vegetation would be expected to occur (see Section 5.2).

In terms of flora, investigations reported in Section 4.0 concluded that in terms of conservation value, given the relatively small size of the site, the extensive distribution of many of the flora species and the limited degree of disturbance of much of their ranges, the overall conservation value for flora of the site is considered to be low to moderate.

There were no Declared Rare Flora recorded for the site, however 2 Priority species were identified. The value of these two species may be considered higher than the remainder of the flora however, it must also be noted that these species have not been specifically surveyed on a regional scale and it is likely that they are more common than current herbarium collection suggest (Appendix H). This conclusion is supported by the geographical range extensions for several species which resulted from survey work reported here.

In regard to fauna, investigations carried out for this proposal are reported in Section 4.0 and concluded that:

- No rare or endangered fauna were identified from the site.

- The samphire flats of *Arthrocnemum* sp. and associated salt lakes are widely distributed on a regional scale from Carnarvon in the south to Onslow in the north.

- The sparsely vegetated beach front and coastal heath/scrub habitats are also widely distributed on a regional scale, and are both encompassed by the Cape Range National Park.

- The Coral Coast Resort project area is expected to contain fauna species which are generally widespread and abundant in similar habitats throughout the region. Based upon the current study, the project area is not expected to contain regional endemics or locally restricted species.

5.2 Landforms and Drainage Patterns

Establishment of the facilities proposed for the Coral Coast Resort will result in physical changes to the existing landforms and drainage patterns, including the following;

- A 45ha portion of land currently comprising sandy beach, foredunes, and salt flat will be transformed to built structures associated with the marina and entrance channel, and will form a new shallow sub-marine basin connected to the ocean;

- A 170ha area of salt flats and 75ha (including the above) of foredune surrounding the marina will be transformed to a combination of hard structures (resort buildings, golf course, roads, homes) and landscaped areas;

- A 6ha area in the parabolic dune landform to the immediate west of the proposed marina will be modified by recontouring and transformed to built forms including roads, houses and associated services;

- The proposed entrance road from Coral Bay Road will require an area of salt flat of 1.5km length and approximately 20m width, resulting in an area of approximately 3ha to be filled to enable road construction. The drainage pattern within the salt lake will be preserved by the incorporation of a series of culverts extending under the road. Sizing and location of the culverts will be carried out by the project engineers with the objective of maintaining the surface hydraulic connection and drainage pattern between the areas divided by the road formation.

- A 5ha area of pleistocene dune formation and vegetation will be cleared and physically modified by construction works for the Services/Light Industrial Area, east of the Coral Bay townsite.

- Following agreement of a new location for the airstrip, a 1.5km long by 50m wide area totalling 7.5ha will be modified by clearing and earthworks to establish the airstrip.

Site selection criteria will favour areas where earthwork requirements are minimal in order to minimise construction costs.

In total, landform modification will directly impact an area of approximately 266.5ha, comprising salt flats, contemporary and relict shore parallel beach ridges, holocene parabolic dunes, and pleistocene dunes.

The significance of this impact must be considered in both regional and local context. In a local context, the following factors are relevant:

- all of the landforms which will be affected by construction will continue to be represented by large examples in the periphery of the site, viz:

  - the area of salt flat in the Point Maud hinterland totals approximately 800ha, of which 170 ha will be modified.

  - the area of relict foredunes between Point Maud and the parabolic dunes south of Greyling Hill total approximately 350ha, of which 75ha will be affected by construction.

  - the area of parabolic holocene dunes which form the Point Maud foreland totals 250ha, of which 6ha will be modified.

  - there are very extensive areas of pleistocene dune landforms in the hinterland of the Point Maud area, totalling thousands of hectares, and in this context modifications for the Services/Light Industrial Area and airstrip will affect a negligible area.

In a regional context, additional factors are relevant in terms of landforms and habitat.

The accumulation of holocene sediments and associated landforms extends fully along the coastline of the North West Cape, and whilst varying in width and landform development, is quite narrow.

Hesp (1986) examined and described Holocene landforms adjacent to the Ningaloo Marine Park, and mapped a number of coastal locations in accordance with a scheme of geomorphic units.

Evolutionary processes were also described. Data presented by Hesp (1986) and in the Coral Bay Planning Study (DPUD, 1992), show that the proposed development site includes and presents a physical junction of Holocene parabolic dunes which form the Point Maud foreland; an adjoining hinterland comprising saline flats; and the southern portion of a relict foredune plain, however includes only a portion of the geomorphic units represented in the coastal region as a whole.

Site surveys carried out for this proposal examined local coastal areas to the north and south of the site. In combination with the work of Hesp (1986) and geomorphic mapping information presented in DPUD (1992), the following factors have been identified:

- Parabolic dunes, both vegetated and stable, are extensive both north and south of the site, with major hind-shore accumulation at Point Anderson to the south, and Bruboodjoo Point, Point Cloates, Norwegian Bay and Winderabandi Point (and several other more distant locations) to the north.

- Large scale saline flats (relict tidal flats) exist at Bruboodjoo Point and Point Cloates, which also present parabolic dunes behind the shore, and the junction between the parabolic dunes and saline flats as at Point Maud. A further large-scale saline flat is located some 7km south of Yardie Creek, whilst similar examples have been mapped at several locations other than those mapped by Hesp.

- Relict foredune plains are common on the coast to the south and north of Point Maud.

The available local and regional data therefore demonstrate that the landforms which will be affected by construction for the project are typical of the North West Cape coastal fringe and occur widely in this area. The physical inter-relationship presented by the juxtaposition of parabolic dunes and a hinterland of saline flats and the physical habitats which are created are demonstrated at least two nearby locations; Bruboodjoo Point and Point Cloates. Relict foredune plains are common.

These data lead to the conclusion that construction impacts of the project will not fully remove any local examples of any characteristic landform type, or effect any landforms or landform processes which are not represented at several more locations in the coastal region to the north and south.

5.3 Dewatering

Preliminary site investigations indicate that excavation to completed depths varying from minus 2.5m AHD to about minus 4m AHD will intersect sediments which comprise sands and relatively weakly cemented calcarenite.

Following the removal and stockpiling of topsoils and vegetation, excavation will be carried out using large scrapers and excavators. This work will be carried out during the dry season, however dewatering of the basin will be required for excavation below sea level.

The most appropriate methods for the management of water produced by the dewatering program will be determined during the detailed design phase of the project and will be specified as part of the Construction Management Plan, which will be prepared in consultation with appropriate authorities, and agreed with the DEP.

The two principal water management methods, which could be used either separately or in combination consist of return to the superficial aquifer by soil absorption (recharge) or evaporation.

The first stage of developing the Dewatering Management Plan will be the estimation of the quantity of water which will be produced and its likely quality, based on trials carried out on the site. Initial investigations indicate that the water produced will be saline and possibly hypersaline, consistent with the coastal location of the site and landform/soil/groundwater characteristics. The amount of suspended and settleable solids which will be carried by the dewatering produce may vary depending upon the specific nature of sediments being removed during each phase of the operation.

The second phase will identify environmentally acceptable opportunities for selection of sites which could be used for water treatment by sedimentation ponds prior to disposal by either recharge to the shallow aquifer from where the water was abstracted or evaporation, or a combination of these processes.

Recognising that excavation of the marine basin will be carried out during the dry months of the year and that evaporation potential is very large (around 3m/annum), it is envisaged that a satisfactory plan for management of dewatering product can be developed with little constraint.

Construction of the marina basin will be carried out under landlocked conditions, and all excavations and associated hard walling will be completed prior to opening of the ocean connection. The harbour entrance will be excavated by a floating dredge process when all inland marina construction is completed. The timing of the final connection to the ocean will be controlled in recognition of the need to manage turbid water escape to the ocean. Water quality in the marina, and tide, swell and weather conditions will be primary factors in the scheduling of this phase of the operation.

Sediments generated by marina basin excavation will be deposited, dewatered and compacted for the access road from Coral Bay Road, the resort and residential areas around the harbour and as required for the golf course and other appropriate areas. Where necessary supplementary water will be employed for dust suppression purposes.

5.4 Supply of Construction Materials

Although the final choice of quarry has not yet been made, existing quarries within 70km of Coral Bay are considered to be the most attractive sources of rock for the breakwaters. Environmental impacts resulting from the supply of these materials will be in accordance with Government approvals for these operations.

The quarried rock (Trealla limestone) would be transported to site on private and public roads at a rate of up to 1500 tonne per day. This will involve about 6 to 8 trucks completing a total of about 35 round trips per day. The construction of the breakwaters will take about six months to complete.

Other construction materials required will be sourced from existing operations at Carnarvon, Exmouth and other areas within the region as available, with the balance of materials being trucked from Perth or other sources as necessary.

Apart from the process of using spoil from the marina excavation for filling of development areas, which is discussed elsewhere, the procurement of construction materials for the project will not result in any local impacts.

5.5 Coastal and Nearshore Landform Modifications

Coastal works will be limited to construction of the entrance channel and associated breakwaters and to establishment of an onshore kiosk in the vicinity of the old Mauds Landing jetty site.

The entrance channel to the marina will be dredged to minus 3.5m AHD and will extend approximately 400m offshore. The dredged channel will be protected by rock breakwaters which will extend across the foreshore and seawards for a distance of approximately 400m.

The seabed in the vicinity of the proposed marina is bare of any attached biota and has a relatively low conservation value in this regard. The total foreshore and subtidal area that will be directly affected by the entrance channel dredging and breakwater construction will be less than 2ha.

Works which impinge on the near-coastal area such as the golf course, residential accommodation and parking areas and accesses will be constructed in such a way as to avoid unnecessary alterations to the existing land forms commensurate with appropriate design practices, and to ensure that re-stabilisation and on-going stability of the landform is maintained.

5.6 Coastal Processes

As outline in section 4, the beaches of the southern portion of Bateman Bay are believed to be stable and in balance with the persistent low-amplitude swell regime.

The construction activity associated with the breakwater and dredging of the entrance channel for the proposed marina are therefore likely to have negligible impact on the coastal processes in the southern portion of Bateman Bay.

5.7 Nearshore Water Quality

As described in Section 3, the excavation of the marina and associated waterways is planned to be completed in the "dry". This is a technique where the area is dewatered and land-based equipment (scrapers, excavators and trucks) are used to remove sediments for transfer to areas requiring fill. Groundwater produced by dewatering will be handled in accordance with the Construction Management Plan (see Section 6). The marina will be fully excavated and walling installed prior to excavating the entrance channel to ensure this work will not effect nearshore water quality.

The entrance channel to the marina will involve some dredging using floating plant. The type of dredge is likely to be a cutter-suction dredge, which uses a rotating cutter to agitate the sand and a slurry pump to suck the sand into the hydraulic system and pump the sand and water slurry to

a contained settlement pond onshore. The settlement pond will allow the sand to settle out and specially designed and operated outlets will release the excess water to soak into the developed area.

The cutting action of this type of dredge can create a fine sediment plume under some conditions, however the marine sediments in the vicinity of the entrance channel are calcium carbonate sands, so the turbid plume from this source is expected to be minimal in extent. CCMD's coastal engineering advice is that any suspended sediment in the plumes is anticipated to settle on the seabed within close proximity of the marina entrance, and certainly within the 5km distance to the closest reef structures supporting biota.

The coastal waters near to the entrance channel which would be subject to increased turbidity do not support any seagrass beds or coral communities that would be vulnerable to adverse impact as a result of suspended solids settlement from any turbidity plume.

It is not intended for the marina to be dredged "in the wet". However, if such construction methods were necessary, the marina entrance channel would remain closed whilst internal dredging was in progress, to prevent the loss of any suspended sediments to the ocean.

The sediments in the marina basin will include a higher proportion of fine particulates from the nearshore sediments, including gypsiferous muds and clay size materials, which would settle less rapidly once suspended in the water column. Dredging operations within the marina would need to be monitored to ensure that they did not cause unacceptable export of turbid water to the adjacent nearshore coastal waters. In the event that monitoring identified a visible turbidity plume from dredging operations which could potentially reach sensitive coral communities, then either a silt curtain would be installed, or the marine entrance channel would be re-closed to reduce the on-going loss of suspended sediments.

The rubble mound breakwaters will be constructed from freshly quarried Trealla Limestone. The rock will be dumped from trucks into the water and selectively positioned using a large hydraulic excavator working from the top of the rubble mound. This type of construction has been commonly used on breakwaters around the State.

At some stages, a small plume of fine material may form, however as this plume moves away from the breakwater construction site under the action of the prevailing currents, the fine particles will gradually settle to the sea bed within the distance (5km) to reef areas. The

occurrence of any turbid plumes are likely to be temporary and intermittent, and no long-term impacts are expected to occur.

Recognising that the persistent wave-driven currents over the reef will ensure that the incoming, new ocean water pushes any plume away from the reef and that water currents are routinely from south to north, under typical conditions none of the fine material in these minor plumes is expected to travel toward or reach the Maud Sanctuary Zone or the Ningaloo Reef south of the site.

In terms of fuel management, the refuelling area for construction machinery and any fuel storage vessel utilised on-site will be located within an area which is sealed with a continuous double-thickness polythene sheet covered with soil, of sufficient volume to contain any spill which may occur during re-fuelling in accordance with standard practice in hazardous materials management. In the event that any spill occurs outside the compound, the contaminated soil will be immediately removed for disposal in an approved manner.

5.8 Marine Flora and Fauna

The nearshore area adjacent to the marina is devoid of attached flora or fauna that may be affected by project construction. The nearest sensitive marine habitat to the project area is a scatterded seagrass meadow located approximately 2km northeast of the site. No significant adverse impact to the seagrass meadow is anticipated from construction activity.

5.9 Traffic

Construction operations will generate considerable traffic including heavy haulage plant bringing rock for the marina and breakwaters and other construction materials, together with passenger vehicles. This additional traffic will be heaviest during the first 6 months of construction when the breakwaters are being constructed. Later phases of the project will mainly result in housing construction activities, resulting in lower numbers of smaller vehicle movement.

Access to the Townsite for construction purposes will be via the main entry road off Coral Bay Road. This entry will be constructed to a trafficable stage as the first construction activity.

Subject to final planning, construction workers will initially be accommodated in the caravan park area. Management during the first phase of the project will seek to minimise the impact of additional and heavy vehicles so as to minimise the potential for impact on existing landuses at the Coral Bay townsite.

5.10 Noise and Dust

The existing Coral Bay Townsite is about 3km from the closest part of Coral Coast Resort and 2km from the proposed Service/Light Industrial Area. Cardabia Station is about 1km from the nearest part of Mauds Townsite.

The site is located north of the Coral Bay townsite, therefore the prevailing winds which are consistently southerly and south-westerly winds will tend to attenuate noise transmission in the direction of the Coral Bay settlement. These factors will mitigate against the creation of nuisance noise conditions at the Coral Bay settlement, however there will need to be appropriate surveillance of reception levels at Coral Bay in order to ensure that acceptable noise levels are maintained.

The transmission of construction noises to the adjacent marine environment is not anticipated to cause any significant adverse impacts. The major noise components will be the dredge and intermittent pile driving operations. There is currently no expectation that blasting will be needed.

As discussed in Section 4.3.4, dugong (*Dugong dugon*) may pass through the nearshore waters adjacent to the marina, particularly within the seagrass meadows located approximately 1.5-2 km to the northeast. There are few publications describing the response of dugongs to sounds. They are believed to have poor hearing in the low frequencies but have been observed to react to boat noise and other sudden noises within 1km of the source (Preen, 1992).

