CORAL COAST MARINA DEVELOPMENT

RESPONSES TO SUBMISSIONS
VOLUME II

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1. GLOSSARY OF TERMS AND ABBREVIATIONS

4WD	four wheel drive vehicle
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council.
CALM	Department of Conservation and Land Management (Western Australia)
CAMBA	Agreement for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment between the Government of Australia and the People's Republic of China 1986
CCMD	Coral Coast Marina Development Pty Ltd
CCR	Coral Coast Resort
COAG	Council of Australian Governments
DEP	Department of Environmental Protection (Western Australia)
DNV	Det Norske Veritas
DIA	Development Impact Area
DIN	Dissolved Inorganic Nitrogen
DoT	Department of Transport
EMS	Environmental Management System
EPA	Environmental Protection Authority (Western Australia)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
FES	Fire and Emergency Services
FWA	Fisheries Western Australia

JAMBA	Agreement for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment between the Government of Australia and the Government of Japan 1974
kg	kilogram
kL	kilolitre
km	kilometre
L	litre
LGA	Local Government Authorities
LNG	Liquid Natural Gas
LPG	Liquid Petroleum Gas
m	metre
MfP	Ministry for Planning
m/s	metre per second
MPA	Marine Protected Area
MPRA	Marine Parks and Reserves Authority
MRWA	Main Roads Western Australia
MSMA	Maud Specific Management Area
NRMA	Natural Resource Management Agreement
NES	National Environmental Significance
nm	nautical mile
NMP	Ningaloo Marine Park
NRSMPA	National Representative System of Marine Protected Areas
OCS	Offshore Constitutional Settlement
PER	Public Environment Report
RO	Reverse Osmosis
RV	Recreational Vehicle

SAMMP	Specific Area Marine Management Plan
SCUBA	Self Contained Underwater Breathing Apparatus
SES	State Emergency Service
TBT	Tributyltin
TDS	total dissolved solids
TSS	total suspended solids
UASB	Upflow Anaerobic Sludge Blanket
WA	Western Australia
WWT	wastewater treatment
WWTP	wastewater treatment plant
WRC	Water and Rivers Commission (Western Australia)

2. GENERAL RESPONSES

A. CURRENT AND PREDICTED VISITATION TO THE CORAL BAY AREA

A review of human usage in Ningaloo Marine Park (NMP) is provided in Cary et al. (2000). However information on current visitation to the existing Coral Bay settlement and accordingly utilisation of the central and southern portion of the NMP is limited.

The February 2001 Regional Tourism Monitor indicates that the average length of stay for visitors to the Gascoyne is 7 nights. It is expected that with improved facilities at Coral Coast Resort (CCR) a greater proportion of visitors will stay within the Region for up to a week. On this basis, it is estimated that the typical length of stay at CCR will be in the order of three to four days with the balance of time spent elsewhere within the Region.

It is neither practical nor feasible to limit the number of overnight and day visitors beyond the in-built limitations of availability of accommodation and facilities. Based on 1080 living units at occupancy of up to 2.54 people per unit, the maximum number of people that can be accommodated at the CCR is about 2500 (100% occupancy). Based on similar limits at the Coral Bay settlement, the total capacity of the combined CCR would be 4015 people.

Observation of visitors to the Coral Bay area indicate that a significant proportion do not venture onto the reef system outside of snorkelling within Bills Bay in relatively close proximity to the shore. Of those that do venture onto the reef, a substantial number do so under a commercial tour and therefore under the care and control of the operator and thus in a monitored and regulated environment.

There is a perception that all visitors to the CCR will inevitably visit the reef for diving or fishing, placing undue pressure on the reef system. This perception ignores other activities engaged in. Visitors to the location are going on holiday and not solely to visit the reef. As they would do at other locations such as Rottnest, visitors will engage in a number of activities not involving the reef including just relaxing. While no data exists to suggest a realistic proportion, it seems plausible, given the range of facilities available within CCR, that the proportion visiting the reef may be closer to 50% than it would be to 100%.

Given that a significant proportion of visitors to the location will not visit the reef at all and of those that do, a substantial number will be under the control of a licensed commercial operator, the propensity for any significant damage to the reef system is substantially lessened. The Gascoyne Coast Regional Strategy (1996) supports this position and notes that experience on the Great Barrier Reef has shown that “the impacts of tourists can be managed much more easily because they will access the reef in organised groups".

Existing Visitor Numbers

There are approximately 477 legal accommodation units in the Coral Bay settlement (including 60 backpacker units recently approved). Ministry for Planning statistics

(Ministry for Planning 1995) indicates the following occupation rates for relevant classes of accommodation units:

- short stay residential – caravan and tents, 2 people per unit;
- backpacker accommodation – 1 person per unit;
- chalets and villas – 2.54 people per unit; and
- permanent residents – 2.54 people per unit.

An estimate for the legal upper limit for population of the Coral Bay settlement is 1212 persons based on the conservative application of 2.54 people for each of the 477 living units.

Peak usage however is estimated to exceed this number. The daily population in the Coral Bay area at peak times during school holidays and Easter is approximately 2500 people (Ministry for Planning 1996), although daily figures of up to 4000 people, and an annual average of 46,000 for 1999 have been identified (Cary et al. 2000).

No site data is available for overnight/short stay residential accommodation in the Coral Bay settlement. However one of the caravan parks identified an increase of 40% for first time visitor arrivals between 1994 and 1999 (Cary et al. 2000).

Estimates of visitor numbers have been made and are based on the observations of tourism operators, residents and government agency representatives residing in or regularly visiting the Coral Bay area. These estimates are provided in Table A1, and presented in Figure 1.

TABLE A1
ESTIMATED TOTAL SITE NIGHTS – CORAL BAY SETTLEMENT AND INFORMAL CAMPSITES TO BRUBOODJOO POINT

Month	Coral Bay 2001 (est)	[1] Coral Bay (maximum)	[2] Total Camps (persons)	Predicted Total Maud Region (2001)	[3] Predicted Total (2009)
Jan	945	1212	64	1009	1362
Feb	750	1212	26	776	1047
Mar	750	1212	26	776	1047
Apr	2415	1212	129	2544	3434
May	1560	1212	26	1586	2141
June	1560	1212	26	1586	2141
July	2850	1212	129	2979	4021
Aug	1560	1212	26	1586	2141
Sept	1560	1212	26	1586	2141
Oct	1845	1212	103	1948	2630
Nov	750	1212	26	776	1047
Dec	2415	1212	64	2479	3347
Averages	**1580**	**1212**	**56**	**1636**	**2208**

Notes
[1] Assumes Coral Bay settlement visitation commensurate with the number of official accommodation units available (477), and using conservative industry beds of 2.54 persons per unit (Ministry for Planning 1995). Planning approval was given for a further 60 additional backpacker units (1 person per unit) during 2000. Projected totals in 2009 include 60 additional people.
[2] Estimated camp occupancy north of the Coral Bay settlement to Bruboodjoo Point.
[3] Predicted on a flat increase of 5% per annum above 2001 estimates.

Based on these estimates, the Coral Bay settlement at present provides about 605,000 bed nights annually, at an average occupancy of 3.5 people in each living unit.

Predicted Increased Human Usage Following Implementation of the Proposed CCR

Table A1 above presents an estimation of the total site nights for the Coral Bay settlement and informal campsites to Bruboodjoo Point. A further prediction of anticipated growth to 2009, based on estimates of increased visitation and irrespective of the implementation of CCR concept is also provided. Pressures leading to increased visitation to the Coral Bay area will continue regardless of the implementation of the CCR. The proposal to develop the CCR referred to the EPA and to which these comments refer presents one of many options as to how these pressures may be addressed.

It is believed that implementation of the CCR will in the first instance provide alternative accommodation for 'overflow' short stay residential visitors from the existing Coral Bay settlement facilities and surrounding informal camps. Table A2 presents a summary of predicted Coral Bay area and CCR visitor numbers following completion of the CCR, taken to be 2009.

TABLE A2
ESTIMATED TOTAL SITE NIGHTS – CORAL COAST RESORT, CORAL BAY SETTLEMENT AND INFORMAL CAMPSITES TO BRUBOODJOO POINT, 2009

A	B	C	D	E	F	G	H	I
Month	CORAL BAY					[4] CCR Estimated Total (2009)	[5] CCR New Visitors	Totals Coral Bay and CCR
	2001 (est)	[1] CB maximum 2001 (2009)	[2] 2001 Total Camps	Predicted total (2001)	[3] Estimated Total (2009)			
Jan	945	1212 (1272)	64	1009	1362	2000	1944	3272
Feb	750	1212 (1272)	26	776	1047	1500	1759	2772
Mar	750	1212 (1272)	26	776	1047	1500	1759	2772
Apr	2415	1212 (1272)	129	2544	3434	2500	373	3772
May	1560	1212 (1272)	26	1586	2141	2000	1166	3272
June	1560	1212 (1272)	26	1586	2141	2000	1166	3272
July	2850	1212 (1272)	129	2979	4021	2700	0	3972
Aug	1560	1212 (1272)	26	1586	2141	2000	1166	3272
Sept	1560	1212 (1272)	26	1586	2141	2000	1166	3272
Oct	1845	1212 (1272)	103	1948	2630	2500	1177	3772
Nov	750	1212 (1272)	26	776	1047	1500	1759	2772
Dec	2415	1212 (1272)	64	2479	3347	2000	0	3272
Averages	**1580**	**1212 (1272)**	**56**	**1636**	**2208**	**2017**	**1091**	**3288**

Notes
[1] Assumes Coral Bay settlement visitation commensurate with the number of official accommodation units available (477), and using conservative industry beds per class of accommodation (Ministry For Planning 1995). Approval was given in 2001 for a further 60 backpacker units (single occupancy). For predictions of 2009 visitors, 1272 persons have been used.

[2] Estimated camp occupancy north of the Coral Bay settlement to Bruboodjoo Point.
[3] Predicted on a flat increase of 5% of 2001 estimates for each of seven years (35% increase).
[4] Monthly estimates provided by CCMD.
[5] New visitors to CCR (Column H) have been calculated by:
- determining overflow by subtracting Coral Bay settlement maximum (Column C) from estimated total (Column F); and
- subtracting this overflow from CCR estimated total (Column G).
- Column C based on 477 living units. Approval was given in 2001 for a further 60 backpacker units (single occupancy). For predictions of 2009 visitors, 1272 persons have been used.

Column H in Table A2 presents an estimate of the average number of additional bed nights predicted on a monthly basis that will result from the additional facilities provided by the CCR. The balance above estimated 2001 figures is due to anticipated expansion of the area.

Based on these estimates, the Coral Bay settlement and Mauds Landing combined provide a predicted 3288 bed nights daily at full implementation (2009), at an average occupancy of two people in each living unit. Data on projected site nights by month for the Coral Bay settlement and CCR is presented in Figure 1.

B. ENVIRONMENTAL MANAGEMENT SYSTEM

An environmental management system (EMS) is a structured approach to ensuring sound environmental management in industrial or other activities, including the adoption of pollution prevention techniques and the mitigation of negative environmental impacts. Poor management is often the basic cause of poor environmental performance. Accordingly the adoption of measures that improve management can be viewed as positive in reducing environmental impacts.