It is unlikely that marine noise associated with routine construction activities would significantly affect dugongs or other marine fauna in the vicinity however surveillance of possible dugong movements in the nearshore environment would be appropriate in the event that any non-routine exceptionally loud noise was anticipated.

Dust generation will be managed in accordance with industry practice for sensitive environments, and will employ conventional water suppression and surface stabilisation techniques in order to maintain dust below acceptable levels. Much of the sediment to be excavated during marina construction will be damp or wet and have minimal dust nuisance risk during initial handling.

5.11 Pastoral Activities

Increased traffic and low-level noise may cause some inconvenience to the owners of Cardabia Station. CCMD has liaised closely with the owners and have provided full details of the proposal. All reasonable efforts will be made to minimise inconvenience to pastoral operations at Cardabia Station, and close liaison will be maintained.

5.12 Social Environment

5.12.1 Landscape

The Mauds Landing development site is not visible from the Coral Bay townsite, however it can be seen at 2km in the distance from Coral Bay Road in the north-westerly and northern viewshed from the approach to the townsite.

The site's existing landscape characteristics will change during the construction period, and will be characterised by the presence of construction machinery, stockpiled construction materials, a temporary administration area, and other facilities in the distance to the north from Coral Bay.

From the waters of Bateman Bay, the marina construction will be screened behind the foredunes, however the construction materials and machinery at the marina entrance channel and breakwaters will be clearly visible.

During construction, controls and management established within the Construction Management Plan such as the delineation of no access areas, stockpiling areas, conservation areas, will be implemented to minimise the impact on the affected and surrounding landscape.

Construction access to the site will be limited to designated construction roads, and programming of works will ensure that stockpiling areas and other major activities are confined to designated development areas.

The dune areas in the west of the site which are not affected by development will be declared "No Access" areas and marked accordingly. Similarly, the two salt lakes are intended to be retained as existing landscape and natural drainage features, and will consequently be protected from disturbance via signposting and induction of contractors.

Extensive landscaping will be incorporated as part of the infra-structure stage of the works to ensure that tree planting programmes and developed landscapes are established as soon as possible. Plant stock will be sourced from local nurseries where possible, with species nominated as project approvals become more advanced.

An extensive tree planting programme using indigenous species such as coastal morts and local white gums will provide a basic landscape theme, with selected palm species used in some areas.

As the main development area will be filled to approximately 2.5m, plant stock will have a considerable low-salt content soil base for growth.

5.12.2 Recreational Usage

In the interests of public safety, access to the Mauds Landing development area during the construction phase will be restricted and appropriate warning signs will be erected.

The beach in the immediate vicinity of the site will therefore not be available for recreation during this time, however similar areas both north and south of the site will remain accessible. The beach environment will be re-opened to unrestricted public access (with the exception of off-road vehicles) for recreational purposes at the completion of construction.

Following construction, the breakwaters are expected to be a popular location for fishing and viewing the landscape.

5.12.3 Aboriginal and European Heritage

Based on the conclusions of the archaeological and ethnographic assessment for the project, it is possible that aboriginal artefacts or possibly skeletal material could be disturbed during earthworks at the site. However it should be noted that the construction of the western component of the golf course will require fill, not excavation, and that if at any time artefacts or other material is disturbed, work in the area will cease immediately and the procedure detailed in Appendix J will be implemented.

No sites of European heritage are expected to de disturbed during construction.

6.0 OPERATIONAL STAGE ENVIRONMENTAL IMPACTS

6.1 Terrestrial Environment

6.1.1 Stormwater and Effluent

As a result of the proposal to implement water sensitive design objectives in detailed engineering design for the resort and surrounding areas, the absence of any routine discharge to the marina, and the utilisation of the existing natural drainage processes in the low-lying areas to the east of the site for evaporation and infiltration, there will be no significant impacts to either the marine or terrestrial environment from stormwater disposal.

Little if any additional stormwater will be introduced to the existing surface drainage catchment. Whilst the introduction of impermeable surfaces in the development area will reduce the proportion of direct infiltration in this area and will produce run-off, this will be mitigated by the excision of the marina from the local catchment.

Recognising that landuses in the resort will be restricted to residential/recreational and associated services, stormwater may be expected to carry very low contaminant levels. Contaminants should be limited to low levels of oil and grease from road surfaces and suspended particulate matter. Oils and greases will be trapped in conventional roadside pits, however any remaining contaminants transferred to the drainage dissipation areas will be readily degraded under the prevailing climatic conditions.

Similarly, the transfer of sewage from the resort townsite some 3km inland (Figure 1.2) for treatment in lined ponds and disposal of treated wastewater by evaporation and infiltration under managed and monitored conditions, and possibly by irrigation to horticulture, will reduce the potential for impacts to the marine environment. It is recognised that this treatment plant would require a Works Approval and Licence under Part V of the *Environmental Protection Act*. Ultimately, it is anticipated that a package treatment plant will be constructed when sufficient demand is generated (refer Appendix B).

It is important to recognise there is 3m per year evaporation potential, a relatively small quantity of effluent to be disposed, and a large area of land available to effect disposal by evaporation and/or evapotranspiration from horticulture and irrigation.

Regular routine monitoring of groundwater quality in the shallow aquifer down-gradient of the disposal area (see Section 7) will enable early-warning of any nutrient movement towards the coast such that corrective procedures to the disposal methodology could be introduced before any significant risk of contaminant migration could develop. Based on landforms, topography and rainfall characteristics of the area, the rate of groundwater movement to the coast is expected to be extremely slow, which will allow close monitoring and remedial action if necessary.

In summary, under properly managed conditions, the capability of the terrestrial environment at the proposed disposal area for treated sewage disposal is considered to be very high. This factor, the opportunity to closely monitor disposal impacts, and a substantial safety factor in terms of time and distance from the ocean, lead to the conclusion that environmental impact from treated sewage disposal will be negligible.

The potential for the future connection of the existing Coral Bay townsite by others to the proposed sewage treatment plant will introduce significant environmental benefit to the area.

Sewage treatment and disposal at Coral Bay is currently utilising technology, management practices and disposal sites which are unacceptable for the location, and create a risk of contaminant entry to the ocean at Bills Bay. In fact, it is very likely that contaminant entry to Bills Bay is already occurring, which has resulted in the initiation of a detailed water quality monitoring study by the Marine Impacts Branch of the Department of Environmental Protection.

The opportunity to potentially remove this source of contamination must be viewed as a highly positive consequence of the proposal.

6.1.2 Municipal Refuse

Solid municipal refuse generated by the Coral Coast Resort will be disposed by managed land fill at a site to be located near the Service/Light Industry Area (Figure 1.2). This area is about 3km inland and has an elevation of approximately 12m above sea level. The refuse site would require to be gazetted under the *Health Act*, which is administered by the Office of Waste Management. By landscape management adjacent the main Coral Bay Road, it will be possible to visually conceal the service industry and associated solid and effluent disposal areas. The existing natural sand ridges will provide adequate visual shielding from the common access into the service industries area and the airstrip.

Due to the prevailing climatic conditions (low rainfall), leachate generation from landfill is likely to be very small. Groundwater monitoring will be employed to determine whether leachate production is occurring and will allow any corrective measures to prevent any significant groundwater contamination and subsequent contaminant entry to the marine environment.

As for the disposal of treated effluent, the capability of the terrestrial environment for the acceptance of landfill leachate at the proposed disposal facility may reasonably be concluded to be very high. The presence of approximately 12m unsaturated soil profile, the high evaporation potential, the low quality of existing groundwater, the 3km physical buffer between the site and the ocean and the ability to readily monitor groundwater downgrade of the site lead to the conclusion that municipal refuse disposal can be readily managed such that risks of environmental impact will be negligible.

It is proposed that refuse disposal operations at the current Coral Bay Tip will be transfered to the new landfill site. The current site is badly located in terms of its location near Bills Bay and its visibility from the main Coral Bay entrance road. Further, the site is located in a low lying area which will exacerbate contamination risk in the under-lying groundwater.

6.1.3 Power Generation

Potential impacts from power generation include atmospheric emissions, fuel spillage, noise and landscape modification.

Diesel turbine plant with a low level stack is the current preferred option for the project, located in the SLIA (Figure 1.2). The selection of high quality technology will enable relevant standards for stack emission quality to be routinely met.

The small quantity of emissions which will be generated, the absence of any other significant emissions in the area, low background concentrations of diesel combustion by products (SO_x, NO_x) and the prevailing wind climate all mitigate strongly against the potential for any significant environmental impact to derive from power generation stack emissions.

Recognising the long term of the project, the proposal to establish plant incrementally and the high cost of diesel based generation, the potential use of renewable energy sources will remain under review.

Fuel transport and storage will be managed in accordance with standard industry practice. Storages will be located in lined and bunded areas and monitoring of groundwater will be carried out.

The plant will incorporate appropriate noise suppression such that there will be no risk of noise nuisance at Coral Bay or the proposed Coral Coast Resort townsite, in accordance with standard industry practice.

As for the services located near to the proposed power station site, the prevailing landform characteristics together with appropriate landscape survey techniques will be utilised to conceal the power station from the Coral Bay Road.

The implementation of appropriate fuel management practices, the large assimilative capacity of the terrestrial environment at the proposed location of the plant, the ability to monitor the groundwater beneath the plant, and the presence of a 3km physical buffer between the site and the ocean, indicate that the risk of significant impact to the marine environment from power generation operations will be negligible.

6.1.4 Land Based Recreation

The establishment of the Coral Coast Resort will increase land based recreational activities in the surrounding onshore environment. This increased usage will need to be actively and formally managed.

CCMD will cooperate and liaise closely with the Shire of Carnarvon and CALM in order to introduce appropriate active and passive management and education of users of the area, in order to minimise the environmental impact risks of increased on-shore recreation.

Control of access to protect sensitive coastal landforms, vegetation and habitats, and protection of native fauna, controlling feral animals, rubbish collection and fire management will be the focus of management requirements. CCMD intends to prohibit the keeping of cats or dogs in the resort and townsite area and will liaise with the Shire of Carnarvon to achieve this objective through planning controls available to Council.

It is proposed that the management philosophy adopted should be in accordance with the established approaches developed for the Cape Range National Park located to the north of the site, where environmental characteristics and recreational uses are directly comparable to those of the project area.

Management of recreation in the terrestrial environment to National Park standards but on an informal basis, should realistically be considered to be environmentally acceptable. The development of a recreation management plan, in conjunction with the Shire of Carnarvon and CALM may be considered appropriate and further discussions in this regard are proposed.

6.2 Marine Environment

6.2.1 Coastal Processes

Longshore transport of sediment is anticipated to be negligible under the prevailing swell wave regime.

During extreme cyclonic storms, there is expected to be significant movements of sand along the southern shores of Bateman Bay toward Point Maud. Calculations suggest that during a particularly severe cyclone as much as 10,000m^3 of sand could be moved towards the breakwater site (Port and Harbour Consultants, 1989). The breakwaters would interrupt this movement and the sand would be trapped on the north-eastern side of the entrance breakwaters. A similar volume would be eroded over the first few hundred metres of beach southwest of the breakwaters.

Over a distance of about 300 to 500m either side of the entrance breakwaters, new beach alignments will evolve during such an extreme cyclone. These alignments will be angled to the incoming swell waves that will persist after the cyclone has passed. In the period following a severe cyclone, the swell will re-shape the beaches to the pre-storm alignments and profiles.

Given the demonstrated stability of the shoreline (Appendix G), impact risks from localised modification of coastal processes should not be significant. However, shoreline profiles can be actively managed using standard civil engineering practices if required.

6.2.2 Marina and Nearshore Water Quality

6.2.2.1 Surface and Groundwater Inputs

There will be no routine discharge of stormwater to the marina or marine environment. All stormwater will be managed on-shore. The stormwater handling system will be designed to cater for normal rainfall events. Cyclonic rainfall may cause discharge to the marina, however it is

important to recognise that under these circumstances drainage of stormwater to the marine environment will likely occur under natural conditions in any case.

Whilst detailed groundwater investigations have not been carried out, site characteristics identified from available topograhic maps, site surveys and water table levels identified in shallow excavations for soil profile examination indicate that the water table gradient is very flat and groundwater movement is extremely slow. This is supported by the fact that apart from a small area west of Giralia Range and the shallowest water at Point Maud, all the unconfined groundwater in the area is saltier than 6,000mg/L total soluble salt (TSS), indicating that the saline groundwater is being diluted very slowly by freshwater recharge, if at all (Rockwater Pty Ltd 1994, Appendix C). There is also evidence in the topographic data and from water levels and the salinities observed beneath the salt lakes that groundwater may in fact be moving inwards from the sea into the area of the salt lakes.

These background conditions will strongly mitigate the potential for migration to the marine environment of any contaminants which might enter the shallow groundwater beneath the resort.

The resort and townsite will be fully sewered and therefore entrained contaminants will be transferred away from the site.

Further reduction of the potential for contaminant entry to the marine environment will be derived from procedures which will be implemented to manage irrigation and fertilisation practice in the resort and townsite and the golf course (see Section 7).

6.2.2.2 Metal Contamination

In common with all marinas, heavy metals are expected to accumulate in small amounts in the sediments within the marina from anti-fouling and other paints used on boats. However given the very low densities of moored boats that will occupy the marina (most boats will be trailered and will not be anti-fouled), the metal absorption capacity of the natural calcareous sediments, and the high flushing efficiency of the marina design (Appendix G), the potential for metal accumulation is considered unlikely to be significant.

Anti-fouling paints containing tributyl-tin (TBT) are prohibited for use on vessels of length less than 25m, or on any piling, pier or other structure in an enclosed or semi-enclosed water body in Western Australia (*Environmental Protection Amendment Regulation No. 2, 1991*). Pursuant to

the regulations, no marine structures within the development will be treated with organotin anti-fouling paint.

The marina development will not include hardstand areas to be used for boat maintenance which may otherwise contribute significant quantities of metals contained in paint flakes.

6.2.2.3 Other Vessel Discharges

The discharge of sewage, hydrocarbons or litter from boats into the marina will be prohibited and all users of the marina will be informed accordingly using signage and public education. Adequate rubbish bins and sewered toilets will be provided in public areas around the marina, and a sewage pump-out facility will be provided for boats equipped with holding tanks.

The potential will exist for accidental hydrocarbon spillages into the marina due to vessel accidents, fire or spillages during refuelling. However the volumes involved would generally be small and would be unlikely to cause significant environmental impact.

Nonetheless, management items which will be incorporated in the marine facilities at the marina are as follows:

- an oil absorbent boom capable of confining any spillage to the marina;
- an air curtain at the entrance to protect the coral garden;
- a refuelling safety plan;
- a management procedure for regular inspection, cleaning and maintenance of refuelling equipment;
- a sullage and bilge water pump-out facility; and
- a metals monitoring programme for marine biota and sediments.

An Emergency Response Plan for accidental spillages or other emergency will be formulated for the marina (see Section 7).

6.2.2.4 Marina Flushing

The water quality which will prevail in the marina and associated waterways will be dependent upon the following factors:

- the quality of the source water;
- the management of nutrient and pollutant inflow; and
- the mixing and exchange processes.

The source water for the marina and associated waterways will be ocean water from the southern portion of Bateman Bay. As described in Section 4 and Appendix G, this area is flushed by tidal and wind driven currents and the influx of ocean water caused by waves breaking on the nearby Ningaloo Reef. These persistent flushing mechanisms will ensure that the source water is clean and clear ocean water.

Management of nutrient and pollutant inflow have previously been addressed.

The most important mechanisms that will contribute to water exchange in the proposed marina are tidal variations and wind-induced currents. The marina design will optimise tidal exchange by incorporation of the following criteria.

- A wide (110m) entrance channel;
- no barriers to prevent circulation; and
- rounded interior marina corners to promote circulation.

Appendix G provides a calculation of the contribution of tidal forcing alone to marina flushing, using the tidal prism ratio method. The astronomical tides in Bateman Bay are semi-diurnal (two cycles per day) with the typical spring range being 0.9m and a typical neap range of 0.4m.

The tidal prism ratio (TPR) is defined as the volume of tidal flow entering the waterway from low to high tide to the total volume of water in the marina and waterways. For the proposed development the TPR has been calculated to be about 25% for a 0.9m tidal range (spring tides) and about 10% for a 0.4m tidal range (neap tides).

Table 6.1 shows predicted effective water exchange and flushing caused by spring and neap tides.

TABLE 6.1
Estimated Tidal Exchanges

Location	Estimated Efficiency Coefficient"	Estimated Tidal Exchange (%)	
		Spring Tides	Neap Tides
Marina	0.7	18	9
Coral Garden	0.4	10	4
Eastern Swimming Beach	0.4	10	4
South-Western Waterway	<0.05	<2	<0.5

Note: The estimates of tidal exchange are for one tidal cycle. There are two tidal cycles each day.

These estimates indicate that the Marina, Coral Garden and Eastern Swimming Beach will all be well flushed by the action of the astronomical tides. The South-Western Waterway arm, which will extend up to 800m from the Marina, will not be as well flushed by the action of the astronomical tides, however wind action is anticipated to be significant in this section of the marina, as discussed below.

Winds blowing over closed-end waterways are known to create water motions that are important for water mixing and exchange. McKeehan (1975) specifically studied the effects of wind on water motion in waterways. This work included a theoretical approach as well as presenting extensive measurements taken in existing residential canal estates. This study shows that wind blowing over a closed-end waterway causes:

- a slope of the water surface, raising the level at the down-wind end of the waterway; and

- down-wind water motion in the upper levels of the water profile and a reverse motion in the bottom layer.

The water flow at the surface is usually taken to be in the range of 2 to 5% of wind speed, decreasing rapidly with depth and reaching zero at about one-third of the total depth. Underneath this level, there is a reverse flow in order to satisfy conservation of mass.

As outlined in Section 2.1, there are strong sea-breezes at Mauds Landing during most afternoons. The wind speed is typically 20 kmh or greater. The South-Western Waterway has been aligned to take full benefit of these persistent winds. Local topography and the layout of the buildings along the waterway will funnel the southerly and southwesterly winds along this waterway and cause strong wind-induced currents and associated water exchange.

These commonly occurring southerly winds will be an important mechanism in the flushing of the South-Western Waterway. Using the methods outlined in McKeehan (1975), it was calculated that a southwesterly wind of 20 kmh would cause the top one-third of the water column to move at an average rate of 0.08m/second. This would be accompanied by a return flow of equal volume in the bottom two-thirds of the water column. As this waterway is about 800m long, it would take about three hours for the top one-third of the water column to travel the length of the waterway. This will result in exchange of about one-third of the volume of the waterway with the Marina water. As the sea-breezes often last up to six hours, these events would cause significant exchange between the waterway and the Marina.

The anticipated flushing rates described above are considered adequate to ensure that water quality within the Marina remains essentially similar to that of the adjacent coastal waters.

6.2.2.5 Conclusions

There will be no routine input of contaminants to the proposed marina or adjacent nearshore waters. The development will be deep sewered and all stormwater will be directed away from the coast and the marina and into the adjacent salt flat.

Tidal and wind induced flushing of the marina will cause an efficient exchange of water.

It is therefore considered most unlikely that the water quality in the marina would deteriorate, nor would it cause deterioration in water quality in the adjacent nearshore waters. However, a Water Quality and Sediment Monitoring Programme will be implemented to ensure that this is the case (Section 7.2.3).

The opportunity that is presented by the proposal for the Coral bay community to be connected to the sewage treatment facility will mitigate the existing concern regarding eutrophication in Bills Bay and is considered to be a major positive impact of the proposal.

6.2.3 Effects of Increased Recreation on Ningaloo Marine Park

The Coral Coast Marina Resort will be primarily a recreational/tourist development and consequently the Ningaloo Marine Park will be the focus of recreation activities pursued by both visitors and residents. The proposed development will accommodate, over a twenty year period, a seasonal peak population for up to approximately 5,000, in addition to those at Coral Bay.

As discussed in Section 2, visitor numbers in the Coral Bay area will increase irrespective of whether the present proposal proceeds.

The sustainability of the increased recreation pressure upon the Ningaloo Marine Park is a significant environmental concern and requires ongoing diligence in the implementation of appropriate management. Assessment of the extent and implications of increased human usage of the Marine Park resources is a difficult task. The degree of impact will depend on such factors as the type of activity, the intensity of use, the sensitivity of specific habitats and biota to a particular disturbance, and the success of management.

The potential impacts of increased recreation associated with the present proposal also needs to be measured against the potential impacts that would occur with continued growth of the Bills Bay settlement in the absence of the Coral Coast Resort, including intensification of the existing pressure resulting from the townships location immediately adjacent to the Bills Bay Sanctuary Zone.

Practical consideration of potential impacts, based on existing knowledge and experience of recreational utilisation of Ningaloo Marine Park, enables some conclusions to be derived. The background to these conclusions is presented in the following sections which address recreational activities in terms of the following categories:

- beach activities;
- general boating;
- offshore recreational fishing;
- diving and collecting; and
- commercial tourism concessions.

Beach Activities

The beaches within the general area are attractive for swimming, beach fishing and other conventional seashore activities.

Because it is sheltered from the prevailing winds and sea conditions, the beach at the southern end of Bills Bay (adjacent to the Coral Bay settlement) is the most popular swimming beach in the area. Wave conditions and the greater exposure of the beaches adjacent to the proposed resort site create conditions which are less attractive for family swimming. It is anticipated that the major swimming activity at the Coral Coast Resort will occur at the beaches to be constructed within the marina, however the construction of the breakwaters may result in the lee side (northern) becoming more acceptable for swimming than under existing conditions. It is currently proposed to establish a shark net across the two groynes on the north side of the entrance channel to create a safe ocean swimming beach.

The beach at Bills Bay is presently also used for launching and retrieval of boats, vehicle and trailer parking and boat storage, all of which create aesthetic and safety problems and conflict with swimming and other passive uses. The proposed development will offer an alternative facility from which to base boating and tourism activities and importantly provides an opportunity for appropriate authorities to remove or reduce the recreational boating usage and safety conflicts at Bills Bay.

For regular visitors to Coral Bay who currently enjoy the remoteness and solitude of the beach along the north coast of Point Maud, the proposed development will cause some reduction to the amenity values which are presently available although this is a subjective matter. The major impacts upon these users would be the visual intrusion of the breakwaters in the beach landscape and the modification to access along the full length of the beach. Increased usage of the beach environment is a further impact.

The impacts of the resort and marina construction will include changes to access along the beach, and increased use of the beach for conventional sea shore activities.

Additional fishing use on the beach will occur and in the medium to long term, current bag limits for recreational fishes are considered in need of review to protect the fishery. The efficiency of ongoing unconstrained vehicle access along the full length of the beach should also be given consideration with a view to limiting this access to appropriate areas.

Boating

The marina will provide mooring facilities for approximately 200 boats, together with launching ramps. Most boats using the marina will be trailered and the moorings will be mostly occupied by short-stay visitors who choose not to launch and retrieve their boat each day.

The main potential impacts of the increased number of boats within the Marine Park will arise from illicit waste discharges and accidental fuel spillages, together with potential damage from anchoring.

The marina will provide facilities for sullage pump-out and ancillary waste disposal, so wastes from increased boats should not become an environmental problem provided there is adequate ongoing education and policing. There is a growing awareness in the community with respect to waste disposal. Adequate waste receptacles at the boat launching and mooring areas, together with appropriate signage, will assist to promote community responsibility.

The marina will provide the opportunity for the appropriate authorities to limit or prohibit offshore mooring of boats in the Bills Bay area. The removal of moorings, the reduction or prohibition of anchoring near the beach and the reduction of boat traffic in the shallows of Bills Bay will prevent damage to coral formations close to the shore, which is presently of significant concern, and would derive a positive impact in this area.

Boat excursions from the marina will invariably involve short-term anchorage at specific localities. Fragile corals are particularly vulnerable to anchor and chain damage and recovery can be slow. At popular diving and fishing reefs, increased boating activity may result in significant damage if left unmanaged.

Random anchor damage is an unavoidable consequence of boating activity. However education of boaters, including appropriate signage at the launching ramp, will encourage sensitive anchoring and minimise the likelihood of significant impact. Another potential solution is the provision of permanent mooring bouys at popular locations, so that vessels simply tie-off to the mooring while diving, thereby avoiding continual random anchoring. CCMD wishes to pursue the implementation of such matters with CALM leading to early establishment of beneficial facilities.

The long term commercial success of the resort and townsite project relies on the maintenance of the marine recreational resources in optimal condition. In addition to the need to foster the achievement of management targets to meet CALM objectives for the marine park, CCMD therefore has a financial interest in these objectives and will cooperate closely with appropriate authorities in the education of recreational users of the area in regard to environmental management objectives and practices.

Recreational Fishing

Fishing is a major recreational activity at Coral Bay (Section 4), and fishing pressures will increase with increased visitors and residents to the area. The recreational fishery includes beach fishing, fishing from dinghies within the lagoon, and fishing outside the reef from larger vessels and charter boats. The Ningaloo Marine Park Management Plan (CALM, 1989) prohibits fishing or spearfishing within the Maud Sanctuary Zone (Figure 4.6), thereby concentrating the activity to the north and south, or outside of the reef.

The increased population that will arise from the proposed development will increase recreational fishing pressure, which may cause catch rates to decline and the size of fish taken to be smaller, although specific bag limits and minimum fish sizes are currently in place.

It may be that current bag limits are too generous to sustain the increased pressure. Increased monitoring and research will be necessary to determine management requirements, particularly for resident reef fishes which would be the most vulnerable to increased fishing effort.

The provision of a focal point for boat launching and retrieval adjacent to premises which are to be provided by CCMD for CALM's use will provide a substantially improved opportunity for recreational fishing catches to be monitored and policed. Policing of recreational catches is considered an essential component of future management.

Diving

Diving with snorkle or SCUBA to explore the coral reef is increasingly popular within Ningaloo Marine Park. Observation of whale sharks during their annual autumn migration is also rapidly growing in popularity.

Recreational diving upon coral reefs is essentially non-intrusive and increased activity would not cause significant impact. Appropriate visitor education would assist to ensure that diving did not in itself cause damage to fragile corals or other reef organisms.

The whale shark season at Ningaloo Reef now has an international reputation and each year large numbers of divers visit the area to dive and take photographs. Fears have been expressed that the high level of human contact could be harmful to the sharks, although this has not been substantiated.

CALM, in consultation with the Exmouth and Coral Bay communities, has developed a code of conduct aimed to prevent possible adverse effects from whale sharks diving. Riding and touching the sharks is now illegal, the number of divers in contact with a shark at any time is limited and vessel movements near sharks are controlled. The evidence indicates that whale sharks are not perturbed by increasing human contact, indeed, they appear to be coming more accepting of it (Taylor, 1994). Nevertheless, the potential impacts of further increased activity in this regard needs to be monitored and managed to ensure that it remains an on-going opportunity.

Collecting

Prior to the declaration of the Marine Park, collecting shells, aquarium fish, corals and other marine fauna was a common recreational activity. These activities are anecdotally reported as having occurred at a large scale and the collection of live mollusc species is believed to have caused significant ecological impact.

The collection of live marine animals (other than those used for personal consumption and bait) is now prohibited within Ningaloo Marine Park. Provided there is adequate signage to inform all visitors to the Coral Coast Resort of this prohibition, there is negligible risk that increased public use of the Park will significantly increase the unauthorised collection of plants or animals.

Commercial Tourism Concessions

The increased visitor numbers to the area and the facilities provided by the Coral Coast Resort will inevitably result in increased demand for tourism concessions within nearby areas of the Marine Park (eg. glass-bottom boat, reef viewing tours, charter fishing vessels, dive tours etc.). The present proposal does not include the provision of any concessional use of Park waters, which would require independent approval from the National Parks and Nature Conservation Authority and the Minister for Conservation and Land Management, together with possible assessment by the DEP and approval by the Minister for the Environment.

Whilst CCMD has no authority or formal role in the approval process for commercial concessions, the Company's view is that concessions should only be allowed if "they are consistent with the purpose of the Park and consistent with the preservation of environmental values. They must not impinge on rare or fragile ecosystems, impair key features of the landscape, or increase visitor pressure to an unacceptable level or detract from the reasonable enjoyment of the Park by the public. The use of the facility or service provided by the concession should enhance the appropriate use and enjoyment of the park and should ameliorate the impact of visitors" in accordance with the Ningaloo Marine Park Management Plan (CALM, 1989).

Concluding Remarks

The resolution of potential conflicts between the economic and social desire to enable increased recreational uses of the Ningaloo Marine Park, and the need to manage the park on a sustainable basis in accordance with the current management plan is a complex issue.

By virtue of its role as a proponent for the Coral Coast Resort. CCMD is a "stakeholder" in the future use and management of the park but has no decision making authority to enable it to implement management.

The authority to implement those measures lies with State and Local Government, and in this regards CCMD wishes to cooperate and closely liaise with government authorities in order to achieve the necessary outcomes.

It is inevitable that increased visitation and recreational uses of the marine park will occur regardless of whether the Coral Coast Resort is to be constructed. It is also reasonable to conclude that the Coral Coast Resort will facilitate this increased visitation and recreational usage.

However, the socio-economic and environmental desirability of this facilitating role must be evaluated in the context of the opportunity to formalise intensify and most importantly to fund environmental management, from income derived from the visitor centre which is to be provided to CALM by CCMD, and with recognition of the following beneficial outcomes of the project;

- the new marina will create an opportunity for appropriate government authorities to relocate boating launching and harbourage (except coral viewing boats) from Bills Bay

to the new marina and thus reduce impacts on the coral communities from current activity;

- the provision of a sewage treatment plant will provide the opportunity for current unacceptable sewage disposal at Coral Bay to be discontinued and will remove the largest current source of potential (or actual) contaminant discharge to the nearshore waters of the marine park; relocation of the existing rubbish tip will also be beneficial in this regard;

- the channelling of boating activity through the new marina's boat launching ramps, which will be situated in close proximity to premises proposed for CALM's use will provide the best possible opportunity for ongoing education of park users, and most importantly to actively oversee and police the fishing and other activities of marine park users.

- substantial revenue generated for CALM by the visitor centre could support user education, active policing of park users, and the provision of offshore management facilities such as mooring buoys in popular diving areas to minimise anchor damage; and;

- in the absence of a new resort and associated facilities at Mauds Landing, growth in visitation and recreational uses will focus upon the Coral Bay townsite and Bill's Bay. Previous studies have concluded that the Coral Bay townsite has neither the resources nor services to cater for this growth to environmentally acceptable standards and have identified risks of environmental degradation in Bills Bay as a result of current uses.