The practical application of EMS has, until now, been mainly within large enterprises with a specific focus on industrial activities. A set of specifications and standards, under the umbrella of ISO 14000, has been developed as the proposed common international EMS framework.

Implementation of Environmental Management Systems for CCR

It is proposed that health; safety and environmental management systems for the CCR will comply with OHSAS 18001 and ISO 14001. This system will facilitate the management of the Occupational Health, Safety and environmental risks associated with the construction and operation of CCR. Management systems will include the organisational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the proposed Occupational Health, Safety and Environmental policy.

Relevant EMS plans and Det Norske Veritas in consultation with ATA Environmental and major consortium members will develop procedures.

Implementation of EMS for CCR

Major consortium members, Kellogg Brown and Root and Clough Engineering Ltd, (CCR construction) and Kellogg Brown and Root (utilities and services provider, asset manager and facilities maintenance) each hold certification under ISO 9000 group of documents.

Other plans and procedures identified in the management section of the PER document relating to this document (section 4.4 in ATA Environmental 2000a) and summarised in will be incorporated within the ISO 14000 series documentation to ensure coverage of all relevant issues.

C. SPECIFIC AREA MARINE MANAGEMENT PLAN

The model reported in ANZECC Best Practice in Performance Reporting in Natural Resource Management (ANZECC 1997) has been used in the development of Marine Management Plans for Marine Parks in Western Australia (CALM 2000).

A similar model has been used to develop a specific area for the identification and management of impacts within the immediate impact area surrounding the site of the action. Should the CCR development proceed, this Specific Area Marine Management Plan (SAMMP) will be finalised in consultation with CALM, Environment Australia and other agencies with a role in the Management of NMP. Prior to implementation the SAMMP will be made publicly available for comment.

The SAMMP defines two areas for specific management within the broader NMP. The Maud Specific Management Area (MSMA) and Development Impact Area (DIA), contained within the MSMA are anticipated to present the extent of the biological and physical changes that will result from implementation of the action. However, it is clear that changes arising from greater visitation may occur outside these defined areas. The strategies within the SAMMP will focus primarily on mitigating the effects of human activities. These can be direct effects such as damage to coral habitats by indiscriminate mooring and anchoring or through localised over-fishing. Further impacts have been identified as those resulting from ecotourism experience tours on target species such as whale sharks, whales, dugong and various species of turtle. The SAMMP will be finalised with Environment Australia and CALM prior to the construction or placement of any marine structure.

The SAMMP also identifies a number of pro-active strategies involving education and extension programs and active participation of resource users and the local community in the on-going management of the area. This is consistent with both Commonwealth and State objectives for the NMP.

D. MARINE TURTLES

Marine turtles are reptiles that are recognised internationally as species of particular conservation concern. There are six marine turtle species listed as endangered according to the 1990 IUCN (World Conservation Union) Red List of Threatened Animals. Of these, five are known to occur in Australian waters and four are known to breed on Western Australian beaches:

1. Green turtle (Chlonia mydas);

2. Loggerhead turtle (*Caretta caretta);*

3. Hawksbill turtle (*Eretmochelys imbricata);* and

4. Flatback turtle (*Nattator depressus*).

These turtles are known occur within the NMP (Environment Australia 2001). Leatherback turtles (*Dermochelys coriacea*) are considered to be at the extreme of their range but may occur occasionally within NMP (May, Lenanton & Berry 1983).

Aerial surveys of the NMP suggest that an estimated population of approximately 4300 turtles (all species) is resident within the Park (Preen et al. 1997). Turtle densities are extremely high at Ningaloo and exceed the highest densities recorded on the Great Barrier Reef and most of the areas in Torres Strait.

Sandy beaches within the NMP between Coral Bay area and North West Cape are recognised as important nesting rookeries for predominantly loggerhead and green turtles. Approximately 6,000 hatchlings (primarily loggerhead turtles) were recorded during 2000/01 from 68 nest sites from beaches within Bateman Bay (Mack, pers. comm. 2001).

Loggerhead Turtles

Loggerhead turtles are listed as Threatened under controlling Provisions 18 and 18(A) of the EPBC Act, as *Special Protected Fauna* under the Western Australian Act (Environment Australia 1998) and Rare under the Western Australian *Wildlife Conservation Act 1950* (Environment Australia 2000). In Western Australia the loggerhead turtle appears to be the least abundant of the marine turtle occurring within Western Australian water (Marine Turtle Newsletter 1993), and is possibly even scarcer than the hawksbill turtle (Prince 1994a). Loggerhead turtles have a carnivorous diet that includes shellfish, crabs, sea urchins and jellyfish (Environment Australia 1998).

In Western Australia loggerhead turtles generally nest 3 times per year (late October through to early March), with nesting intervals ranging between 13 and 17 days. The mean number of loggerhead eggs per clutch is 127 (Environmental Australia 1998).

In contrast to the other marine turtles occurring in Western Australian waters, the known nesting distribution of the loggerhead turtle is one with a slightly more southerly focus. The major loggerhead turtle nesting sites in Western Australia are confined to the Lower Pilbara and the Gascoyne regions, with Dirk Hartog Island, near Shark Bay confirmed as

the single most important nesting site in Western Australia and the southern Indian Ocean. This site may accommodate in excess of 75% of all nesting adult females that occur within the Western Australian population (Prince 1998; 2001). There are few, if any, loggerhead nesting sites south of Shark Bay due to the lack of adequate nesting habitats (ie. sandy beaches).

Cumulatively, between 1993/94 and 1999/2000, 4,230 nesting adult female loggerheads were tagged from Dirk Hartog Island, Shark Bay nesting beaches (Prince 2000), with 662 of these recorded as remigrants. A further 736 nesting adult females were tagged from beaches on South Muiron Island and the beaches on the adjacent North West Cape between 1986 and 1993/94. It is probable that many of the regularly used loggerhead nesting sites in Western Australia are not currently located within existing or proposed conservation reserves.

In the vicinity of the proposed CCR, as many as 6,000 turtle hatchlings (an estimated 95% of which were loggerhead) were recorded during 2000/01 from 68 nest sites from beaches within Bateman Bay. A further 71 nests were recorded from Bateman Bay during the 1999/2000 season (Mack 2001). The locations of marine turtle nests on the lower section of Bateman Bay over the 2000/2001 nesting season is presented in Figure 2.

The number of nests represents approximately 24 adult females, less than 0.5% of the total known nesting adult female loggerhead population in Western Australia. Given that loggerhead turtles generally nest 3 times per season and provided breeding conditions are optimal, this population has the capacity to produce over 9,000 offspring per season. Loggerheads may utilise the mussel beds 3km north east of Mauds Landing, and are known to occur in significant numbers on the backreef either side of Cardabia Passage (Bowman Bishaw Gorham 1995).

Until recently, predation by foxes was responsible for the loss of up to 70% (approximately 6,400 individuals) of the egg and hatching production of loggerhead turtles from beaches between Point Maud and Oyster Point (Prince 2001), resulting in a long standing, significant impact on the local loggerhead population. However a fox eradication program has recently been undertaken in the vicinity of Maud's Landing that is likely to result in a sharp decline in local loggerhead turtle mortality rates. Capture rates of foxes at nesting beaches on Bateman Bay has dropped from in excess of 50 to 34 in five years (Mack 2001). However, it is unlikely that any quantifiable change in the local adult female Loggerhead population will be detected for at least another 10-15 (Mack 2001).

As is the case for most marine turtle, the sex ratio of loggerhead turtle hatchling varies between beaches and is likely to be a function of beach temperature. Loggerhead turtles have an aversion to artificial light in the near-ultraviolet range of the spectrum (green/yellow to yellow) and, depending on the intensity of the artificial light, are less likely to become disorientated (Lutz 1996).

Green Turtles

Green turtles are listed as Threatened (under Controlling Provisions 18 and 18(A)) and Vulnerable (Controlling Provisions 18 (4) and 18(A) of the EPBC Act. They are also listed as migratory under Controlling Provisions 20 and 20(A). The green turtle is also

listed as Vulnerable under the Western Australian *Wildlife Conservation Act 1950*. In Western Australia, green turtles are considered to be the most abundant of the marine turtle species. The green turtle has an essentially herbivorous diet, with macroalgae (seaweed etc) its primary source of nutrition. However, some juveniles of the species are known to be carnivorous (Environment Australia 1998).

In Western Australia, approximately 20,000 adult nesting females are believed to breed annually in the North West Shelf region (Environment Australia 1998). In WA, green turtles are known to nest approximately three times per season (between late November and March) with intervals between nesting in the range of 10-17 days (Environment Australia 1998). The average number of eggs per clutch of is 115.

The most important nesting sites in Western Australia are centred on the sandy mainland beaches of the North West Cape – NMP area, the Muiron Islands, Serrurier (Long Island), the coastal areas of Barrow Island, some of the Monte Bello Islands and some of the islands of the Dampier Archipelago (Prince 1994a). Although by far the most commonly occurring turtle within the NMP, very few if any adult females are known to breed on the sandy beaches of Bateman Bay, to the immediate north of the Coral Bay settlement (Mack 2001).

Between 1986 and 1997, the Western Australian Marine Turtle Project (WAMTP) tagged and released 11471 nesting adult female green turtles in Western Australia. The principal breeding rookery is on Lecepede Island, to the north west of Broome where 5171 adult females were tagged. Detailed observations of mainland rookery sites within the NMP – North West Cape area have only ever been made over the 1988/89 and 1989/90 seasons (Prince 1998). Over 4,000 nesting adult female green turtles were tagged from the North West Cape – Muiron Islands. No green turtle nesting sites are known from Dirk Hartog Island near Shark Bay (Prince 2001).

Tagged green turtles have an annual mortality arising from hunting of the order of 1-2%, although an under reporting of captured tagged turtles has been reported. It has been suggested that very few green turtles are taken by Aboriginals in Western Australia, with half of those tagged on Lacepede Island nesting sites reported taken to date have actually been taken by Aboriginal people in the Northern Territory (Kowarsky 1982).

Studies of green turtles hatchlings have indicated that they are strongly attracted to artificial light in the near ultraviolet (yellow) region of the spectrum (Lutz 1996). Hatchlings often become disorientated by an artificial light source, and depending on the intensity may mistake the light for the sea.

A substantial, regionally important nesting population of green turtles are dependant on Western Australian rookeries for their ongoing survival (Limpus 1982).

Flatback Turtles

The flatback turtle is not currently listed under the EPBC Act, and in Western Australia is probably the next most abundant breeding species of marine turtle after the green turtle (Marine Turtle Newsletter 1993). Flatback turtles are carnivorous, feeding mostly on soft bodied prey such as sea cucumbers, soft corals and jellyfish (Environment Australia 1998).

In Western Australia, the nesting period for flatback turtles is generally between November and February (with records of nesting during the July-August period in King Sound (Prince 1994b), with intervals between nesting ranging between 13 – 16 days. The mean number of flatback eggs per clutch is 54 (Environment Australia 1998). It may nest alone or in mixed species groups (Prince 1994b), which may account for the relatively small number of known nesting sites

In Western Australia, flatback turtle nesting does not appear to be typified by the widespread use of, by small numbers of turtles, the isolated mainland beaches. The more common nesting occurrence appears to be widespread use of scattered beaches on both near-shore and offshore islands and on the mainland (Prince 1994b). Very few observations of the flatback turtle have been reported at sea, and those observations made are generally associated with nearby nesting sites. The majority of rookeries and nesting sites are centred off the southwestern Pilbara Coast (south west of Cape Thouin and the eastern coast of Barrow Island), with smaller rookeries identified in King Sound and the Cambridge Gulf in the Kimberley region. There has been no confirmation of flatback turtles being recorded south of the Exmouth Gulf area (Prince 1994b). Between 1986 and 1997, only around 1000 nesting adult female flatback turtles have been tagged and released in Western Australia, 560 of which were from south west of Cape Thouin and 181 from Rosemary Island in the Dampier Archipelago (Prince 1998)

Hawksbill Turtles

Hawksbill turtles are listed as Threatened (under Controlling Provisions 18 and 18(A)) and Vulnerable (Controlling Provisions 18 (4) and 18(A) of the EPBC Act. They are also listed as migratory under Controlling Provisions 20 and 20(A). The Hawksbill turtle is also listed as Vulnerable under the Western Australian *Wildlife Conservation Act 1950.* They occur worldwide and are found in tropical and warm temperate water (Environment Australia 1998). In Western Australia, though not abundant, the Hawksbill turtle appears to be a regular visitor to areas to the north of Shark Bay, with breeding sites centred on the Pilbara region islands (Marine Turtle Newsletter 1993). The Western Australian population is the only large population of the species remaining in the Indian Ocean (Environment Australia 1998).

The diet of the hawksbill turtle is comprised primarily of sponges, although the species has been known to feed on seagrasses, algae, soft corals and shellfish.

In Western Australia, hawksbill turtles usually nest 3 times per year between August and November at 15-day intervals. The average number of eggs per clutch is 130 (Environment Australia 1998). One or two female hawksbill turtles (less than 5 %) of turtles breeding on Bateman Bay beaches are hawksbill turtles.

Hawksbill turtle nesting sites are often difficult to detect and those known are centred on the Pilbara islands (Dampier Archipelago to Monte Bello group) and northern Gascoyne including some NMP – North West Cape beaches. There has been some difficulty in the detection of nesting sites possibly due to extended seasonally diffuse nesting patterns. Since 1986, 1050 nesting adult female hawksbill turtles have been tagged on Rosemary Island, with another 304 from Varanus Island. The nesting locations from the NMP – North West Cape beaches area are thought to involve very few nesting adult female

hawksbill turtles (Prince 1998). Hawksbills are generally located in the deeper water seaward of Ningaloo Reef (Bowman Bishaw Gorham 1995).

Leatherback Turtles

The leatherback turtle (*Dermochelys coriacea*), the largest of the turtle species, also has the most widespread distribution. They are listed as *Special Protected Fauna* under the Western Australian Wildlife Conservation Act (Environment Australia 1998).

Although not reported within the Ningaloo Reef, the leatherback is a likely regular, non-nesting migrant visitor to Western Australia (Prince 1994a) and the study area is within its assumed distribution and occasional individuals are expected to occur (May, Lenanton & Berry 1983). Between 2 to 6 sightings of the leatherback are recorded off the north West Coast each year, with an occasional individual caught in lobster float lines in the south west of the state. These populations are likely to be dependent on breeding locations outside of Western Australian waters.

Turtle Characteristics and Known Threats

Dobbs (2001) notes that for most species of Australian turtle, including those found in the World Heritage Areas, there is inadequate knowledge of the sizes of their populations, distributions, or the location of key foraging habitats. The management of marine turtles is difficult because of their complex ecology (Environment Australia 1998).

In presenting a draft recovery plan for marine turtles in Australia, Environment Australia (1998) identified a number of characteristics that make it difficult to manage turtles. These include, amongst others:

- they spend most of their lives in the marine environment;
- hatchings disperse widely and follow individual migratory pathways;
- they cross many jurisdictions, national and international boundaries;
- they exhibit complex breeding behaviours (females return to their natal beach to lay several clutches of eggs);
- hatchlings and adults are influenced by environmental cues;
- not all females nest each year;
- individuals are long-lived and slow to mature;
- they occupy different habitats at different stages of their lives; and
- they are subject to a range of impacts at different stages of their lifecycle.

Known threats to survival of marine turtles include:

- fox predation of nests;

- incidental catch in fisheries gear and shark control gear;
- [1]ingestion of synthetic material;
- vessel strike;
- coastal development;
- tourism impacts;
- disease; and
- indigenous harvest of adults, juveniles and eggs for food or tortoiseshell.

[1] Plastic bags are sometimes mistaken by some marine turtle species for squid and are ingested. This often results in the formation of air bubbles within the turtle's gut, resulting in increased buoyancy, greater susceptibility to boat strike and possible death through starvation.

The major impact on turtles in the Ningaloo area is loss of eggs to feral animals. (Mack 2001).

Turtle Management Strategy

The CCR Marine Turtle Management Strategy will consists of the following components:

- Feral Animals
- Light Pollution
- Beach Access
- Vessels Strikes - including consideration of offshoot channels near boat ramps.
- Ecotourism
- Indigenous Hunting
- Public Education
- Appointment of a Turtle Management Officer

Feral Animals

Monitoring of turtle nesting and hatchling emergence north of the Maud's landing site has demonstrated significant predation of eggs by foxes (Mack 2001). Fox predation is believed to account for losses of up to 70% of turtle eggs (Prince 2001).

Continual control of fox populations would have a substantial impact on the number of hatchlings surviving and the turtle population overall. The preferred method for fox control is through the use of approved baits. Alternatively, other less efficient methods such as traps will be employed.

The use of baits for fox control will require negotiation and approval from agencies such as CALM and the Agricultural Protection Board. There is potential for some conflict between users of the area and the control of foxes in terms of the potential for non-target animals such as domestic pets being inadvertently killed. The program therefore will be designed in consultation with the relevant agencies.
Control measures will be concentrated near potential food sources such as refuse dumps within the Coral Coast Marina Development (CCMD) management area.

Complimentary fox control should also be undertaken along the length of the turtle nesting beaches at least during the turtle nesting season. The main nesting area is outside the boundaries of the development, occurring along the coast adjoining the Cardabia pastoral station managed by the Baiyungu Aboriginal Corporation. CCMD will liaise

with CALM and the Baiyungu Aboriginal Corporation to encourage a continual comprehensive approach to fox control.

Visitors and residents of the area will be prohibited from bringing or keeping cats and dogs within the development area.

Light Pollution

Artificial lighting can attract and disorientate hatchlings and increase mortality. The development will be designed to ensure minimal fugitive light reaches the beaches. The development is located between 2km and 6km south of the main nesting beaches although some nesting does occur along the beaches fronting the proposed development.

Lighting management at the development is proposed to include the following aspects:

- The development is located behind the dunes along the beach, which will restrict the light reaching the beaches.

- Orientation of the buildings and windows will be considered during detailed design. The design will aim to minimise the number of windows facing toward the north (where the main turtle nesting activity occurs) and include elements to shield lighting from beaches fronting the development.

- High intensity lighting and floodlights will not used within the development area. Lights throughout the CCR will be directional, low intensity and mounted low on supports or buildings.

- Lights and access paths will be positioned low with the light directed to provide sufficient illumination of the path for safety but with a limited light spillage above the vegetation and dunes.

- Lighting in the green-yellow to yellow region of the spectrum (560 to 600nm) will be used for outside lighting within the development and including lights associated with accommodation units. This range has been shown to be less attractive to loggerhead and green turtle hatchlings (Lutz 1996).

- Where necessary, shielding of lights within the development and accommodation units and motion-detector lights will be used.

- Residents will be informed on the impacts of lights on hatchlings and will be encouraged to use low intensity lighting and window treatments to prevent light spill during the nesting and hatching season.

- The Environmental Code prepared for the development will include information for visitors to discourage the use of lighting and torches on the beaches at night during the nesting and hatching periods and provide guidelines for minimising impacts.

Beach Access

Development of the marina will interrupt movement of 4WD vehicles along the coast from the Coral Bay settlement. Access to beaches adjoining the site within the development area will be controlled by the use of appropriate structures and signage. Vehicles may however, be able to deviate around the development area and access beaches to the north through Cardabia station.

Developers of the CCR will liaise with the Baiyungu Aboriginal Corporation and CALM in relation to means to prohibit access, particularly during the nesting season (between 1 November and 31 March), onto the beaches north of the CCR development site. Access onto the beaches should be limited to quad bikes used by authorised operators such as CALM and Fisheries WA officers, and approved tour operators.

4WD vehicles would be permitted to access the beaches during between 1 November and 31 December only during daylight hours between 6am and 7pm. All vehicle access to the beaches would be prohibited during the main hatching period from 1 January to 31 March as the tyre tracks can present major obstacles for hatchlings as they migrate to the water.

Pedestrian access to the nesting beaches north of the Cardabia access track would also be prohibited during the breeding season between 1 November and 31 March unless as part of a coordinated tour or ecotourism activity.

Methods to prohibit access will be investigated during detailed design phases of the development. Control of access to these areas will be achieved through methods such as public education, signage, regular patrols of the beaches, creation of formalised parking areas and walk trails, and use of strategically placed bollards and fencing.

Vessel Strikes

The potential for injuries or deaths due to boat speed is considered relatively low. The greatest potential for impacts is by larger boats accessing areas outside the reef where can reach greater speeds. All visitors and tour operators using boats from the development site will be required to comply with a Environmental Code of conduct prepared for the area. This will specify areas where boats are permitted and maximum boat speeds.

Limiting boat speeds will enable greater time for turtles to evade boats as they approach. The increased regulatory presence of CALM and Fisheries WA officers will enable enforcement of the Environmental Code.

Ecotourism

Tour operators such as whale watching tours and whale shark interactions within the area are largely controlled through a licensing requirement of CALM. A code of conduct will however, be developed as part of CCMD, in liaison with CALM, for tour companies operating out of the development area. The code will outline guidelines for operation including access, vehicle speeds, and activities.

It is anticipated that the potential greatest impact will be during the nesting and hatching season between November and March. Tour operators may undertake night searches to

locate nesting turtles or watch hatchlings emerge. The use of vehicles and lights including torches, and general noise and disturbance during these activities may disrupt nesting and disorientate hatchlings. Activities and visitor groups will need to coordinated and managed appropriately to avoid significant disturbance of turtle nesting.

Developers of CCMD have no direct control or management responsibility of the neighbouring areas such as Cardabia station but will work in close liaison with the Baiyungu Aboriginal Corporation in relation to ecotourism opportunities, access arrangements and night searches and interactions with turtles. The developers of CCMD will appoint a person dedicated to turtle management within the area who will, in consultation with CALM, liaise with tour organisers and visitor groups.

Indigenous Hunting

Developer of CCMD will liaise closely with the Baiyungu Aboriginal Corporation, the leaseholders of Cardabia station, to encourage only controlled gathering of turtle eggs and hunting of marine turtles.

Public Education

An Environmental Code will be prepared for the CCR. The code will provide guidelines for various activities for visitors, residents and tour operators. The guidelines will range from topics such as boat usage and speed, use of 4WD vehicles, interactions with marine life and habitat including whales, dugongs, turtles, seagrass and coral, and beach usage. The code will include aspects such as litter disposal and pollution to prevent fauna such as turtles suffering injuries or being killed as a result of rubbish or marine debris.