On the basis of these factors, CCMD concludes that the nett outcomes of establishing the Coral Coast Resort and thus focussing and facilitating management of marine and terrestrial resources by appropriate government authorities, will be environmentally beneficial. CCMD is of the opinion that the benefits of providing financial resources to environmental management, which resources will be derived from visitor centre business, cannot be underestimated and provide an opportunity for CALM to intensify and extend active management which could otherwise not be obtained. This active management will be fundamental to the sustainability of recreational uses of the Ningaloo Marine Park.

6.2.4 Commercial Fishing

The oceanic waters of the Park are open to commercial line fishing. Two vessels which operate as recreational charter boats from Coral Bay are also licensed to fish commercially as well as carry tourists. There is also one wet-line commercial fisher and one commercial rock lobster diver.

Commercial fishing in Western Australia is regulated and managed for sustainable yield by the Fisheries Department. In Ningaloo Marine Park commercial fishing is regulated in consultation with CALM and no new licences will be issued for operating inside of the reef. Additionally, some existing licences are not transferable.

It is also anticipated that the significantly increased tourism activity generated by the development will result in additional fishing and diving charter vessels, each of which may want to supplement their income through commercial fishing. However pursuant to their licence conditions, these vessels will be subject to the regulatory control of the Fisheries Department and will in accordance with current regulations only be allowed to fish outside of the reef.

The provision of facilities for commercial fishing and charter vessels inside the proposed marina will alleviate the present problems associated with their operations at Bills Bay and conflict with recreational users.

6.3 Social Environment

Following its establishment and stabilisation as a resort township, community service provision such as health care, education, emergency services, law enforcement, traffic management and other similar matters will proceed in accordance with conventional local and state government procedures.

7.0 ENVIRONMENTAL MANAGEMENT AND MONITORING

7.1 Terrestrial Environment

7.1.1 Stormwater

Management of stormwater generated by the resort and residential areas will be achieved by the implementation of water sensitive design to the greatest practiced extent during the detailed design phase of the project and the disposal of stormwater on a fully on-shore basis using a combination of evaporation and infiltration processes. Sites for stormwater management infrastructure will be chosen during the detailed design phase of the project and will be located in areas where minimal impact to existing vegetation, landforms and landscape can be achieved. Monitoring the stormwater system will be carried out in accordance with normal practice for civic infrastructure and will include surveillance of the systems physical and structural integrity, servicing of sediment traps and oil/grease separation devices.

7.1.2 Effluent Disposal

As previously described, management of sewage to environmentally acceptable standards will be achieved by full reticulation of the development, treatment at a site remote from the coast (in the SLIA), and disposal using practices which will not pollute the superficial aquifer, or create public health risk.

As an environmental safe-guard, monitoring of the success in maintaining acceptable water quality in the underlying aquifer will be accomplished by the establishment and periodic sampling of an observation bore network to be located downgradient of the treatment plant and disposal area. This will be a component of a Shallow Groundwater Monitoring Programme (see Section 7.1.4) and will ensure that the existing problems of nutrient-enriched water entering the marine environment are not replicated. The identification of unacceptable water quality in the superficial aquifer would be appropriately rectified according to the contingencies included in the Programme, or by such engineering solutions which may be necessary.

7.1.3 Golf Course Reticulation and Fertiliser Management

The irrigation and fertiliser requirements of all landscaped areas within the development,

including the golf course and other recreational areas, will be the subject of a comprehensive Nutrient and Irrigation Management Plan (NIMP). The NIMP will apply to all grassed/landscaped areas requiring water and fertiliser application, including active and passive recreation areas, and broadly incorporate the following components:

- Recommendations for low water/nutrient requirement grass/vegetation types;
- Prescribed fertiliser applications (if necessary) on the basis of regular chemical analysis of soils and plant nutrient status;
- Prescribed watering/reticulation regime based on historical climatic data updated on a continual basis by on-site measurement and observation;
- Management strategies to minimise nutrient export from the site; and
- An annual fertilser application audit.

The NIMP will be formulated in conjunction with the Department of Environmental Protection.

Grass and landscaping vegetation types will be carefully selected to minimise both water and fertiliser requirements. Species such as saltene couch, zoysia and other appropriate grasses will be considered. The water volumes used for irrigation will be limited to the minimum necessary to maintain adequate ground cover and growth for the proposed purposes. It has been established that use of the natural artesian waters in conjunction with local soils provides an excellent growing medium for grasses. Any supplementation of nutrients by fertiliser applications will be minimal, and will be applied only in accordance with the NIMP formulated for the site.

Any fertilisers kept on-site will be stored above anticipated maximum flood levels, and will be provided with adequate weather protection to ensure that fertiliser discharge into the natural environment does not occur.

Fertiliser application will not be a major requirement for landscaping and residential garden propagation and maintenance provided plants are irrigated with artesian water. An education programme will be put in place to ensure that residents are fully advised of requirements in regard to nutrient control and management within the Resort, together with active discouragement of fertiliser use within residential areas.

7.1.4 Groundwater Protection

The shallow, saline groundwater below the resort and townsite will be protected by the implementation of the Nutrient and Irrigation Management Plan for the site. Westward groundwater movement below the site has been estimated to be very slow, however a Shallow Groundwater Monitoring Programme (SGMP) will be formulated for monitoring of groundwater throughout the project area, including the golf course, adjacent to and surrounding the marina, and between residential areas and Bateman Bay and at the Services/Light Industrial Area where the borefield will monitor the power station, fuel storages municipal landfill and treated effluent disposal area.

The SGMP will include:

- the installation of shallow groundwater monitor bores at regular intervals throughout the project area and adjacent to and between the SLIA and the coast;
- the collection of baseline data prior to the commencement of operation; and
- regular measurement of groundwater quality within the bores including:
  - nutrients (phosphorus, nitrogen, ammonia, nitrite/nitrate);
  - salinity; and
  - bacterial counts.

The SGMP will be formulated in conjunction with the Department of Environmental Protection and the Water Authority of Western Australia.

In addition to the above, a comprehensive water quality monitoring programme will be formulated for the waters of the marina to ensure that water quality is acceptable (see Section 7.2.3).

The Birdrong artesian formation, from which the resort water supply will be drawn, is located approximately 800m below ground surface. The abstraction of water from the formation will be the subject of a license approval from the Water Authority of Western Australia, and will require annual reporting of abstraction volumes and quality to the Authority. CCMD will comply with the requirements of the Water Authority of Western Australia in regard to groundwater abstraction.

7.1.5 Power Generation

Management of power generation plant will be in accordance with standard industry practice in regard to system performance, combuston efficiency, and stack gas quality.

Any stack gas monitoring will be carried out in accordance with the requirements of the Department of Environmental Protection, Pollution Prevention Branch.

Transfer and storage of fuels will be carried out in accordance with designs and procedures specified by the DEP and other appropriate government authorities.

Groundwater monitoring will be carried out in accordance with the Shallow Groundwater Monitoring Programme (Section 7.1.4) which will be developed in the detailed design phase of the project.

7.1.6 Refuse Disposal

Municipal refuse will be managed using compacted landfill with dust litter and fire suppression, in accordance with the requirements of the Shire of Carnarvon and the Health Department of Western Australia.

Monitoring of groundwater quality downgradient of the borefield will be carried out in accordance with the Shallow Groundwater Monitoring Programme (Section 7.1.4). Monitoring of dust suppression and windblown litter containment will be carried out on an as needed basis.

7.1.7 Tourism

The number of visitors using accommodation at the resort, including all short-term residents, campers, caravaners and back-packers, will be monitored on a routine basis as part of the normal business management procedures implemented by the operator.

7.1.8 Rehabilitation

The primary requirement for rehabilitation will occur after the construction phase of the project. All areas which are disturbed by construction but are not required for resort/townsite purposes, will be stabilised and revegetated using appropriate land care procedures and techniques.

Rehabilitation success will be monitored, and any necessary corrective works or maintenance will be carried out in conjunction with landscape management and maintenance practices for the resort and townsite.

Surveillance of natural areas within the townsite but beyond the resort and residential areas will be carried out on a routine basis and corrective works implemented as necessary.

7.1.9 Fire Management

Fire management in the vicinity of the resort/townsite and Service/Light Industrial Area will be carried out in accordance with requirements of the Shire of Carnarvon and Bush Fires Board of Western Australia.

Firebreaks will be established and maintained in strategically appropriate locations and fire hydrants for fire suppression will be constructed in accordance with conventional industry standards. Whilst normal operational procedures will not include firing of the deposited refuse, there will be risk of nuisance fires at the landfill site. Appropriate firebreaks and firefighting procedures will be developed for the facility in consultation with appropriate authorities.

7.2 Marine Environment

7.2.1 Coastal Processes

The proposed development is not expected to have significant effect on the coastal processes in Bateman Bay. This will be confirmed by a Shoreline Movement Monitoring Programme (SMMP).

Each year for the first three years following development, the beaches each side of the breakwaters will be surveyed for 2km as part of the SMMP. Beach profiles will be taken at 250m centres and extend from +3m AHD to -6m AHD or 1000m offshore. A level will be taken every 10m or at change of grade. The surveys will be completed with a horizontal accuracy of +/- 1m and a vertical accuracy of +/- 0.1m. The results will be plotted on a series of profiles which include the as-constructed and previous monitoring survey results collected as part of this investigation.

Significant regular movement of sand along the beach littoral zone in the vicinity of the marina is not anticipated, and it is therefore considered unlikely that the project will require sand by-

passing to replenish the beach. However there may be some accretion near the northern breakwater during severe storms and cyclones. If sand by-passing is occasionally considered necessary this can be achieved using conventional earthmoving equipment. Access will be provided from the breakwater to the beach on both sides of the marina for this purpose. CCMD will liaise with appropriate government authorities as required and will carry out any necessary works in consultation with government.

7.2.2 Engineered Structures

The proponent will maintain the breakwaters and harbour revetments to the satisfaction of the Department of Transport, including necessary repairs if any damage is sustained during a severe cyclone, in accordance with townsite management responsibility.

The entrance channel bathymetry will be monitored on an annual basis. There is adequate capacity for sediment storage against the breakwaters to cater for expected accretion over the next 40 to 50 years, consequently there should be little sedimentation within the entrance channel within that time. If dredging should be required, a dredge from Carnarvon can be mobilised.

Prior to construction the proponent will liaise with the Shire of Carnarvon and the Commissioner for Soil Conservation to develop a Foreshore Management Plan (FMP) to the satisfaction of the DEP and DPUD. This will ensure the protection of Point Maud.

The FMP will include:

- the maintenance of public access to the beach at Mauds Landing, including the area through the proposed golf course;
- the formalisation of parking and picnic areas in appropriate locations;
- the definition of dune preservation and fencing areas;
- rationalisation of 4WD access to the beach area in the vicinity of the site; and
- appropriate signage for public education.

Construction of the marina entrance channel will prevent the movement of 4WD vehicles along the full length of the beachfront. Recognising the likely increase in use of the beach adjacent to the resort, CCMD will liaise with the Shire of Carvarvon and CALM in order to determine appropriate control measures for vehicle access and movements along the beach and will cooperate in the implementation of vehicle access restriction which may result from that consultation.

7.2.3 Water Quality

Water quality problems in the marina harbour are not anticipated (Section 6.2.2). It is anticipated that water quality will be maintained to be compatible with the following appropriate beneficial uses:

- Direct contact recreation.
- Ecosystem protection.

Recommended water quality criteria appropriate to these beneficial uses are defined in the EPA (1993) Bulletin 711. The minimum water quality criteria that would be required to be met in the marina are described in Tables 2.2 and 3.2 of Bulletin 711.

The marina water quality will be maintained primarily through:

- a marina design which will ensure adequate flushing;
- a disposal of stormwater to the salt flats inland of the site;
- appropriate nutrient and irrigation management within landscaped areas of the development;
- the provision of deep sewerage; and
- the provision of sewage pump-out facilities and adequate rubbish disposal facilities at the marina.

The marina harbour would be inspected routinely by the marina manager and any corrective action required to maintain water quality and aesthetics to the required standard will be implemented immediately. Routine maintenance will include removal of any flotsam or other debris.

Prior to dredging the marina entrance channel, the proponent will prepare an Emergency Response Plan (ERP). The ERP will address contingencies for:

- fire and explosions;
- collision between vessels;
- fuel and oil pollution; and
- sewage and chemical spills.

The ERP shall be to the satisfaction of the DEP upon advice from the Department of Transport and shall be trialled, updated and maintained in accordance with its requirements.

Prior to dredging the marina entrance channel, the proponent as Waterways Manager for the marina will prepare and implement a Water Quality and Sediment Monitoring Program (WQSMP) in accordance with the requirements of the DEP. The objective of the WQSMP will be to allow assessment of the success of management strategies outlined herein. The sampling periods and intensity of testing will need to allow for appropriate statistical comparison between sampling periods. Water quality parameters measured will include:

- suspended solids;
- dissolved oxygen
- bacteria concentrations; and
- nutrient concentrations.

Sediments will be monitored for particle size, nutrients, metals and hydrocarbons. Specialist marine scientists engaged by the proponent will supervise the monitoring and interpretation of the results and recommend management action.

The Water Quality and Sediment Monitoring Program will run for a five year period or until such lesser time that it can be verified to the satisfaction of the EPA that the development has had little or no detrimental impact on the existing environment.

7.2.4 Management and Monitoring of Recreation Impacts

The proponent will have no jurisdiction to manage recreational activities within Ningaloo Marine Park. The ultimate responsibility for the control of potential impacts of recreational activity within the Ningaloo Marine Park is with CALM and the Fisheries Department. CALM's management strategy is described in the Ningaloo Marine Park Management Plan (CALM, 1989).

The proponent will aid CALM to avoid or mitigate adverse effects to Marine Park conservation values, as follows:

- Office space will be provided by CCMD within the resort development for use by CALM and Fisheries Department staff.

- CCMD will construct and establish a Marine Park Visitor Research and Education Centre within the resort, to provide for research education and interpretation programs for visitors and residents.

- CCMD will co-operate with CALM officers to establish and maintain appropriate awareness and appreciation of the attributes of the Marine Park.

- CCMD will distribute literature to all visitors to raise their awareness of the recreational potential of the terrestrial and marine habitats and their environmental limitations.

- CCMD will conduct induction courses for all employees and contract personnel, which will include information regarding the environmental attributes of the region and their sensitivities, together with information defining individual environmental responsibilities.

- CCMD will erect signs at appropriate locations within the development to notify visitors of their environmental management responsibilities.

- CCMD will incorporate environmental protection clauses in all contracts let during the project and will otherwise assist CALM officers, where practicable, to implement and police the Ningaloo Marine Park Management Plan (CALM, 1989), particularly those aspects pertaining to visitor education and awareness.

Increased recreational activity within the Coral Bay region is consistent with management of the Ningaloo Marine Park. CALM's management goals and objectives for the marine park are derived from the CALM Act:

> *"to fulfil so much of the demand for recreation by members of the public as is consistent with the proper conservation and restoration of the natural environment, the protection of indigenous flora and fauna and the preservation of any feature of archaeological, historic or scientific interest".*

The Management Plan for Ningaloo Marine Park (CALM, 1989) identified the following principal goals and objectives:

- conservation: conserve marine species, marine ecosystems and natural, historic and cultural features;

- recreation: facilitate public enjoyment of the Park to the extent compatible with conservation of its natural environment;

- education: create an awareness and understanding of the marine and coastal environment and the limitation on their use.