Additional to the code, information will be made available to visitors and residents of the development regarding the environmental values and characteristics of the area and the issues and impacts associated with conserving these values. It is anticipated that the information will be disseminated though a variety of means such signage, information leaflets, visitor centre, short videos and staff at the development.

Turtle Management Officer

CCMD plans to appoint a dedicated person to oversee turtle management during the nesting season. The person will be present at the site between 1 November and 31 March each year.

Duties of the appointed person are proposed to include:

- Coordinate fox control.
- Control beach access.
- Coordinate all searches for nesting turtles and emerging hatchlings.
- Liaise with visitors and tour operators.
- Identify opportunities for, and undertake public education.
- Liaise with Baiyungu Aboriginal people.
- Locate all nests each morning.
- Record location, mark and provide protection for nests.
- Coordinate collection of tagging and monitoring data.

- Provide CALM with statistical data.
- Record incidences of turtle deaths, injuries or disturbance.
- Identify any turtles that may enter the marina and relocate them to Bateman Bay.
- Check shark exclusion mesh daily.
- Identify potential issues or impacts, and take action to notify relevant parties such as CALM and CCMD managers, as necessary.

The person appointed will be experienced in working with turtles or will undertake training to recognise species tracks and locate nests.

Much of the activities to be undertaken by the appointed officer will be undertaken on beaches outside the boundary of the CCMD area. Close liaison and support of CALM and Baiyungu Aboriginal Corporation will be required in order for the officer to effectively perform the duties outlined above. CALM has previously indicated support in relation to the appointment of a turtle management officer (Myers 2001). The Baiyungu Aboriginal Corporation has indicated willingness for members of the Baiyungu community to be trained to undertake the turtle management role.

Protection of the turtle nests will involve identification of nest sites and recording of their location during the nesting season, which occur between about November and March each year. This will involve patrols of the beaches early each morning, before tracks disappear as a result of wind or tidal action, to identify nests. Locations will also be marked at night during coordinated activities on the beach.

Each of the nests will be clearly marked and protected using material such as timber slats and/or plastic mesh. This will also assist in preventing turtles inadvertently destroying other nests as they excavate a body hole and egg chamber. Where turtles choose to lay eggs in locations that are closer to the development or disturbance, greater protection of the nests may be required. The nests will be monitored routinely until the eggs have hatched.

Volunteers can have an important role in monitoring populations and assisting conservation efforts. Residents of the development and members of the Baiyungu Aboriginal community may be enlisted to provide additional support to the nominated officer in monitoring nesting and hatching, and liaising with tour operators or leading ecotourism visits. The volunteers will need to be coordinated by the Turtle Management Officer with assistance from CALM.

E. BOAT NUMBERS AND UTILSATION IN NMP

Existing Boat Numbers

The Coral Bay settlement is a popular access point to the central and southern sections of the NMP.

Department of Planning and Infrastructure, Coastal Facilities Branch has referred a proposal to establish a boat launching facility at North Bills Bay to the EPA with a view to providing an alternative to current boat launching and mooring in South Bills Bay. A brief description of the alternative sites referred is presented in Appendix 4. Gascoyne Development Commission (1999) undertook a marine traffic study to quantify existing and potential marine traffic (including swimmers) as an aid to the evaluation of the most appropriate site for the boat ramp. The study combined community survey and counts.

Count data indicated up to 30 boats anchored or moored in Bills Bay during the survey period (in part coinciding with school holidays), with up to 46% of all boats active outside of Bills Bay (Gascoyne Development Commission 1999). No count was made of boats launched over the beach between survey times. Simpson (2001) advised that over 60 recreational boats moored or anchored during peak periods, with a further 15 commercial vessels operating from the Coral Bay area. These include two licensed whale shark boats, nine charter vessels and three coral viewing vessels.

Observations were made on recreational and commercial boat numbers present at the Coral Bay settlement and surrounding informal campsites during the Easter school holidays 2001 and non-holiday periods following. The following counts were undertaken and results tabulated:

- foreshore counts - boat trailers and boats at anchor/on the beach, including car-toppers obviously in use;
- caravan park empty - boat trailers and car toppers obviously in use parked in the caravan park and other public places (road verges);
- caravan park loaded - boats on trailers and loaded car toppers each parked in the caravan park and other public places (road verges);
- informal camps - count of informal camps along Bateman Bay, including boats (principally car toppers/light trailed craft either on the car, in the camp or on the beach; and
- moored boats - boats either at a formal or temporary mooring, or beached.

The following assumptions were made:

- total boats - summed empty trailers and car-toppers either on the beach, caravan parks or public areas, less moored non-commercial boats; and
- total boats in use - summed empty trailers and car-toppers either on the beach, caravan parks or public areas, less one half of moored non-commercial boats.

Averages and summary data is presented in Table E1. Observations on weather and approximated visitor numbers are also provided. The weather was conducive to boating, particularly in the morning.

On the limited data collected in April and May 2001, on average 98 private boats were present during the school holiday period, of which 46% were in use at 0800, and 28% in use at noon. During non-holiday periods, boat utilisation increased to 57% and 44% at 0800 and noon respectively, although on a much reduced number of boats (about 39). About 13 commercial boats were observed operating during the review period.

Potential impact of boat use in the marine park can include:

- physical injury and disturbance to wildlife;
- hydrocarbon losses during fuelling and boat operation;
- nutrient enrichment due to discharge of sewage;
- damage to coral reef and other benthic biota due to anchoring activities, boat groundings and suction; and
- foredune and beach erosion (launching and retrieving).

The Gascoyne Development Commission (1999) also noted that the beach adjoining Bills Bay east of the boat mooring area was the most popular for beach goers at almost any given time of day, approximately doubling those south of Fletchers Hill, the coastal promontory west of the Coral Bay settlement. Over the period surveyed (three days between 25 August to 21 September 1999), an average of 134 swimmers were recreating on the Bills Bay beach east of the boat mooring area at midday. Numbers reduced to an average of 98 at 2pm, rising to an average of 107 at 4pm. Recreational use of the beach south of Fletchers Hill peaked at 4pm on the days surveyed averaging 68 swimmers.

Opportunistic observations of boat traffic during the Gascoyne Development Commission (1999) survey indicated that ninety percent of boats used the in shore channel past Fletcher Hill to depart from, or return to Bills Bay, with the majority of these (84%) passing within 25 m to 100 m of the shore. This area is well known for its outstanding lagoonal corals and is frequented by snorkellers wishing to view them. All respondents to the Gascoyne Development Commission survey swam or snorkelled in Bills Bay on a daily basis (Gascoyne Development Commission 1999).

Boat and Tour Related Activities

SCUBA diving, fishing, whale watching and snorkelling are popular activities for visitors to the NMP. Shore based turtle egg-laying and hatching tours are also seasonally popular being catered for by either self-drive ‘quad’ motorbikes or in 4WD vehicles. Cary et al. (2000) describes these activities.

Snorkelling activities may be private from either shore or boat, or as participants in organised snorkelling tours from either shore or boat. Snorkelling participants may have the opportunity to view and interact with a range of species within both State and

Commonwealth controlled portions of the marine park. Snorkelling to view corals, reef fish, turtles, manta rays occur in shallow waters, generally within the lagoon. Occasionally dugongs are also encountered.

In the pelagic zone, snorkellers may swim with whale sharks and whale-watching tours can view humpback and other whales. Commercial operators engaged for these activities are licensed and managed by CALM.

Figure 3, prepared in consultation with the Coral Bay settlement tourism operators indicates the major wildlife interaction and viewing areas in the central Ningaloo Reef area. The lines radiating out from the entrance of the proposed CCR indicate distances of five, ten, fifteen and fifty kilometres which relate to reasonable travel distances for each of the boat classes cartoppers, small trailed boats of less than 5.5 m length, larger trailed boats of greater than 5.5 m length, and large commercial craft/ moored craft respectively.

On this basis, whale and whale shark interactions, principally undertaken in Commonwealth waters, will generally be limited to more seaworthy larger trailed and moored vessels. All boat classes are capable of travel within lagoon. A summary of occurrence and activity data relating to large finfish and marine mammals is presented in Table E2.

TABLE E1
AVERAGE NUMBER OF BOATS OBSERVED AT THE CORAL BAY SETTLEMENT DURING HOLIDAY AND NON-HOLIDAY PERIODS, SELECTED DAYS APRIL AND MAY 2001

	FORESHORE				CARAVAN PARK (trailers/roof empty)				CARAVAN PARK (boats on trailer)				INFORMAL CAMPS		MOORINGS		TOTALS (BOATS)		
	cartop	<5.5m	>5.5m	total	cartop	<5.5m	>5.5m	total	cartop	<5.5m	>5.5m	total	total camps	total boats	total	Comme-rcial	All	in use	% in use
Ave holidays	6	20	5	31	2	2	3	7	11	16	8	34	21	17	31	9	98	37	37
Ave non holidays	1	6	2	9	1	1	0	2	6	6	2	14	6	5	12	10	39	20	50
ave hols 0800	7	25	6	38	3	2	3	8	9	11	7	27	21	16	35	13	101	46	46
ave hols 1200	5	15	5	25	2	2	4	7	13	20	8	41	21	18	26	6	96	27	28
ave non hols 0800	2	7	2	11	1	1	0	2	4	5	2	11	6	5	15	12	41	24	57
ave non hols 1200	0	5	2	7	0	1	0	1	6	6	2	14	5	5	9	8	35	16	44

Date	Day	Weather	Winds 0800		Winds 1200		Description	Population Estimate
			dirn	strength	dirn	strength		
20/4/01	Holiday Fri	Hot, fine, mild night.	calm	0	NE	15 km/hr	Caravan Parks full lots of informal camping	2700
22/4/01	Holiday Sun	humid, overcast	E	10 km/hr	NE	20 km/hr	Caravan Parks full lots of informal camping	2700
4/5/01	Post holiday	fine, clear, warm-hot	SE	10 kn/hr	ENE	15 km/hr	Caravan Parks м full. Few informal campsites.	800

TABLE E2
SUMMARISED OCCURRENCE AND ACTIVITY DATA FOR THREATENED AND MIGRATORY MARINE SPECIES THAT ON THE BASIS OF THEIR KNOWN DISTRIBUTION MAY ON OCCASION BE OBSERVED IN THE NMP

	Activity				Frequency			Location			Comments
	Migration	Feeding	Reproduction	Resting Basking	Occasional	Frequent	Resident	Open Waters	Bateman Bay	Mauds Landing	
TURTLES Green		X	X	X		X					Low numbers (up to 5%) breeding on Bateman Bay beaches. Congregate on back reef areas adjacent to Cardabia Passage.
Loggerhead		X	X	X		X					Make up the majority (95+%) of breeding turtles on Bateman Bay beaches. Congregate on back reef areas adjacent to Cardabia Passage.
Hawksbill		X		X	X			X			Limit of range.
SHARKS Whale shark	X	X		X	X			X			Feeding and basking observed offshore.
MAMMALS Dugong	X	X		X	X				X	X	Likely transient through Bateman Bay and Mauds due to limited food availability.
Humpback Whales	X	X		X	X			X	X		Baleen whale feeding and basking observed offshore. Southern right cows and calves occasionally enter Bateman Bay to rest. Toothed whales and porpoises enter Bateman Bay and have been observed off Mauds.

Pressures on species of national importance and their support systems relevant to the proposed action include:

- physical injury and disturbance/harassment;
- environmental degradation due to hydrocarbon losses during fuelling and boat operation;
- environmental degradation due to nutrient enrichment resulting from discharge of sewage;
- environmental degradation due to sedimentation resulting from construction and boating activities;
- damage to coral reef and other benthic biota due to anchoring activities, boat groundings and propeller suction;
- damage to coral reef and other benthic biota due to SCUBA diving and snorkelling activities;
- increase in predator numbers;
- ingestion of litter; and
- foredune and beach erosion.

Very little data is available on visitor numbers engaged in organised boat and tour related activities operating out of the Coral Bay settlement. Numbers of visitors engaging in these activities independently either in private boat or from shore is unknown.

Estimates of visitor participation in organised boat and tour related activities have been made and are based on the observations of tourism operators, residents and government agency representatives residing in or regularly visiting the Coral Bay area. These estimates are provided in Table E3. Data for likely increases in demand for these services, independent of the implementation of the CCR, are also provided, based on current participation rates and a projected 5 % (flat) increase in visitation to Coral Bay area.

TABLE E3
SUMMARY OF ESTIMATED CORAL BAY BOAT AND TOUR RELATED ACTIVITIES, 2001 & PROJECTED TO 2009

SCUBA DIVING		
Time of demand	Occurs all year	
# boats	4	boats
Places	100	
boat utilisation	66	%
total divers	23100	dives
% of beds diving	3.8	
additional demand to 2009	8085	to 2009
at 66% boat utilisation	490	boat trips
at 90% boat utilisation	359	boat trips

FISHING CHARTER		
Time of demand	Occurs all year	
# boats	3	boats
Places	47	
boat utilisation	60	%
total fishing days	9870	fishers
% of beds fishing	1.7	%
additional demand to 2009	3455	fishers
at 66% boat utilisation	368	boat trips
at 90% boat utilisation	245	boat trips
SNORKELLING/ECOTOURISM EXPERIENCES		
Time of demand	all year	
# boats	4	boats
Places	90	
boat utilisation	66	%
total snorkellers	20790	dives
% of beds snorkelling	3.4	%
additional demand	7277	to 2009
at 66% boat utilisation	490	boat trips
at 90% boat utilisation	359	boat trips
HUMPBACK WHALE VIEWING		
Time of demand	Limited to migration, up to 12 weeks	
# boats	3	[5] boats
Places	63	
boat utilisation	50	%
total participants	2646	observers
% of beds viewing	0.4	% 1.9% for the 12 week period of migration
additional demand	926	(to beginning of 2009)
at 50% boat utilisation	88	boat trips
at 80% boat utilisation	55	boat trips
WHALE SHARK EXPERIENCES		
Time of demand	Limited to period following coral spawning, 10 weeks	
# boats	2	
Places	32	
boat utilisation	80	%
total participants	1792	snorkellers
% of beds snorkelling (annual)	0.3	% 1.5% for the 10 week period of congregation
additional demand	627	to 2009
at 80% boat utilisation	49	boat trips
at 90% boat utilisation	44	boat trips

BEACH TURTLE NESTING/ HATCHING EXPERIENCES		
Time of demand	Combined nesting and hatching 14 weeks	
Operators	3	
# quadbikes/4WD places	24	
Utilisation	95	%
total participants	2234.4	participants
% of beds viewing	0.4	% 1.4% for the 14 week period of beach activity
additional demand	782	
at 95% vehicle utilisation	additional 8 places daily	

Activities for the balance of recreational use of the Ningaloo Marine National Park and adjoining lands include:

- use of headlands, dunes and beaches (for swimming, sunbathing, walking, beach fishing, use of recreation vehicles and eco-tourism);
- recreational fishing targeting finfish from shore or by private boat; and
- water sports, including swimming, snorkelling and SCUBA diving from shore or from private boat, and to a lesser extent windsurfing and sailing.

Increase in Private and Commercial Boat Numbers

Based on a maximum population at the Coral Bay settlement of 1212 visitors and residents, it is estimated 55 boats (trailed craft and car-toppers) and including four glass bottom commercial vessels may continue to operate from Bills Bay, or be garaged at the existing Coral Bay settlement facilities. It is further anticipated that all trailed boats will be launched at the ramps provided in the CCR development.

A further 68 boats, including all the large commercial vessels are likely to relocate to Mauds Landing. Based on calculations of additional commercial and charter boat demands, calculated boat ownership for residents at the CCR (see section 8.1 in Appendix 8 of the PER (ATA Environmental 2000a), and short term residents as adjusted following recent boat counts in the Coral Bay area, additional boats at the CCR are expected to total 153. In combination with boats anticipated to remain in the Coral Bay settlement, a total of 208 boats are anticipated.

Based on boat usage trends identified in Table E1, during busy holiday periods 46 % of boats can be anticipated to be in use at 0800 (96 boats), and 28% (59 boats) at noon.

Additional Boat and Tour Related Activities

Table E4 presents estimates of additional demand for organised boat and tour related activities in 2009 at full implementation of the CCR. Anticipated increases for the Coral Bay area irrespective of the implementation of the CCR have also been calculated.

In summary, it is predicted that about half the additional demand calculated to 2009 is based on additional beds being made available by the construction of the CCR, with the balance resulting from expected increasing demands in the Coral Bay area.

TABLE E4
SUMMARY OF ESTIMATED CORAL BAY BOAT AND TOUR RELATED ACTIVITIES

	Length of Season	Coral Bay	Coral Coast Resort	
		Predicted Additional demand to 2009	Predicted Demand 2009 based on visitor N^{os}.	[1] Net based on visitor N^{os} less Coral Bay overflow
SCUBA DIVING				
additional places	all year	8085 dives	39467 dives	8282 dives
Additional boats at 66% util.		490 boat trips	992 boat trips	502 boat trips
all boats at 90% util.		359 boat trips	727 boat trips	368 boat trips
FISHING CHARTER				
additional places	all year	3455 fishers	16863 fishers	3539 fishers
Additional boats at 60% util.		368 boat trips	744 boat trips	736 boat trips
all boats at 90% util.		245 boat trips	496 boat trips	251 boat trips
SNORKELLING/ECOTOURISM EXPERIENCES				
additional places	all year	7277 divers	35520 divers	7475 divers
Additional boats at 66% util.		490 boat trips	992 boat trips	502 boat trips
all boats at 90% util.		359 boat trips	727 boat trips	368 boat trips
HUMPBACK WHALE VIEWING				
additional places	12 weeks	926 seats	4521 seats	949 seats
Additional boats at 50% util.		88 boat trips	179 boat trips	90 boat trips
all boats at 90% util.		55 boat trips	112 boat trips	56 boat trips
WHALE SHARK EXPERIENCES				
additional places	10 weeks	627 snorkellers	3062 snorkellers	642 snorkellers
Additional boats at 80% util.		49 boat trips	120 boat trips	71 boat trips
all boats at 90% util.		44 boat trips	88 boat trips	45 boat trips
BEACH TURTLE NESTING/HATCHING EXPERIENCES				
		782	3818	801
all places at 95% util.	14 weeks	8 places	32 places	9 places

Notes
1. Net increase in demand for boat and tour related activities has been determined by subtracting Coral Bay area predicted additional demand (2001 to 2009) and Coral Bay area overflow from the predicted increase in demand arising from the implementation of the CCR.

TABLE E5

ASSESSMENT OF BOAT NUMBERS AND km TRAVELLED

source, discussions with ecotorism operators

	PROPOSED CORAL COAST DEVELOPMENT						CORAL BAY EXISTING		
Item	Trailed	Pens	Totals	# trips/wee	Distance/yr	Source	Trailed	Moored	Distance/yr
Permanent residents	33	8	41	2	93938	M.P Rogers and Assoc, 2000	10		15860
Residential staff	27	7	34	1	76414	M.P Rogers and Assoc, 2000	10		8580
[1] short stay residential	44	0	44	4	96208	boat counts Coral Bay April/May 2001	63		140616
Visiting yachts	0	20	20	1	26000	M.P Rogers and Assoc, 2000	0		0
New Commercial boats	5	10	15	6	176280	discussions with ecotourism operators	0		0
CALM & Dept Fisheries	3	2	5	2	20280	M.P Rogers and Assoc, 2000	0		0
[2] Commercial Boats from Bills Bay	2	12	14	6		boat counts Coral Bay April/May 2001	2	16	271440
Overflow from Bills Bay	54		54	4		calculated			
SUM FOR CCR AND CORAL BAY 2009	168	59	227		491120	CORAL BAY 2001	85	16	436496

[1] assumes informal camps no longer needed, based on actual count data

[2] Not counted as existing boats relocated

ANNUAL DISTANCE TRAVELLED, CCR and Coral Bay, 2009 927616

% INCREASE DUE TO CCR 53

ASSUMPTIONS

source, boat counts Coral Bay April/May 2001

Percentage of Boats by Size

	% obs.	**distance travelled km/day**	
cartoppers	25.71	10	(source, boat counts Coral Bay April/May 2001)
<5.5	52.86	20	
> 5.5	22.86	30	
COMMERCIAL		100	

source, discussions with ecotourism operators

63.56

Proportion of Boats in Size Class by Group

BOATS BY GROUP	cartopper	<5.5	>5.5	COMMERCIAL
Residents	0.1	0.6	0.3	
Residential staff	0.2	0.5	0.3	
[1] short stay residential	0.25	0.5	0.25	
Visiting yachts			1	
New Commercial operators	0.2	0.3	0.5	
CALM & Dept Fisheries	0.2	0.2	0.6	
[2] Large Boats from Bills Bay			0.1	0.9

source, boat counts Coral Bay April/May 2001, otherwise discussion with tourism operators

F. POWER SUPPLY AND MANAGEMENT

The power supply systems selected for the Coral Bay area must meet certain criteria relating to such matters as reliability of supply, redundancy and consider the characteristics of supply requirements.

Examples of a base load power generation from renewable sources are briefly described below.

Hydroelectric Power

An example of a base load power generation from a renewable source that has been implemented in the Kimberley is the Ord River hydro-electricity scheme. A 30MW hydroelectric power station at the Ord River Dam on Lake Argyle, 80km south of Kununurra, was completed in April 1996. The project also involved the construction of 132kV transmission cables to the Argyle Diamond Mine (located to the south) and the townsite of Kununurra (to the north). Western Power 'on-sells' power to householders and businesses in Kununurra, Wyndham and the Argyle village.

This power source is too remote to be economically viable for the Coral Bay area, and no ready sources of water stored energy occur within the region.

Tidal Power

The Office of Energy notes that there is considerable potential for tidal energy production in the North West of Western Australia where there are large tidal basins and high tides (Office of Energy 2001).

The Environmental Protection Authority (EPA) recently considered a proposal for establishment of a Tidal Power Base Load Energy Project at Doctors Creek near Derby (EPA 1999, 2000a). Derby Hydro Power Ltd has proposed construction of a 48 FMW double basin tidal power station on the natural forked bay at Doctors Creek near Derby. The tides would supply energy for power generation with supplementary generation by conventional plant during neap tides. The proposal includes transmission lines linking Derby to Broome and Derby to Fitzroy Crossing and the nearby Blendevale mine.