The objectives of management include the following:

- to provide recreational opportunities and facilities which maximise the quality of experience sought by visitors;

- to promote an appreciation and understanding of the marine environment and sites of cultural significance in the Park, through information, interpretation and education;

- to manage recreational and commercial fishing without adversely affecting fish populations.

- to provide for tourism, to the extent consistent with maintenance of resources.

The Ningaloo Marine Park Management Plan (CALM, 1989) is due for review and/or revision within the next five years. Additional management consideration will likely then be appropriate to facilitate on-going management control of the increasing recreational pressures and the relocation of a significant proportion of recreational activity from the Coral Bay settlement to the Coral Coast Resort. In particular, it is likely that resolution of potentially competing recreational uses, for example diving and fishing, may require reconsideration in some parts of the recreation zone north of Point Maud.

CCMD has no authority or jurisdiction over marine park or terrestrial environmental management (beyond the townsite boundary). However, because of the reliance on maintaining environmental quality in the region CCMD is a stakeholder in the area and has parallel objections to CALM in regard to environmental management matters.

CCMD anticipates ongoing input to the management planning and implementation process and will make recommendation for improvement of environmental protection where appropriate.

The proponent will assist CALM, where practicable, in the review and implementation of the Ningaloo Marine Park Management Plan.

8.0 CONCLUSIONS

8.1 Overall Benefits of the Project

The importance of tourism as a significant growth industry within the Gascoyne Region, together with the high and continually expanding demand for tourist facilities outside the existing townsites of Carnarvon and Exmouth, is widely recognised by both the public and private sectors.

However, in an inappropriate location unmanaged development with an attendant increase in human presence, may result in unacceptable impact on the surrounding environment, particularly the Ningaloo Marine Park.

Recent regional studies have identified the Mauds Landing site as the preferred location for future development in the Gascoyne region.

The proposed establishment of the Coral Coast Resort at Mauds Landing provides significant benefits in both a regional and local context:

- The opportunity to implement significant improvements in the management of effluent, nutrients and waste disposal, removing the potential impact of leachates from the existing Coral Bay townsite on the marine environment;

- The provision of technically advanced utilities including effluent treatment and disposal, potable water and electricity supply and the opportunity for connection of the existing Bills Bay settlement to these services;

- Resolution of the pressures for further expansion of Bills Bay to cater for increasing demand for both short and long-term accommodation and the relief of present overcrowding problems;

- The availability of significantly expanded and improved community facilities and services to residents, tourists and local pastoralists;

- The opportunity for the relevant authorities, notably the Department of Conservation and Land Management and the Department of Fisheries, to develop and institute more effective management controls on the Maud Sanctuary Zone and the Ningaloo Marine Park as a consequence of a new source of financial resources with which to implement a permanent on-site presence, better control of recreational fishing, surveillance of recreational boats, greater control of marine safety, substantially safer boat access and management, and substantially improved boat handling and launching facilities;

- Through the provision of a Visitor and Research Centre by CCMD, the opportunity for the Authorities, particularly the Department of Conservation and Land Management, to undertake a much higher level of active management due to a significant presence in the south of the Ningaloo Marine Park, while at the same time increasing visitor awareness and education of the Park and the marine ecosystem;

- The opportunity for the Department of Conservation and Land Management to substantially increase its revenue sources from the Ningaloo Marine Park through entry fees to the visitor centre. The revenue likely to be generated for CALM in the first year of operation has been conservatively estimated at $250,000;

- The establishment of a broad range of community services and facilities including public utilities at no cost to State Government or Local Government;

- The construction of substantially improved airstrip facilities;

- Increased local employment opportunities, broadening and diversifying the local economic base and reducing present seasonality;

- Substantially increased opportunities for the development of local businesses in the tourism, services, maintenance and retail sectors;

- Introduction of greater competition in the provision of goods, services and consumables; and

- An enormous impact on the tourism and construction industries of the Gascoyne Region

8.2 Environmental Impacts

The Coral Coast Resort has been planned and designed with the specific objective of minimising the potential impacts to the marine, terrestrial and social environments. Environmental management strategies for the project are summarised in Section 8.3.

Primary impacts associated with the implementation of the proposal during the construction phase of the project are the modification of vegetation, flora, and fauna, drainage patterns and landforms, dust and noise generation, nearshore water quality, traffic, and landscape alterations.

A Construction Management Plan will be formulated to prevent unnecessary disturbance to the surrounding environment. Additionally, the following factors must be considered on assessment of construction phase impacts:

- The site is predominantly located on a relict saline tidal flat, of which only a small proportion will be disturbed. This landform is well-represented both north and south of the site. Both the vegetated dunes in the west of the site and the salt lake will not be developed and will be protected from disturbance;

- The development area has been assessed as having relatively low flora, vegetation and fauna diversity. No rare and endangered or gazetted species occur on the site;

- Natural drainage patterns of the saline flat will be preserved;

- The sea bed in the vicinity of the proposed marina and associated breakwaters is effectively free of attached biota;

- The construction of the breakwater and dredging operations will be managed with the objective of reducing effect on both nearshore coastal process and water quality to negligible levels;

- Dewatering of the marina basin will be conducted to ensure that no turbid water is discharged to the marine environment;

- Access of construction machinery to the site will be appropriately managed to ensure minimum nuisance;

- Noise and dust generation from the project will be monitored and managed to ensure minimum nuisance;
- Inconvenience to pastoral operations and operators in the area will be minimised;
- Controls will be implemented to minimise the impact of construction on the surrounding landscape;
- In the interests of public safety, access to Mauds Landing will be restricted during construction; and
- In the event that aboriginal sites or artefacts are discovered during construction, the response strategy will be implemented immediately.

8.3 Environmental Management

During the construction and operation stages of the project, detailed environmental management strategies will be implemented to mitigate anticipated environmental impacts of the project, including:

- Appropriate and detailed design of the proposal;
- Induction courses for all personnel to ensure environmental responsibilities are fully understood;
- All construction contracts will incorporate environmental management clauses which bind both contractor and employee to environmental management performance standards.
- Conservation of vegetation and dunes outside of the development area;
- No development on the salt lakes;
- The containment and treatment of de-watering product during the construction of the marina;

- Fuel storage management during construction and operation;
- Effective noise and dust control during construction;
- Strategic response to the discovery of aboriginal sites, artefacts or other material;
- The formulation and implementation of management plans and monitoring programmes including:

  A Construction Management Plan (including a Dewatering Management Plan);
  A Nutrient and Irrigation Management Plan;
  A Shallow Groundwater Monitoring Programme;
  A Shoreline Movement Monitoring Plan;
  A Foreshore Management Plan;
  An Emergency Response Plan for the marina; and
  A Water Quality and Sediment Monitoring Programme for the marina;

- The prohibition of cats or dogs from the resort, including residential areas;
- Assistance to CALM and CALM officers, where practicable, to implement the Ningaloo Marine Park Management Plan, particularly those aspects pertaining to visitor education and awareness;
- Assistance to CALM in the management of shore-based recreation in the area;
- The provision of office space within the resort development for use by CALM, Fisheries Department staff and other researchers; and
- The operation and maintenance of specified infrastructure by CCMD for a minimum period of 5 years from construction, to ensure responsible environmental management.

8.4 Conclusions

The environmental management benefits of the proposal will accrue to the existing Coral Bay settlement and Ningaloo Marine Park, and for the future visitors to this area. These benefits could not be realised in the event that this proposed project does not proceed.

The realisation of the Coral Coast Resort will provide an important focus for recreation based activity adjacent to the Ningaloo Marine Park. The resort has been appropriately planned and will be designed, constructed and managed in an environmentally responsible and sustainable manner.

9.0 PROPONENT'S COMMITMENTS

The proponent undertakes to comply with each of the commitments made in this document to the satisfaction of the relevant statutory authority. This section of the report summarizes individual commitments which have been made within this Public Environmental Review, and is divided into pre-construction, construction, and post-construction and operational phases of the project.

9.1 Pre-Construction Phase

1. The proponent will accommodate environmental management objectives listed below in the following commitments within the detailed design stage of the project to the greatest possible degree, to the satisfaction of the Department of Environmental Protection, the Shire of Carnarvon, and the Department of Planning and Urban Development.

2. During the detailed engineering design phase of the project the proponent will design the provision of services to the resort, including reticulated sewerage and a sewage treatment plant and treated effluent disposal facility at the Service/Light Industrial Area, and potable water and electricity supply systems, in a manner which will allow their expansion for the connection of the existing Coral Bay Townsite to the new services, to the satisfaction of the service authorities. The proponent will not, however, be responsible for the connection of the existing Coral Bay Townsite to the new services provided.

3. The proponent will design stormwater handling and disposal facilities during the detailed engineering design phase of the project, to direct stormwater away from the marina and marine environment, in accordance with current regulatory design specifications and to the satisfaction of the Shire of Carnarvon and the Water Authority of Western Australia.

4. Prior to the commencement of construction, the proponent will prepare a Construction Management Plan (CMP) which will set out appropriate procedures for environmental management of construction activities.

   The CMP will provide detailed procedures to be followed by contractors involved in the construction works. The CMP will include the following matters:

- Environmental responsibilities of all construction staff;
- The identification and marking of "no access" areas, including:
  - aboriginal site areas
  - salt lake areas
  - dune conservation areas
  - heavy vehicle and machinery access and "no traffic" areas
- Fuel storage and refuelling areas and associated management (including spill cleanup procedures);
- Stockpiling and materials handling areas;
- Dewatering and product disposal (including a Dewatering Management Plan);
- Noise and dust suppression;
- Building rubble, construction spoil, and refuse disposal sites and methods;
- Temporary effluent treatment and disposal procedures;
- Wildlife protection responsibilities and conservation areas; and
- Fire management and suppression procedures.

The CMP will be formulated in conjunction with, and to the satisfaction of, the Department of Environmental Protection (DEP) and the Shire of Carnarvon.

5. As a component of the CMP, a Dewatering Management Plan (DMP) will be formulated by the proponent to:

- estimate the quantity of water which will be produced;
- determine the likely quality of dewatered product based on trials carried out on the site;
- estimate the amount of suspended and settleable solids which will be carried by the dewatering product;
- identify environmentally acceptable sites for water treatment by sedimentation ponds prior to disposal; and
- analyse disposal options - either recharge to the shallow aquifer from where the water was abstracted or evaporation, or a combination of these processes.

The DMP will be formulated in conjunction with, and to the satisfaction of, the DEP and the Shire of Carnarvon.

6. Prior to construction the proponent will liaise with the Shire of Carnarvon and the Commissioner for Soil Conservation and DPUD to develop a Foreshore Management Plan (FMP), to ensure the protection of Point Maud and the foreshore environment.

The FMP will include:

- the maintenance of public access to the beach at Mauds Landing, including the area through the proposed golf course;
- the formalisation of parking and picnic areas in appropriate locations;
- the definition of dune preservation and fencing areas;
- rationalisation of 4WD access to the beach area in the vicinity of the site;
- appropriate signage for public education;
- spoil and landform stabilisation and revegetation methods; and
- fire management procedures.

The FMP will be formulated in conjunction with, and to the satisfaction of, the DEP and Department of Planning and Urban Development (DPUD), and the Department of Conservation and Land Management (CALM).

9.2 Construction Phase

7. The proponent will conduct induction courses for all construction phase employees and contract personnel, which will include information regarding the environmental attributes of the region and their sensitivities, together with information defining individual environmental responsibilities, to the satisfaction of the Shire of Carnarvon. All construction contracts will incorporate appropriate environmental management clauses, which bind both contractor and employees to protect identified environmentally sensitive areas, such as the coastal dunes.

8. All reasonable efforts will be made to minimise inconvenience to pastoral operations at Cardabia Station, and close liaison will be maintained.

9. Management during the first phase of the project will seek to minimise the impact of additional traffic and heavy vehicles thereby minimising the potential for impact on existing landuses at the Coral Bay townsite.

10. Access to the Townsite for construction purposes will be via the main entry road off Coral Bay Road. This entry will be constructed to a trafficable stage as the first construction activity.

11. Public safety will be recognised by the restriction of access to the development site during the construction phase and the erection of appropriate warning signs, in consultation with the Shire of Carnarvon.

12. The proponent will control and manage public access to the Bateman Bay beach in the close vicinity of the entrance channel and associated construction works for public safety purposes to the satisfaction of the Shire of Carnarvon.

13. The proponent will construct internal public roads in accordance with the Shire of Carnarvon's and relevant industry standards. Road reserve widths will be minimised whilst maintaining adequate area for the installation of services to reduce public land requiring stabilisation and landscaping. Common trenching practices will be employed wherever possible throughout the development.

14. The proponent will develop road pavement construction specifications to suit the needs of the locality, and will draw on the experience of the Shire of Carnarvon and the regional Main Roads WA officers, to the satisfaction of the Shire of Carnarvon and the Main Roads WA.

15. The proponent will optimise soil stabilisation and revegetation success by the recovery, stockpiling and and re-application of top soil and vegetation during site preparation works, to the greatest practical extent, in consultation with the Shire of Carnarvon.

16. The proponent will achieve effective noise and dust control during the construction phase of the project in accordance with current engineering industry codes of practice, to the satisfaction of the Department of Environmental Protection and the Shire of Carnarvon.

17. The proponent will design, construct and manage bulk fuel storages in accordance with specifications set by the Water Authority and Department of Transport. In terms of fuel management, the refuelling area for construction machinery and any fuel storage vessel utilised on-site will be located within an area which is sealed with a continuous double-

thickness polythene sheet covered with soil, of sufficient volume to contain any spill which may occur during re-fuelling in accordance with standard practice in hazardous materials management. In the event that any spill occurs outside the compound, the contaminated soil will be immediately removed for disposal in an approved manner to be determined in consultation with the Shire of Carnarvon.

18. The proponent will construct the marina basin under landlocked conditions, and all excavations and associated hard walling will be completed prior to opening of the ocean connection. The harbour entrance will be excavated by a floating dredge process when all inland marina construction is completed. The final connection to the ocean will be completed under conditions which minimise the potential for turbid water escape including a contained settlement pond ashore, to the satisfaction of the DEP, CALM and the Shire of Carnarvon.

19. In the event that monitoring identifies a visible turbidity plume from dredging operations which could potentially reach sensitive coral communities, then either a silt curtain would be installed, or the marine entrance channel would be re-closed to reduce the on-going loss of suspended sediments.

20. It is not intended for the marina to be dredged "in the wet". However, if such construction methods were necessary, the marina entrance channel would remain closed by the proponent whilst internal dredging was in progress, to prevent the loss of any suspended sediments to the ocean.

21. Prior to dredging the marina entrance channel, the proponent will prepare an Emergency Response Plan (ERP). The ERP will address contingencies for:

- fire and explosions;
- collision between vessels;
- fuel and oil pollution; and
- sewage and chemical spills.

The ERP shall be to the satisfaction of the DEP upon advice from the Department of Transport and shall be trialled, updated and maintained in accordance with its requirements.

22. Prior to the opening of the entrance channel to the marina, the proponent will prepare a Water Quality and Sediment Monitoring Programme for the marina and nearshore environment, to the satisfaction of the Department of Environmental Protection upon advice from the Department of Transport. The objective of the monitoring program will be to allow assessment of the success of the management strategies for the project, and incorporate corrective procedures as may be indicated by the results of monitoring. Water quality parameters measured will include:

- suspended solids;
- dissolved oxygen
- bacteria concentrations; and
- nutrient concentrations.