Capital cost of tidal power stations could extend to A$ 3 million per MW of installed generation capacity, (Australian Greenhouse Office 2000) dependant on site requirements, design and electricity demand, compared to A$900,000 per MW by gas turbine. The EPA, in its consideration of the whole of lifecycle impacts of the Tidal Power proposal, commented that the potential for environmental benefit from savings in greenhouse gas emissions is reduced due to other impacts.

In concluding statements within its Report and Recommendations (Environmental Protection Authority 1999), the EPA said of the proposal for tidal power that:

> *.....more conventional forms of power generation would have different and lower environmental impacts (with the exception of greenhouse gas) with a higher level of certainty about the ability to manage impacts that would result.*

The Coral Bay area is considered to be in the transitional zone between the small, primarily diurnal tides (one tidal cycle per day) of the southwest coast and the large semi-diurnal tides (two tidal cycles per day) of the North West Shelf. The mean spring (largest) tidal range being about 0.9m, and about 0.4m during neap tides is insufficient to pond water to economically generate electricity even if an appropriate landform existed within the region.

Wind Energy

Wind power is also being used in an increasing number of isolated stand-alone generation systems for households or small communities in remote areas.

Applications in Western Australia include:

- Nine 225kW variable pitch wind turbines connected to Esperance's conventional diesel power station at Ten Mile owned and operated by Western Power.

- The first of three 50m high variable speed wind turbines at Denham supplying up to 70 percent of the towns electricity requirements.

- A mini wind farm at Exmouth, 1300km North of Perth. Plant consists of three 20kW Australian made Westwind turbines with tilt-down towers.

Western Power Corporation is currently constructing a 21.6MW installation wind farm near Albany, to be connected to the interconnected grid, which should produce around 70-80 GW hours per annum.

Given the right conditions, electricity generated from wind energy may be appropriate for remote communities that currently rely on diesel fuel for electricity generation. Western Power notes that in some places of the world, wind can also be competitive with large-scale coal and gas generation on big grid systems, but this is not yet the case in Australia (Western Power, 2001).

The average wind velocity in the Coral Bay area is too low or unreliable for the economic use of wind farms in isolation, but some potential exists for supplementing existing conventional power sources with energy derived from the wind during periods of high wind velocity.

Solar Energy

Office of Energy (2001) notes that there are currently two systems used for converting solar energy into electricity:

- photovoltaic (PV) systems which convert sunlight directly into electricity; and

- solar thermal power systems which produce electricity indirectly from solar radiation by converting it into thermal energy and then producing electricity using an engine.

In Western Australia only PV is used to produce electricity. Applications in current use include:

- A 20kW Kalbarri Photovoltaic System owned by Western Power Corporation.
- Uses a 3.6kW privately owned solar/diesel hybrid system installed at the Broome Bird Observatory.
- Various grid connected rooftop PV systems connected to the southwest interconnected grid in 1997 under Western Power's Renewable Energy 'Buyback' Scheme. The scheme applies to home renewable energy systems from 250W to 5kW.

Office of Energy (2001) notes that the cost of electricity from PV is generally higher than from fossil fuels or alternative renewable energy sources within Western Australia. A recent proposal to install a solar farm at Broken Hill, 42 solar dishes covering 20ha are required to generate 1MW of power, will cost A$8 million (Waste Management and Environment 2000).

Western Power (2001) notes that solar power is still one of the most expensive ways to produce renewable energy and will only be used in limited circumstances, or with the aid of government subsidies, unless the capital cost is considerably reduced by a breakthrough in PV production techniques.

For base-load power applications the use of solar energy is capital intensive, requires substantial storage capacity for periods of low light intensity and on extensive collector area.

Due to the brackish nature of artesian water used for most non-potable applications in the Coral Bay area, solar hot water heaters have very high maintenance costs.

Biomass Generators

Power can be produced in two main ways from biomass:

- The sustainable growing of crops that can then be burnt to produce power. Because crops absorb carbon dioxide from the atmosphere when growing, and then release it when burnt to produce heat (which is captured to generate power), the entire cycle has an almost neutral impact.
- The capturing of methane from rotting organic matter in landfill sites (rubbish tips), sewage works, or other waste treatment sites, which is then used in small gas-fired power stations. In this process, the methane that would normally escape into the atmosphere is put to good use producing power as it is burnt and converted to carbon dioxide. Methane is a much more potent greenhouse gas than carbon dioxide and so the whole process lessens the impact of the captured gas from decomposing waste by around 80%.

Western Power currently purchases around 40 Gigawatt hours of power from landfill gas power producers (Western Power 2001).

There are no sources of biomass or landfill gases that would allow economic generation of power from biomass generation in the Coral Bay area.

Dual Fuel Gas Generators

The adoption of dual fuel gas fired engines and use of LPG or LNG as primary fuel provides the most acceptable option for power generation within the Coral Bay area when considered in terms of reduction in greenhouse emissions, reliability of supply and certainty of outcomes.

The amount of $C0_2$ emitted from fossil fuel depends on the type and amount of fuel consumed during generation, the fraction of the fuel that is oxidised, and the carbon content of the fuel. This relationship can be described in two parts:

1) The amount of carbon contained in the fuel per unit of energy produced varies for different fuel types. For example, coal contains the highest amount of carbon (and accordingly CO_2 produced) per unit of energy. For petroleum the amount of carbon per unit of energy is about eighty percent of that for coal; for natural gas, it is about fifty percent (EPA 1999, 2000a). LPG has similar characteristics.

   Simplistically, the fuels are constructed from different combinations of carbon (C) and hydrogen (H) molecules. The following is a list of the fuels in descending complexity of carbon/hydrogen combinations and in descending ratio of carbon molecules to hydrogen molecules:

FUEL	APPROX. CHEMICAL FORMULA	RATIO CARBON TO HYDROGEN
Diesel	$C_{12}H_{26}$	1:2.167
Petrol	C_8H_{17}	1:2.125
Natural Gas (Methane)	CH_4	1:4.000

   The relevance of the ratio of carbon to hydrogen molecules is that greenhouse gas emissions are inversely proportional to this ratio. Thus diesel with a low ratio of hydrogen to carbon molecules (given all other things being equal) will produce more carbon dioxide when used as a fuel.

2) Not all carbon in fuel products is oxidised to CO_2 for two reasons. Firstly, inefficiencies in the combustion process leave carbon unburnt, which causes a small fraction of the carbon to remain unburnt as soot or ash. As noted earlier, some carbon is not immediately oxidised to CO_2 and is emitted in the form of other hydrocarbons. Secondly, fossil fuels are also used for non-energy purposes, primarily as a feedstock for such products as fertiliser, lubricants, and asphalt.

   If distillate/kerosene were the primary fuel source, CO_2 emissions from power generation would be approximately 25% greater.

G. REVIEW OF STYGOFAUNA AT THE MAUDS TOWNSITE AND SERVICES AREA

Thirteen shallow monitoring bores were constructed at the Mauds Townsite and services areas with a view to collecting samples to determine for the presence of stygofauna. A copy of the full report is provided in Appendix 1. Dr Brenton Knott of the Zoology Department, University of Western Australia, sorted preserved samples. Samples were sorted under a dissecting microscope at 120-250 times magnifications.

Sample descriptions and fauna recovered is summarised in Table G1 below.

TABLE G1
RESULTS OF FAUNAL ASSESSMENT OF SHALLOW BORE WATER SAMPLES TAKEN AT THE PROPOSED CORAL COAST MARINA AND SERVICES AREAS

SAMPLE	SEDIMENT VOLUME (m/L)	SEDIMENT	FAUNA
MMW 1	27.5	fine dark silt with some detritus	1 foraminifera ; 0 metazoans
MMW 2	7.5	sand with some detritus	foraminifera; 0 metazoans
MMW 3	8.5	sand with some detritus	few foraminifera; 0 metazoans
MMW 4	3	sand with some detritus	few foraminifera; 0 metazoans
MMW 5	2.5	sand with some detritus	2 oligochaetes; few foraminifera
MMW 6	10	sand; considerable flocculent detritus	1 oligochaete; few foraminifera
MMW 7	5	sand with some detritus	few foraminifera; 0 metazoans
MMW 8	10	sand; no silt; small fragments of rope	1 oligochaete; very few foraminifera
SMW 1	5	3 mL light brown silt, with plant detritus; 2 mL sand	0 foraminifera; 0 metazoans
SMW 2	10	light brown silt, with plant detritus	1 pseudoscorpion; 0 aquatic forms
SMW 3	10	light brown silt, with plant detritus	0 foraminifera; 0 metazoans
SMW 4	35	7.5 mL light brown silt, with plant detritus; 27.5 mL sand	0 foraminifera; 0 metazoans
SMW4	4.0	flocculent silt; ℑ1 mL sand	0 animals; 0 foraminifera
SMW5	9.5	1 mL light brown silt, with plant detritus; 8.5 mL sand;	0 foraminifera; 0 metazoans

Notes
MMW denotes Marina Area (Mauds Landing Settlement) stygofauna monitoring bores.
SMW denotes Services area stygofauna monitoring bores.

In all samples labelled MMW, there was also a white substance to greater or lesser extent, presumably fragments of plant material covered in $CaCO_3$ precipitate. The silt in the samples labelled SMW was so fine that animals would have difficulty finding adequate living space, and be unable to keep body surfaces sufficiently clean for gas exchange. Sands from the Mauds Landing samples are slightly angular, and with the occasional pieces of plant detritus, Accordingly there is some scope for habitation by stygofauna from this area.

Only three specimens were recovered, all oligochaetes. The two specimens in MMW5, despite being different in size, likely belong to the same species, based on setal morphology.

Identification has yet to confirm whether these specimens are but tubificids or niaids. The single specimen from MMW6 differs in setal morphology and presumably represents a different species, possibly even family.

The species are likely to occur throughout area of the particular substrate from which they are recorded. Dr Knott notes that there is no way of knowing whether the foraminifera were alive or are just tests; with the latter possibility the more likely. Pseudoscorpions are not aquatic, and the specimen in SMW2 undoubtedly represents an 'accidental'.

H. JUSTIFICATION OF CORAL COAST RESORT

Development of a Resort at Mauds Landing

Mauds landing has been identified as a Townsite since the late 1800's and was the site of a substantial jetty used for loading of regional rural produce onto coastal steamers. More recently, in the post war period, limited development associated with the fishing industry occurred within the Townsite but has since been removed. The existing settlement of Coral Bay is situated within the southern portion of the Mauds Landing Townsite.

The Gascoyne Coast Regional Strategy (Ministry for Planning 1996) recognised the potential of Mauds Landing as a significant tourist destination, reducing pressure on other more sensitive locations along the North West Cape and facilitating low key wilderness style development in appropriate locations. The Gascoyne Coast Regional Strategy in effect reinforced the conclusions of the North West Cape Regional Tourism Study undertaken on behalf of Government in 1993 by Jones Lang Wooton. The Strategy was prepared by the Western Australian Planning Commission in 1996 with inter-governmental representation including CALM, DEP and the Shires of Carnarvon and Exmouth.