Sediments will be monitored for particle size, nutrients, metals and hydrocarbons. The Water Quality and Sediment Monitoring Program will run for a five year period or until such lesser time that it can be verified to the satisfaction of the EPA that the development has had little or no detrimental impact on the existing environment. Specialist marine scientists engaged by the proponent will supervise the monitoring and interpretation of the results and recommend management action.

23. There is currently no expectation that blasting will be required, however should blasting be necessary the proponent will obtain permission from the Shire of Carnarvon. In the event that any non-routine exceptionally loud noise was anticipated, surveillance of possible dugong movements in the nearshore environment would be implemented.

24. Works which impinge on the near-coastal area such as the golf course, residential accommodation, parking areas and accesses will be constructed by the proponent in such a way as to avoid unnecessary alterations to the existing landforms commensurate with appropriate design practices, and to ensure that re-stabilisation and on-going stability of the landform is maintained, to the satisfaction of DEP, CALM and the Shire of Carnarvon.

25. The dune areas in the west of the site which are not affected by development will be declared "No Access" areas by the proponent and marked accordingly. Similarly, the two salt lakes are intended to be retained as existing landscape and natural drainage features, and will consequently be protected from disturbance, to the satisfaction of the Shire of Carnarvon.

26. The proponent will conduct an extensive tree planting programme to the satisfaction of the Shire of Carnarvon.

27. In the event that an aboriginal site, artefacts or other material is uncovered during earthworks, the proponent will immediately cease work in that area and the procedure detailed in Appendix J will be implemented, to the satisfaction of the Department of Aboriginal Sites.

28. The proponent will apply for appropriate licenses and abstract and monitor groundwater in accordance with the requirements of the Water Authority of Western Australia.

29. Environmental impacts resulting from the supply of construction materials will be in accordance with Government approvals for these operations.

9.3 Post-Construction and Operational Phase

30. The proponent will conduct induction courses for all operational stage employees and contract personnel, which will include information regarding the environmental attributes of the region and their sensitivities, together with information defining individual environmental responsibilities, to the satisfaction of the Shire of Carnarvon.

31. Prior to landscaping of the golf course and resort/townsite, the irrigation and fertiliser requirements of all landscaped areas within the development, including the golf course and other recreational areas, will be the subject of a comprehensive Nutrient and Irrigation Management Plan (NIMP) by the proponent. The NIMP will apply to all grassed/landscaped areas requiring water and fertiliser application, including active and passive recreation areas, and broadly incorporate the following components:

- Recommendations for low water/nutrient requirement grass/vegetation types;
- Prescribed fertiliser applications (if necessary) on the basis of regular chemical analysis of soils and plant nutrient status;
- Prescribed watering/reticulation regime based on historical climatic data updated on a continual basis by on-site measurement and observation;
- Management strategies to minimise nutrient export from the site; and
- An annual fertiliser application audit.

Any fertilisers kept on-site will be stored above anticipated maximum flood levels, and will be provided with adequate weather protection to ensure that fertiliser discharge into the natural environment does not occur.

The NIMP will be formulated in conjunction with, and to the satisfaction of, the Department of Environmental Protection.

32. The proponent will formulate a Shallow Groundwater Monitoring Programme (SGMP) to monitor groundwater throughout the project area, including the golf course, adjacent to and surrounding the marina, between residential areas and Bateman Bay, and at the Services/Light Industrial Area (SLIA) where the borefield will monitor groundwater below the power station, fuel storage, municipal landfill and treated effluent disposal areas.

The SGMP will include:

- the installation of shallow groundwater monitor bores at regular intervals throughout the project area and adjacent to and between the SLIA and the coast;
- the collection of baseline data prior to the commencement of operation; and
- quarterly measurement of groundwater quality within the bores including:
  - nutrients (phosphorus, nitrogen, ammonia, nitrite/nitrate);
  - salinity; and
  - pathogenic bacteria counts.

The SGMP will be formulated in conjunction with the Department of Environmental Protection to the satisfaction of the Water Authority of Western Australia.

33. The proponent will formulate and implement a Shoreline Movement Monitoring Plan to survey the beaches for 2km each side of the breakwaters, and the bathymetry of the entrance channel, for three years following development of the marina, to the satisfaction of the Department of Transport.

34. To ensure a high level of sympathetic residential design, all building designs and material schedules will be vetted for approval by the the proponent (Resort Manager) prior to lodgement with Council for Building Approval.

35. The proponent will develop residential landscaping guidelines identifying suitable species of grasses, shrubs and trees as well as identifying principles of residential landscape design that maximise building orientation and passive climate control, whilst minimising the requirement for water and fertilisers.

36. All areas which are disturbed by construction but are not required for resort/townsite purposes, will be stabilised and revegetated using appropriate land care procedures and techniques. Rehabilitation success will be monitored, and any necessary corrective works or maintenance will be carried out in conjunction with landscape management and maintenance practices for the resort and townsite to the satisfaction of the Shire of Carnarvon. Surveillance of natural areas within the townsite but beyond the resort and residential areas will be carried out on a routine basis and corrective works implemented as necessary.

37. The proponent will formulate an education programme to ensure that residents are fully advised of requirements in regard to nutrient control and management within the resort, together with active discouragement of fertiliser use within residential areas, to the satisfaction of the DEP.

38. To maximise the protection of native terrestrial fauna in the area, the proponent will consult with the Shire of Carnarvon to determine appropriate procedures for the prohibition of cats and dogs in the resort and townsite areas.

39. The marina harbour will be inspected routinely by the Marina Manager and any corrective action required to maintain water quality and aesthetics to the required standard will be implemented immediately, to the satisfaction of the Shire of Carnarvon.

40. The discharge of sewage, hydrocarbons or litter from boats into the marina will be prohibited and all users of the marina will be informed accordingly using signage and public education. Adequate rubbish bins and sewered toilets will be provided in public areas around the marina.

41. A sewage pump-out facility will be provided at a convenient and practical location on the service jetty within the marina for vessel discharge, and wastewater collected will be directed to the main reticulation system for treatment and disposal.

42. Fire management in the vicinity of the resort/townsite and Service/Light Industrial Area, including the establishment and maintenance of firebreaks by the proponent in strategically appropriate locations, and fire hydrants for fire suppression, will be conducted in accordance with conventional industry standards and the requirements of the Shire of Carnarvon and Bush Fires Board of Western Australia.

43. Office space will be provided by the proponent within the resort development for use by CALM and Fisheries Department staff.

44. The proponent will construct and establish a Marine Park Visitor/Research Centre within the resort, to provide for education and interpretation programs for visitors and residents in consultation with CALM.

45. The proponent will co-operate with CALM officers to establish and maintain appropriate awareness and appreciation of the attributes of the Ningaloo Marine Park to the satisfaction of the DEP and CALM.

46. The proponent will distribute literature to visitors to raise their awareness of the recreational potential of the terrestrial and marine habitats and their environmental limitations, to the satisfaction of the DEP and CALM.

47. The proponent will erect signs at appropriate locations within the development to notify visitors of their environmental management responsibilities, to the satisfaction of the DEP and CALM.

48. The proponent will otherwise assist CALM, where practicable, to implement and police the Ningaloo Marine Park Management Plan (CALM, 1989), particularly those aspects pertaining to visitor education and awareness, to the satisfaction of the DEP and CALM.

49. The proponent will maintain the breakwaters and harbour revetments to the satisfaction of the Department of Transport, including necessary repairs if any damage is sustained during a severe cyclone, during the period in which CCMD is responsible for townsite management.

50. The proponent will select high technology power generation (diesel turbine plant) to enable the relevant standards of stack emission to be routinely met.

51. Recognising that establishment of power generation plant will be incremental and will occur over a twenty-year period, the economics and practicality of incorporating renewable energy sources, including solar and wind power, will remain under review by the proponent.

52. The proponent commits that infrastructure established as part of the Coral Coast Resort development will be operated and maintained for a minimum period of 5 years from construction or until the relevant Authorities, such as the Local Authority and Service Authorities, wish to take over responsibility for operation and maintenance of the facilities.

A Management Corporation will be established and be responsible for the normal day to day services and maintenance of functions including maintenance of roads and pathways, maintenance of parks and public landscaping areas, waste collection and disposal, street and public place cleaning, and the provision of street lighting. The Management Corporation would also be responsible for maintenance of the marina.

Management of the site will be to the satisfaction of the Shire of Carnarvon.

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FIGURES

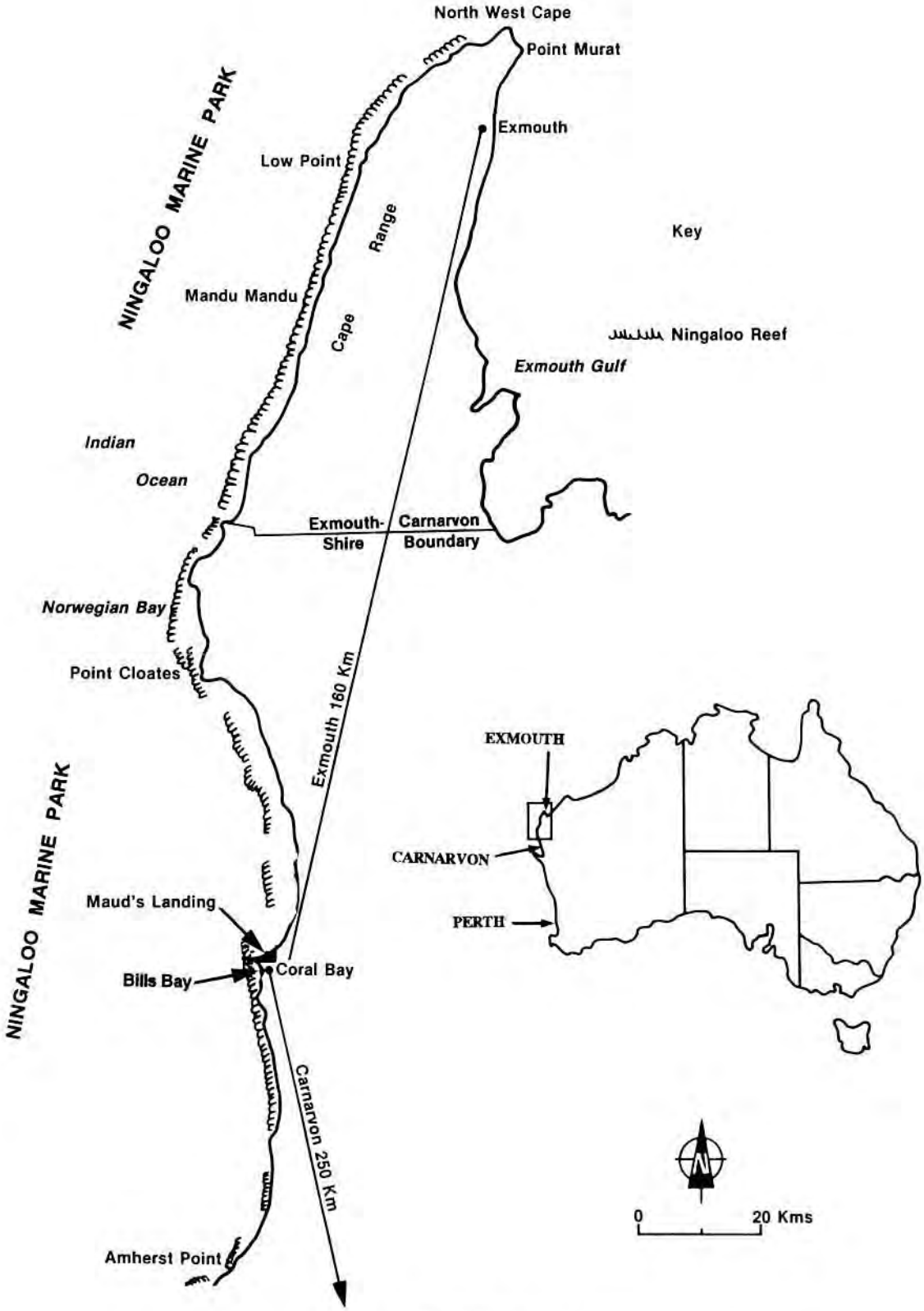

FIGURE 1.1

Regional Location of Mauds Landing, Western Australia

(Modified from DCE, 1984)

Figure 4.6 shows the boundaries of the Ningaloo Marine Park

FIGURE 1.2

Local Setting of the Proposed Development

Coral Coast
MARINA DEVELOPMENT PTY LTD

CORAL COAST RESORT

MAUDS LANDING

KOLTASZ SMITH & PARTNERS — TOWN PLANNERS

TREVOR SALEEBA & ASSOCIATES — ARCHITECTS & URBAN DESIGNERS

FIGURE 1.3

Coral Coast Resort Master Plan

(After Koltasz Smith and Partners, 1994)

PLEASE SEE REAR POCKET OF THIS DOCUMENT

Figure 4.6 shows the boundaries of the Ningaloo Marine Park

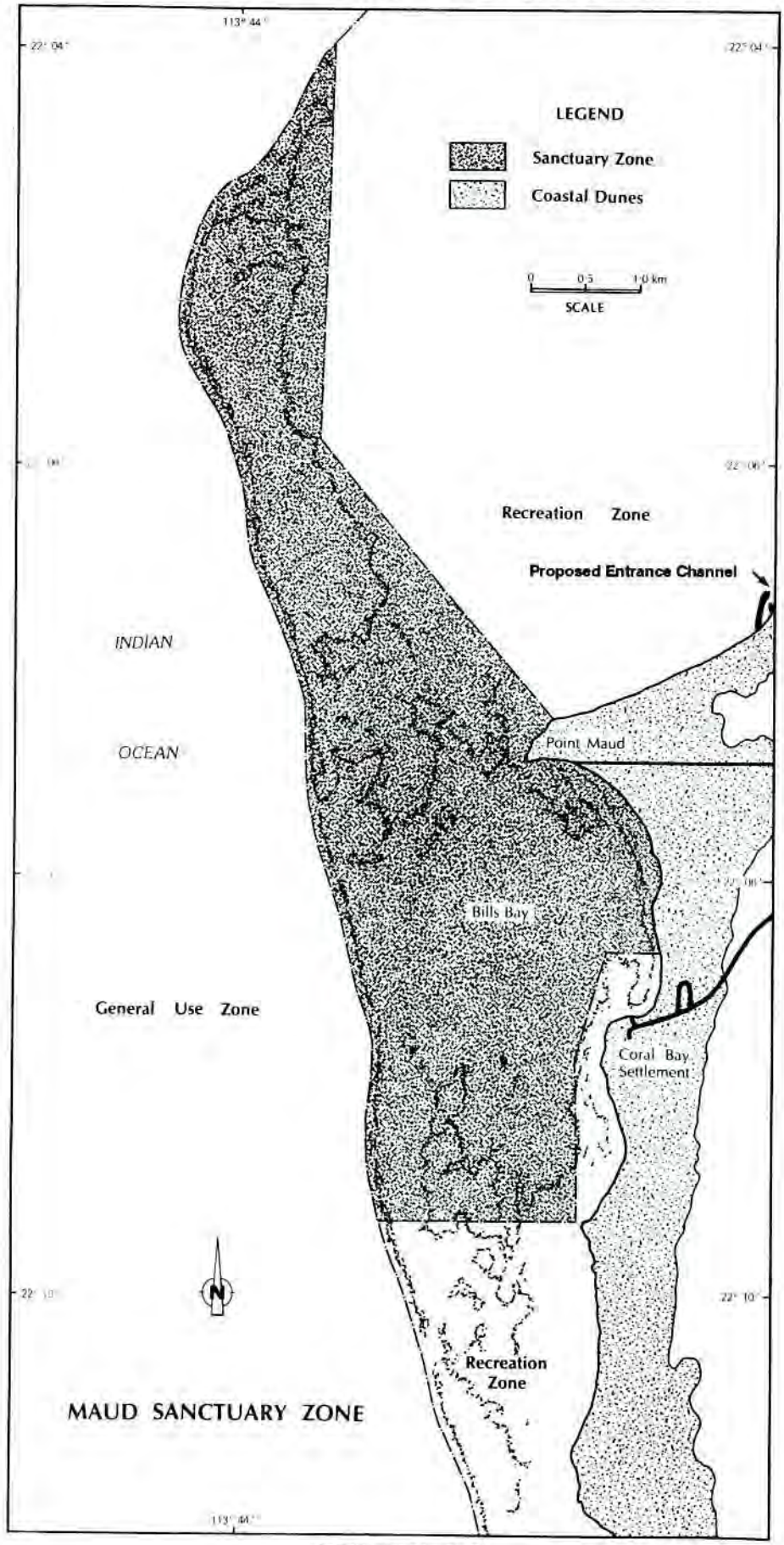

FIGURE 1.5

Location of the Site in Relation to the Maud Sanctuary Zone and Recreation Zones (Ningaloo Marine Park) (After CALM, 1989)

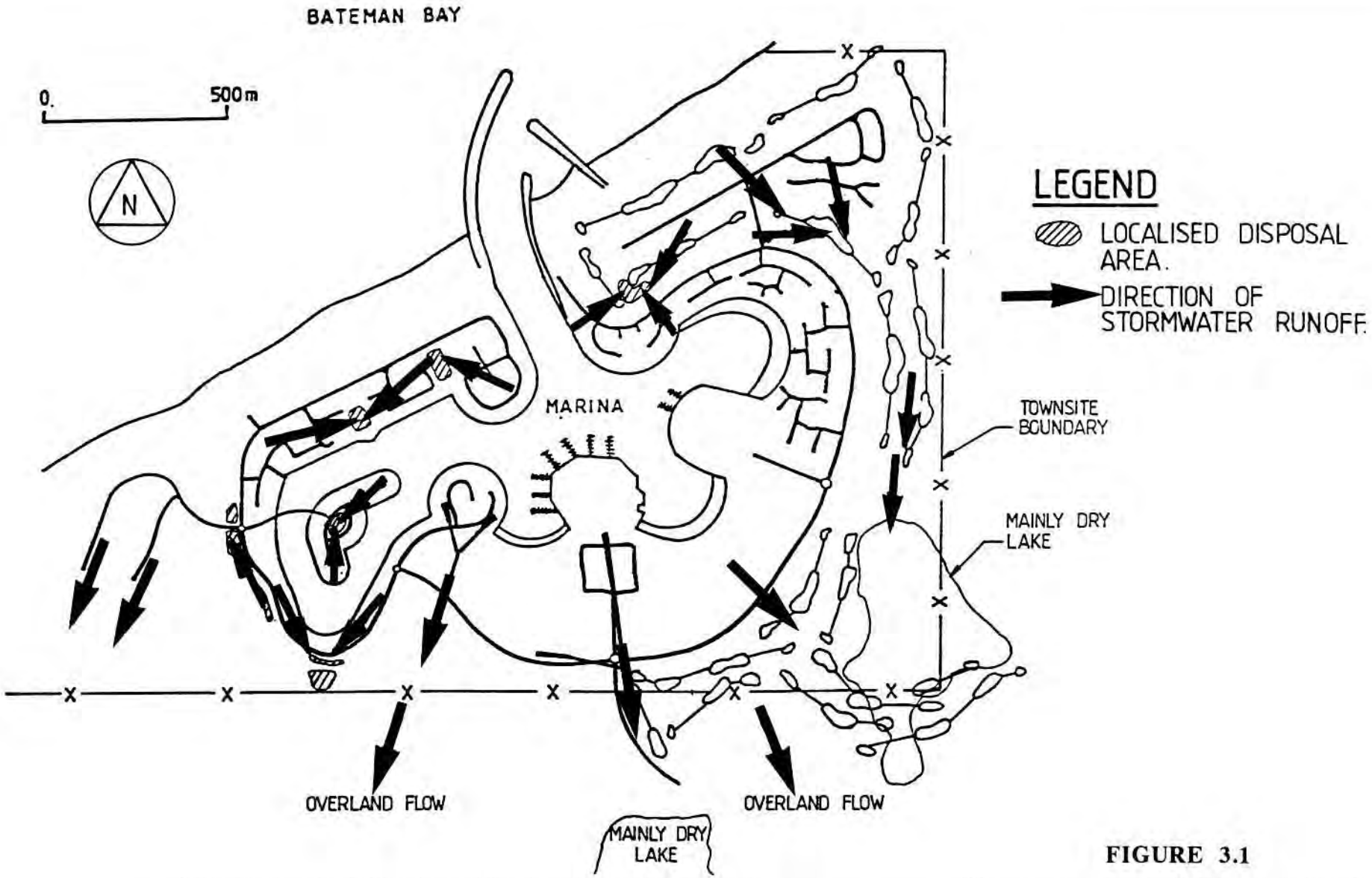

FIGURE 3.1

Stormwater Run-off Disposal Strategy

(After Ewing Consulting Engineers, 1994)

Overland flow to 760ha of available low-lying salt flat, which currently performs as a drainage area during storm/cyclonic events.

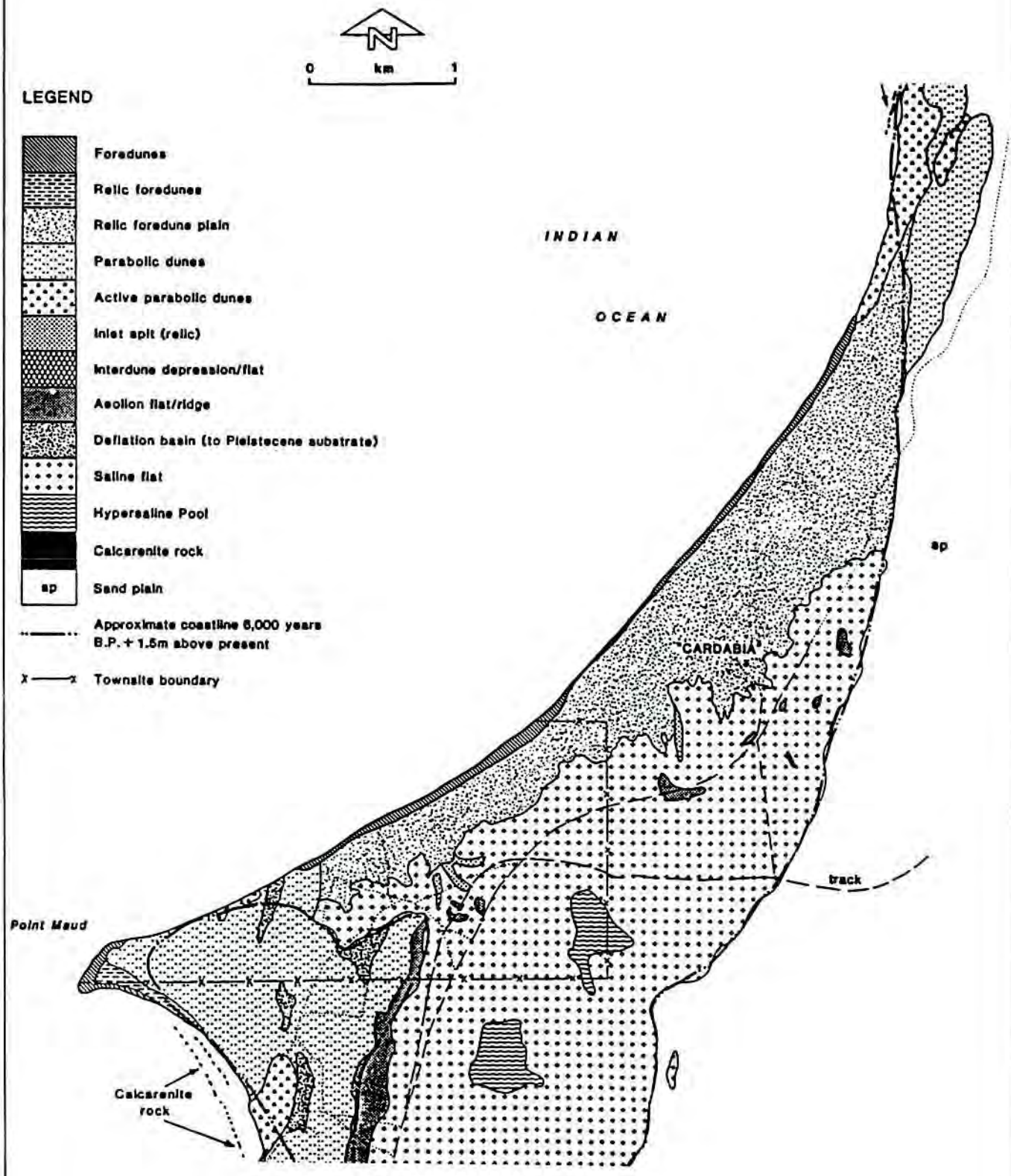

FIGURE 4.1

Predominant Landforms of the Mauds Landing Area

(After DPUD, 1992)

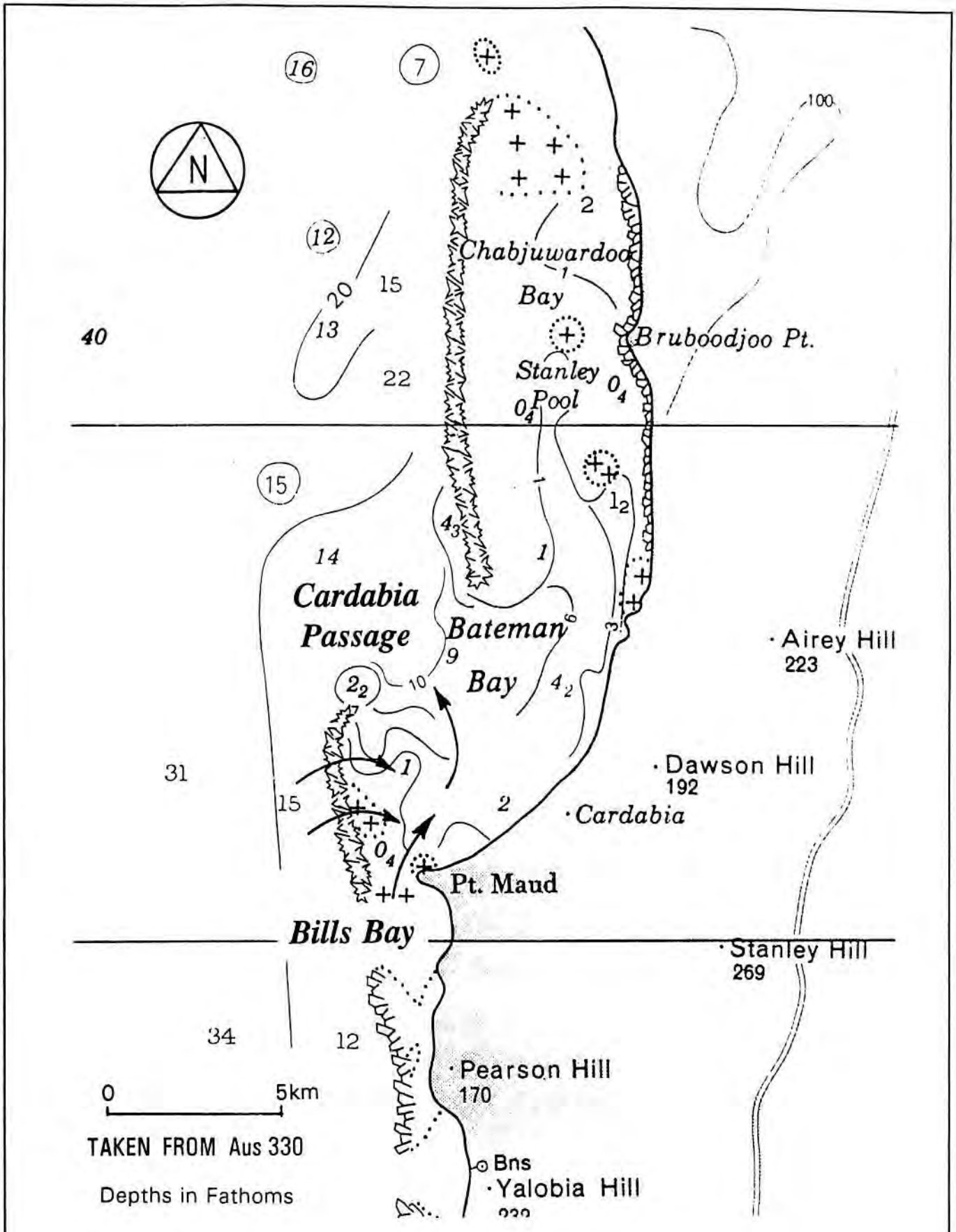

FIGURE 4.2

Predominant Ocean Water Current Patterns Adjacent to Mauds Landing

(After M P Rogers and Associates, 1994)

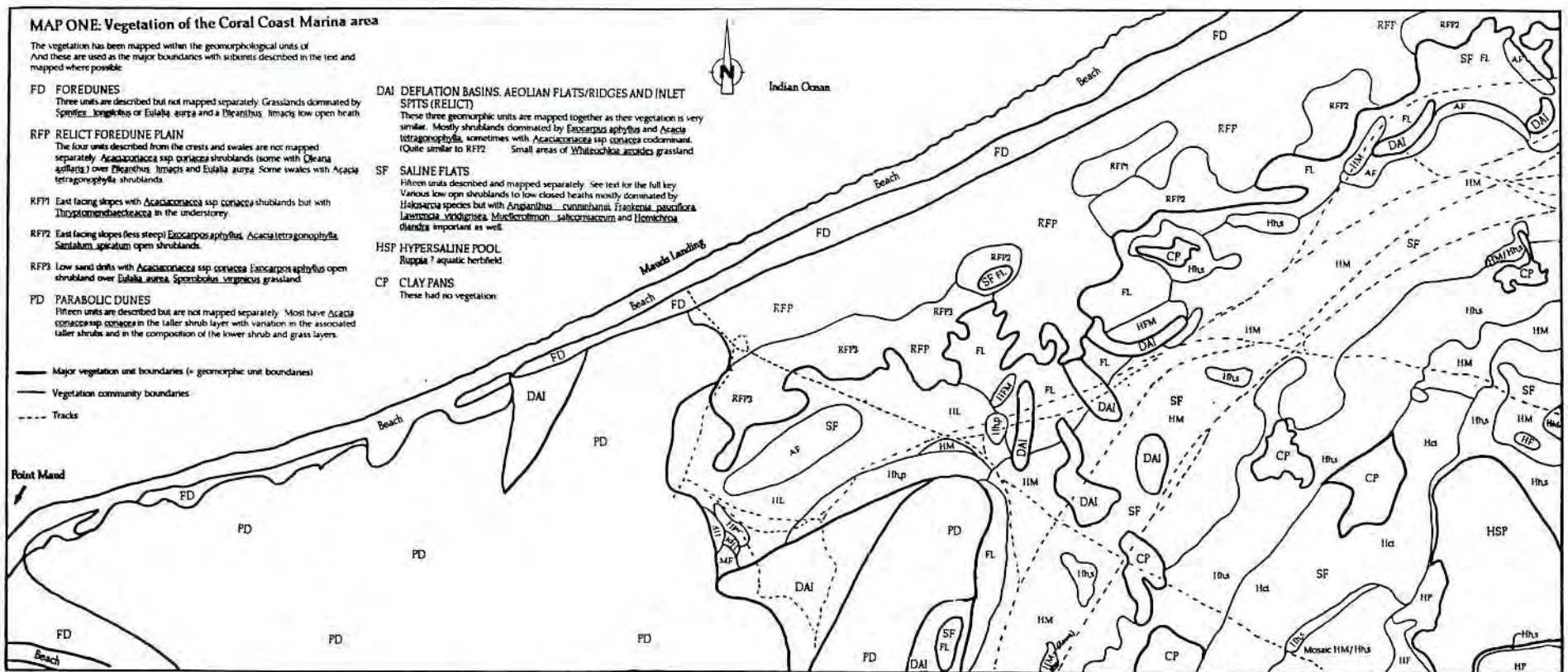

FIGURE 4.3

Vegetation Associations of the Mauds Landing Area

(After Trudgen, 1994)