Following refusal of the original CCMD Structure Plan, State Cabinet in April 1999 adopted a set of Guidelines for a resort development at Mauds Landing. An inter-governmental Task Force including Department of Environmental Protection, CALM, Ministry for Planning, WA Tourism Commission and the Shires of Carnarvon and Exmouth prepared the Guidelines.

The Guidelines reflected the assessment criteria established under the Gascoyne Coast Regional Strategy and established a development form and scale acceptable to Government and the Taskforce.

CCMD was invited to submit a revised proposal in accordance with the Guidelines. The resulting proposal, which accords wholly with that the subject of the PER, was assessed by the Taskforce and Government and found to be in full compliance with the Guidelines.

Utilisation of the terminology "consistent with Cabinet requirements" within the PER in no way implies that Cabinet has required the development to proceed, but rather has specified a series of design objectives for the proposal to be considered compliant. Use of the term in the context of the PER document (ATA Environmental 2000a) is therefore not considered misleading. However, it is significant to also note that government has endorsed the Gascoyne Coast Regional Strategy, which identifies the importance of development at Mauds Landing in the sustainable management of increasing tourism to the Region.

I. SCALE OF DEVELOPMENT

The development proposed for CCR will result in a combined tourist and resident population comparable to that of the Coral Bay settlement under normal conditions and less than the Coral Bay settlement under peak loading when numbers at the Coral Bay settlement are believed to be in excess of 3,000 persons. To suggest that the proposed CCR is not in keeping with its local environment is to suggest that the Coral Bay settlement is equally if not more inappropriate and out of keeping with the environment.

The proposed CCR Structure Plan has been developed in response to Guidelines adopted by State Cabinet for a revised development proposal at Mauds Landing. An inter-disciplinary Taskforce including the Ministry for Planning, Department of Conservation and Land Management, Department of Environmental Protection, WA Tourism Commission and the Shire of Carnarvon developed the Guidelines. The Guidelines were developed in response to the previous proposal, the scale of which was considered by the Minister for Environment to be inappropriate.

The Guidelines developed and complied with are considered by Cabinet and the Taskforce to meet the criteria established under the Gascoyne Coast Regional Strategy for acceptability of development at Mauds Landing. The criteria cover a broad range of local, regional, servicing and management issues including the ability to protect the environment and regional tourism assets as well as ensuring that the development does not compete with the regional centres of Carnarvon and Exmouth.

Accordingly, it can be concluded that all relevant authorities have determined that the scale of development now proposed is appropriate both to the location and to the environment.

The proposed CCR was the subject of rigorous scrutiny by Cabinet and the Taskforce prior to consent to preparation of the Structure Plan and PER. The proposal submitted, which is wholly consistent with the PER, was determined by Cabinet and the Task Force to comply fully with the Guidelines. Accordingly, there is no justification to further reduce the scale of proposal, nor is there any scope.

Additionally, it is not practical nor feasible to develop and fully service a smaller scale marina and boat launching facility with accommodation limited to a caravan park, backpackers and convenience store.

The development footprint within the Mauds Landing Townsite represents a 40% reduction on the previous proposal reducing from approximately 221ha to 131ha. While it is correct that the stated land area required for the Services Area has increased from 5ha to 62ha, the increased land area is the direct result of the need to identify and set aside all future servicing land requirements for Native Title purposes. The previous proposal was not subject of current Native Title restrictions and accordingly waste disposal and landfill areas, buffers and the like were not included in the area requirements identified previously. Rather, they were to be located adjacent to the services area the land area requirement for which was limited to footprint requirements for the essential utilities of power generation, water and waste water treatment. Had total servicing requirements been included, then it is likely that the total land

requirements for the services area under the previous proposal would have been considerably larger, given the reduced scale of the current proposal.

Peak season average occupancy for the revised proposal is estimated at 2025 persons comprising 1330 tourists and 695 staff occupancy compared to 5130 persons under the previous proposal. An average peak occupancy rate of 80% has been adopted based on peak season rates for comparative tourist locations and specifically Broome. Given the trend to smaller family and household structure, it is possible that future occupancy rates on a per unit basis could be smaller than those utilised in the calculations presented in the PER and accordingly may well result in a lesser average peak population over time than that estimated.

It is not valid to base assessment of impacts on maximum population given that this occurs infrequently and over only a relatively short period of time and coincides with periods of maximum regulatory staffing. From the perspective of assessing impacts and requirements of a proposed development, it is more relevant to consider the pressures and requirements of the likely population over a sustained and identifiable period of peak usage. Accordingly, modelling based on the Broome experience is considered more relevant and realistic.

It is to be noted that the development will be undertaken in stages over a projected seven-year timeframe as outlined at Table 4 of the PER (ATA Environmental 2000a).

J. IMPACTS ON CORAL REEF

Coral reefs are subject to a high frequency of recurrent biological and physical disturbances, with often large temporal and spatial scales (Hughes & Connell 1999).

Recently there has been an increased awareness that humans can alter the temporal and spatial scales of natural disturbance regimes that effect coral reef (Nystrom, Folk & Moberg 2000), and accordingly their dependant communities.

Similarly, recreational SCUBA diving has generally been perceived as an activity entirely compatible with the sustainable use of marine resources (Harriott, Davis & Banks 1997). However the notion that tourism can be a benign form of development is not necessarily true (Hawkins & Roberts 1992; 1993), with even snorkelling being identified as damaging to coral reefs (Allison 1996; Hawkins & Roberts 1993).

Corals have been demonstrated to be capable of regrowth from damaged colonies and from fragments following severe coral death pulses and in recovering from minor damage (Liddle & Kay 1987). Nystrom, Folk and Moberg (2000) have documented the natural disturbance regime of coral reefs. This information is extended in Table J1 to include a description of anthropogenic impacts related to diving-based activity.

TABLE J1
[1] CHARACTERISTICS OF NATURAL AND DIVING BASED ACTIVITY TOURISM DISTURBANCE REGIME OF CORAL REEFS

Process	Spatial Extent	Frequency	Duration
[2] NATURAL Predation and grazing	1-10cm	Weeks to months	Minutes to days
Coral collapse (bioerosion)	1 m	Months to years	Days to weeks
Bleaching or disease of individual corals	1m	Months to years	Days to weeks
Storms	1-100km	Weeks to years	Days
Hurricanes/cyclones	10-1000km	Months to decades	Days
Mass bleaching	10-1000km	Years to decades	Weeks to months
Crown-of-thorns outbreaks	10-1000km	Years to decades	Months to years
Epidemic disease	10-1000km	Months to century	Years
Sea-level or temperature change	Global	$10^4 – 10^5$ years	$10^3 – 10^4$ years
ANTHROPOGENIC [3]Anchor impacts or boat groundings	1 – 5 m	Months to years	minutes
[3]Trampling	1-10 cm	daily	Minutes to hours
[3]Diver impacts	1-30 cm	daily	Minutes to hours
Increased turbidity	1-2 km	days to months	Days to months
Acute non-persistent chemical pollutant	1-2 km	Years to decades	Minutes to days
Persistent chemical pollutants	1-5 km	Months to years	Years to centuries

Notes
1 Adapted from Nystrom, Folk & Moberg (2000).
2 There remains considerable conjecture about the role of man induced indirect change .on 'natural' processes. The removal of predators, for example, has been implicated in outbreaks of pests such as Crown –of Thorns starfish of Drupella population increases.
3 Acute damage such as breakage may result in affected corals being more susceptible to disease.

Nystrom, Folk and Moberg (2000) note that a major difference between many human-induced and natural disturbances is their persistence. Natural disturbances tend to occur in a pulsed manner whereas anthropogenic disturbances often appear in a more persistent manner and slowly accumulate.

Historically the primary concern relating to impacts had been with associated activities such as boat anchoring and groundings, and the potential for discharge of pollutants from vessels. However heavy diving pressures at certain sites have resulted in a few heavily dived sites having been decreed as being close to or even above their capacity to sustain underwater activity without appreciable degradation occurring.

Recent attempts to identify the carrying capacity of coral reefs for SCUBA diving have sought to equate the damage done at the site with the number of people who participating in diving activities at the site. Estimates vary widely, with Hawkins and Roberts (1992) suggesting 50,000 dives per site annually as being sustainable in Egypt. More conservatively, Rouphael and Inglis (1997) have identified sustainable limits of between 4,000 and 6,000 dives per site per year for Caribbean coral reefs. Observations of a number of sites at which this level of utilisation is already occurring confirms direct physical damage to reefs to be relatively small (Hawkins et al. 1998).

Harriott, Davis and Banks (1997) in concluding a report on recreational diving and its impact in Marine Park Authorities (MPAs) in Eastern Australia, identified action needed to be considered urgently in cases where greater than 20,000 dives occurred on a single site within a year. Depending on the characteristics of the site, even 5,000 dives may be unsustainable. The considerable variation in the physical and biological variation in coral reefs will be reflected in the susceptibility of these sites to disturbance (Hughes & Connell 1999) and accordingly the number of visitors that can be accommodated at them (Rouphael & Inglis 1997).

By comparison, annual use at Bonaire (a ‘divable’ coastline of about 52km) was 180, 000 dives in 1991 (Rouphael & Inglis 1997) and at John Pennecamp Marine Reserve in the Florida Keys 150,000 dives annually at a single site. Within Australia, 20,000 dives per year have been reported for Julian Rocks in Northern NSW, and 15,000 and 10,000 dives annually have been reported for each of Heron Island (spread over a large number of moorings (dive sites) and Lady Elliott Island respectively.

Based on current rates of participation, predicted annual increase in boat-based ecotourism related activities as a consequence of the implementation of the action will result in an increase of about 12,900 and 14,300 snorkelling and SCUBA dive experiences respectively. Further pressure (principally inshore) will result from independent shore based snorkelling and diving conducted from private boats.

Salm (1986) proposed that the carrying capacity of coral reefs for marine tourism be influenced by the size and shape of the reef, the coral assemblages, the type of activity pursued at the site and the relative experience of the participants. SCUBA diving, snorkelling and reef walking were predicted to have the largest impact at small reefs, where fragile forms of coral were abundant (Salm 1986). Damage occurs when SCUBA divers kick, hold, bump into, stand or kneel on coral either accidentally or intentionally (Rouphael & Inglis 1997). Harriott, Davis and Banks (1997) determined that contact made by fins resulted in 78% of coral breakages in a series of observations

undertaken at various sites on the Great Barrier Reef. Prior et al. (1995) similarly identified fins as the major source of breakage, followed by contact from the use of still and video cameras, equipment strikes, standing, holding and touching during impacts studies at Sharm al Sheikh in the Red Sea.

Cary et al. (2000) notes that snorkelling is a popular activity amongst visitors to the NMP. Data from a questionnaire conducted by the Gascoyne Development Commission (1999) identified the intention of each visitor to swim daily. The Coral Bay settlement foreshore on Bills Bay is very popular for day and short stay visitors snorkelling privately. Similarly, the lagoonal waters south of Pearson Point are very popular for shore-based snorkelling.

Table E3 identifies the estimated percentage of visitors participating in snorkelling and SCUBA diving activities from the Coral Bay settlement. Four licensed commercial operators regularly offer snorkelling as a component of their wildlife interaction tours. Snorkelling tours are conducted for an estimated 3.4 % of the Coral Bay settlement visitors to State managed waters of the NMP generally within the protected lagoon. Based on estimated data presented in Table E3, it is predicted than an additional 7,277 snorkelling places will need to be provided to meet the demand resulting from the implementation of the CCR. Impacts, relating to fuel spillage, habitat damage due to boat anchoring, propeller damage and snorkellers litter impacts and physical disturbance to wildlife will occur almost entirely within State waters. Snorkelling impacts on whale sharks, as they occur in deep waters, are considered separately below.