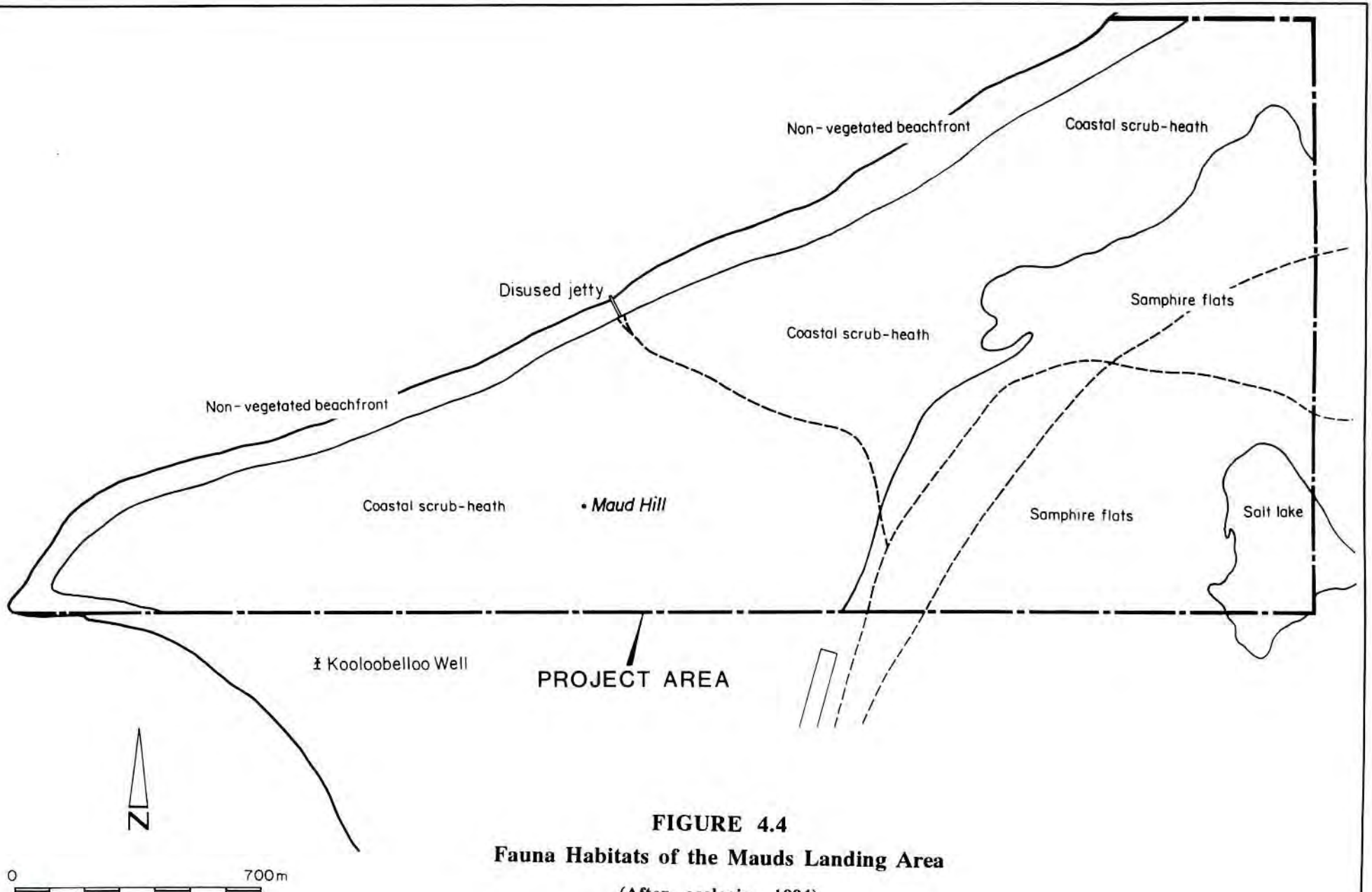

FIGURE 4.4

Fauna Habitats of the Mauds Landing Area

(After ecologia, 1994)

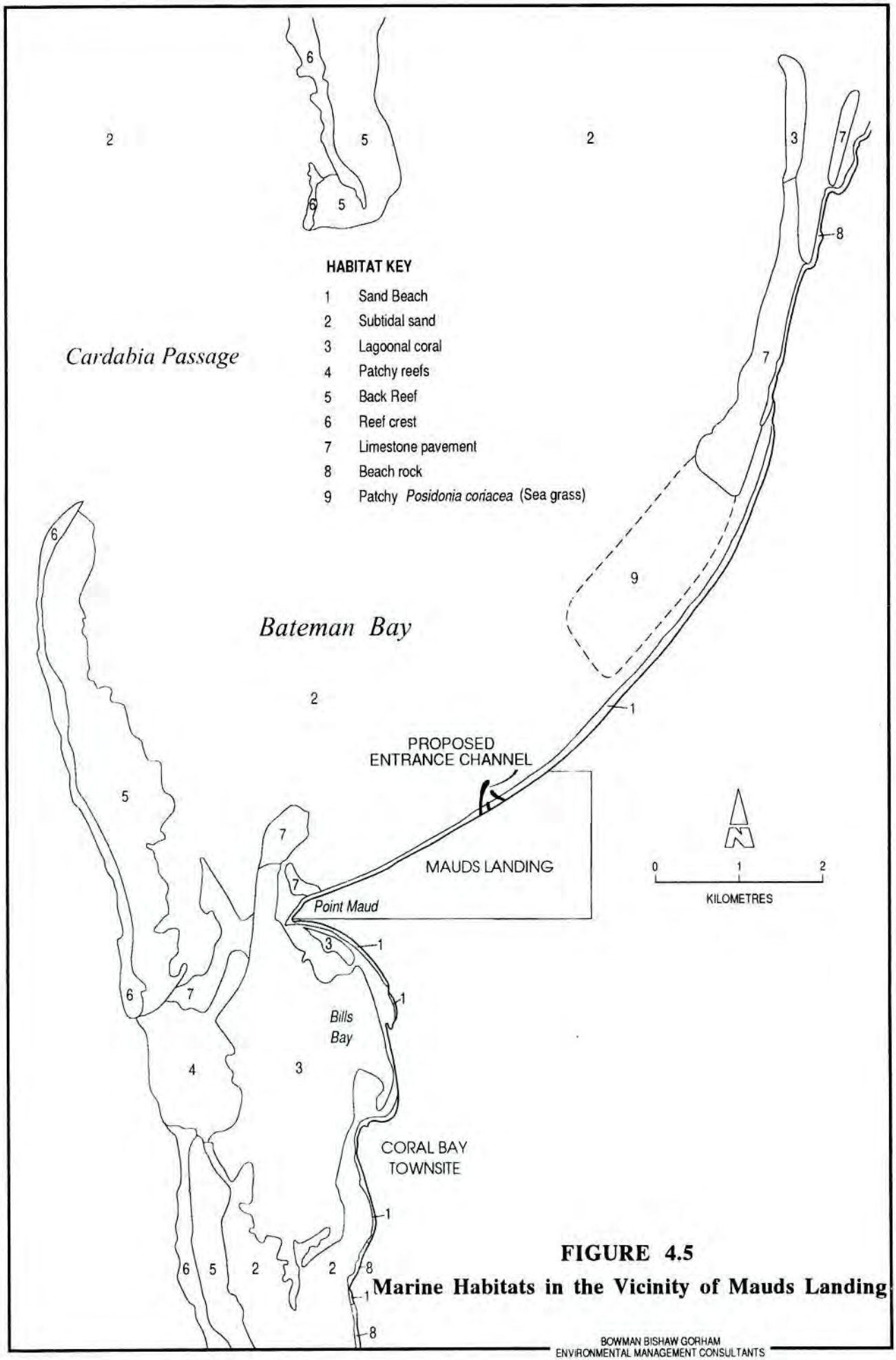

FIGURE 4.5

Marine Habitats in the Vicinity of Mauds Landing

BOWMAN BISHAW GORHAM
ENVIRONMENTAL MANAGEMENT CONSULTANTS

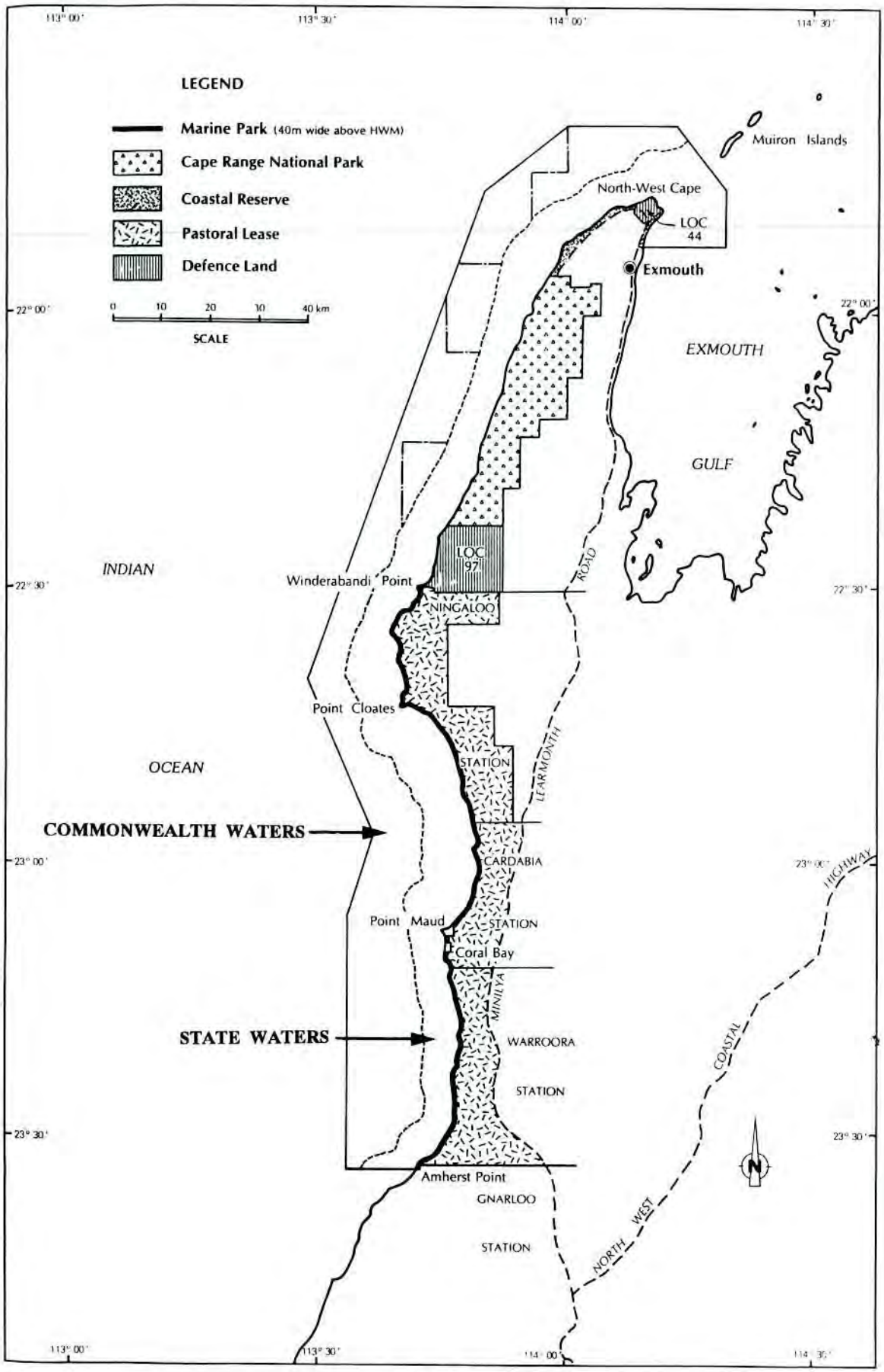

FIGURE 4.6

Boundaries of the Ningaloo Marine Park and Cape Range National Park

(After CALM, 1989)

1. **MARINA**
   a. Breakwater
   b. Coral Garden
   c. Town Beach
   d. Swimming Beach (netted)
   e. Boat Launching Ramps (x4) and Parking
   f. Boat Pens

2. **TOWN CENTRE**
   a. C.A.L.M. Research and Visitor Centre
   b. Retail,Food and Beverages
   c. Serviced Apartments
   d. Tavern
   e. Pedestrian Piazza
   f. Marine Services
   g. Parking
   h. Service Station (Auto and Marine Repairs)
   i. Town Administration

3. **RESORT HOTEL and CONVENTION CENTRE**
   a. Hotel Units
   b. Restaurant/Bars
   c. Conventions and Functions
   d. Courtyard Pools

4. **CLUB RESORT**
   a. Reception/Restaurant and Bars
   b. Studio and Bungalow Units
   c. Courtyard Pools

5. **BACKPACKERS HOSTEL**

6. **CARAVAN and CAMPING PARK**

7. **CHALET PARK**

8. **COMMUNITY FACILITIES**
   a. Medical, Community and Emergency Services
   b. Schools Complex

9. **COUNTRY CLUB**
   a. Clubhouse
   b. Tennis Courts
   c. Bowling Green
   d. Golf Course
   e. Driving Range

BATEMAN BAY

BATEMAN BAY

JETTY

RUINS

PILE

DUNE CONSERVATION

1a. 1d. 10c. 10c. 11a. 10e. 10c. 11a. 1 10b. 11a. 1d. 11c. 2c. 11a. 11a. 11c. 11c. 1d. 10d. 10b. 10d. 1d. 6 10b. 10b. 11c. 7 12 10a.

Coral Coast Resort

Master Plan

PREPARED FOR : Coral Coast MARINA DEVELOPMENT PTY. LTD.

). RECREATION

a. Sports and Recreation Ground
b. Neighbourhood Park
c. B.B.Q./Picnic Area
d. Lookout
e. Cafe/Kiosk and Changerooms

1. RESIDENTIAL

a. Single Residential
b. Group Residential
c. Terrace Town Houses

2. TOWNSITE BOUNDARY

TOWNSITE

SALT LAKE

SSM KG43

KOLTASZ SMITH & PARTNERS