It is predicted that 3.8% of the day and short stay visitors engage in commercial SCUBA diving activities offered from the Coral Bay area (Table E3). Projected to the year 2009 and with the implementation of the CCR, this will result in the demand for approximately 8,085 additional commercial SCUBA diving places. Cary et al. (2000) notes three popular dive locations within the Coral Bay area.

Measures to mitigate diver impacts relate to the improvement of diver knowledge through education, the improvement of diver skills in critical areas such as buoyancy control, the provision of appropriate resources to limit impacts and regulatory limits and controls.

Harriott, Davis and Banks (1997) emphasises the importance of providing appropriate boat moorings in MPAs to limit the greatest single most damaging aspect impacting on coral reefs, and management of the number of divers on any one site to sustainable levels.

In relation to diver skills, 70% of damage was observed as having been done by 4% of divers during a recent field observation in Eastern Australia (Harriott, Davis & Banks 1997). Prior et al. (1995) noted that these shortcomings could be addressed by better diver education (including videos and brochures) and skills improvement, or by channelling inexperienced divers to less susceptible dive sites. Marine park and dive site managers could use economic instruments to raise revenue to increase regulatory presence or introduce regulatory instruments to ban such activities as photography that are known to result in inordinate damage to coral reef structures (Prior et al. 1995).

K. SUMMARY OF POTENTIAL ENVIRONMENTAL IMPACTS ON FAUNA

Whale Sharks

Whale sharks congregate at Ningaloo on a seasonal basis. The whale sharks move from offshore waters into the NMP where they congregate from March to May each year. Peak whale numbers occur about two weeks after the mass asynchronous coral spawning, when it is suggested rapidly expanding zooplankton population growth provides an abundant and rich food source for the planktivorous whale sharks. Between 200-400 whale sharks, believed to be mostly juvenile males, can occur in the Park over a period of about ten to twelve weeks annually. The location of the main aggregation of whale sharks within the NMP varies from year to year.

As whale sharks mainly occupy the turbulent waters along the outer edge of the reef front where the current is flowing northward (the Ningaloo Current), contact in trailed (small) craft is unlikely and most likely human interaction will continue through professional ecotourism operators. Licences allowing interaction between tour boat operators and whale sharks are issued by CALM, and the industry regulated through licensing and application of a code of practice.

Other than the potential to disrupt the lifecycle (breeding, feeding, and migration) of an ecologically significant proportion of the population of the species due to increases in visitor numbers and boating traffic, there are few other pressures on populations of whale sharks in Australian waters. Existing and potential uses and/or pressures include physical disturbance resulting from snorkellers and boat noise, and the possibility of boat collisions principally during commercial whale shark watching tours.

Based on both current demand, and industry patterns (see General Comment E), increased demand for whale shark interactions are predicted to require an additional 71 boat trips at 80% boat utilisation. At full implementation of the CCR development this would require an additional one boat per day each carrying thirteen snorkellers over the approximate ten-week period of the whale shark schooling.

It is considered that a single point of embarkation/disembarkation, regulatory (licensing) controls in place by CALM, and the improved monitoring and education opportunities afforded by the CCR, together with greater regulatory presence will ensure disruption to whale shark lifecycles does not occur. Additionally, the observation that most of the whale sharks that congregate are juvenile males, rather than for example breeding females, implies that significant impacts on the lifecycle of the whale shark population are unlikely to occur.

Dugongs

Dugongs are dispersed along the entire length of the Ningaloo Reef Tract. Based on CALM aerial surveys undertaken in 1989 and 1994, the total population of dugong in the NMP is estimated to be in the order of 1000 individuals. The density of dugongs within the Park is similar to that of other significant dugong habitats in northern Australia. The dugong in this area probably move freely between NMP and Exmouth Gulf, and perhaps the nearshore waters further east.

Dugong is the only fully herbivorous marine mammal in Australia. It is now extinct or near extinct in most of its former range that extended from East Africa to South East Asia and the Western Pacific (Commonwealth of Australia 1995). Northern Australia has the last significant population (estimated as 80,000 in 1995). The species is large, long lived and has a slow reproductive cycle.

Dugongs are generally not resident within Bateman Bay as seagrass habitat is not widespread and biomass low. Ecotourism operators may encounter a dugong on average every second trip when travelling within the lagoon.

Major concerns in managing the species relate to overfishing by indigenous communities, mortalities in fishing nets, and loss of seagrass habitat. Occasional boat strikes are known in Australian waters. The dugong is listed by the IUCN as 'vulnerable to extinction', but not as yet listed under the EPBC Act.

In relation to fishing by indigenous communities, the owners of Cardabia Station, the Baiyungu people, have given an undertaken to assist in cetacean, dugong and turtle management in the area.

Set fishing nets are only allowed in limited areas within the NMP, and increased regulatory presence will reduce the likelihood that illegal netting occurs within Bateman Bay and adjoining areas. Trawling does not occur.

Seagrass habitat is not widespread within Bateman Bay, and dugong encountered are considered to be in transit. Seagrasses in the Mauds Landing area *comprise Posidonia coriacea*, *Amphibolis antarctica* and *Halophila ovalis*. *A. antarctica* was recorded at only a few sites to the north of Mauds Landing. *P. coriacea* occurs at low density (<1 to 10% seafloor cover) over parts of Bateman Bay, but was only recorded at higher densities in discrete patches. These are located at depths of 5-10m along 1.5km of shoreline, extending some 600m out to sea and commencing 4km north of Mauds Landing as well as the northern side of Cardabia Passage at depths of 16-18m. No seagrasses will be lost by the construction of the CCR.

As dugong is only encountered opportunistically, the species is not subject to ecotourism pressures from activities such as snorkelling. When encountered, groups may be given the opportunity to snorkel with dugong or observe them from the boat. Based on current demand for snorkelling trips and industry patterns (Table E3), an increase in snorkelling activities of an additional 502 boat trips at 66% boat utilisation may result, with resulting opportunistic encounters with dugongs. At full implementation of the CCR development, this demand would require one additional boat to carry 17 snorkellers at 66% utilisation.

It is considered that the limited potential to impact on seagrasses, greater controls afforded by the single point of embarkation/disembarkation within this portion of NMP, the improved monitoring and education opportunities afforded by the CCR, and greater regulatory presence will ensure disruption to dugong lifecycles does not occur. Management options, such as the control of boating activities in sensitive areas will be identified and implemented if monitoring indicates increased pressures.

Humpback Whales

Humpback whales migrate to Ningaloo (and further north) to use Ningaloo and Exmouth Gulf to breed, calve and rest. Recorded humpback whale numbers have been increasing significantly along the West Coast.

The humpback whales return to NMP waters in spring (September/October) during their southern migration to summer feeding grounds in Antarctica.

Existing and potential uses and/or pressures include physical disturbance in the form of boat collisions and boat noise principally due to commercial whale watching tours. The current incidence of entanglement of cetaceans in fishing gear or litter is considered to be low, as historically commercial fishing has been limited in the area.

Based on current demand for whale watching trips over approximately twelve weeks of their migration and industry patterns (Table E3), an increase in whale watching requiring an additional 90 boat trips at 50% boat utilisation may result. At full implementation of the CCR development this would require an additional 1.1 boats per day carrying eleven observers for the period of the whale migration, approximately 12 weeks.

It is considered that single point embarkation/disembarkation within this portion of NMP, regulatory (licensing) controls in place by CALM, and the improved monitoring and education opportunities afforded by the CCR, together with greater regulatory presence will ensure disruption to humpback whale lifecycles does not occur.

Turtles

Four species of turtle utilise the waters adjacent to Mauds Landing. The Green, Hawksbill, Loggerhead and Flatback turtles are known from the area. Aerial surveys of the NMP suggest that an estimated population of approximately 4300 turtles (all species) is resident within the Park. Turtle densities are extremely high at Ningaloo and exceed the highest densities recorded on the Great Barrier Reef and most of the areas in Torres Strait.

Green turtles feed on macroalgae and are by far the most common turtle on Ningaloo Reef. However very few (two to five per cent) breed on Bateman Bay beaches.

Loggerhead turtles are carnivorous, feeding mainly on molluscs and crustaceans. They may utilise the mussel beds 3km northeast of Mauds Landing, and occur in significant numbers on the backreef either side of Cardabia Passage. Loggerheads are known to nest on beaches in Bateman Bay, and make up the vast majority (greater than 95%) of the seventy-one and sixty-nine turtle nests being recorded during the 1999-2000 and 2000-2001 seasons respectively. These nesting loggerheads make up about 0.5% of the total known adult female nesting population of loggerheads in Western Australia.

Hawksbill turtles are at the end of their range in the Ningaloo area, feed mainly on sponges and are more often located in deeper water, seaward of Ningaloo Reef.

Flatback turtles are probably the next most abundant breeding species of marine turtle in Western Australia after the green turtle, but are not listed under the EPBC Act.

The major impacts on turtles while in Australian waters are:

- loss of eggs to feral animals;
- mortality of adults while in prawn nets;
- shark nets and gill nets;
- collisions with speed boats;
- subsistence hunting by indigenous communities; and
- habitat degradation.

Feral animal control will include the construction and operation of a managed landfill site to service the region and active feral animal control programs to reduce fox numbers. This will replace a current facility that has poor controls.

Fishing nets are only allowed in limited areas within the NMP, and increased regulatory presence will reduce the likelihood that illegal netting occurs within Bateman Bay and adjoining areas. There is no commercial prawn fishery. Similarly shark and gill are not currently used within the Ningaloo Reef Tract.

Based on recent boat counts and utilisation patterns in the Coral Bay area, it is anticipated that implementation of this proposal will result in an increase in 153 boats ranging from car toppers to moored commercial and private vessels. Based on counts carried out during Easter 2001 about 98 boats operate out of the existing Coral Bay settlement facilities during peak holiday periods. At any one time up to 46% of boats are in use.

Boating related impacts on species of National Environmental Significance will alter however as the need to travel along the sensitive backreef areas to gain ocean access from launch sites in Bills Bay will no longer be necessary as the CCR will provide direct access to Cardabia Passage. Backreef areas are important marine turtle feeding and resting areas. As for dugong, marine turtles are encountered opportunistically during commercial snorkelling trips. At full implementation of the CCR development this demand would require an additional one commercial boat/day carrying 17 snorkellers.

In relation to the direct impacts of construction CCR and marina, the marine breakwaters and entrance channel will remove approximately 300m of beach and foredune that may be used for turtle nesting. The breakwaters will extend 200m seaward from the high water mark (HWM) and may present an obstacle to turtle nesting or movement. Plotting of loggerhead turtle nests during the 2000/01 summer identified three nesting sites on the beach immediately in front of the proposed CCR. The majority of turtle nesting occurs approximately 6km to the north of the development. Nesting turtles represent a breeding population of about 24 loggerheads and one or two green turtles. This constitutes about 0.5% of the estimated stock of breeding female loggerhead turtles in Western Australia.

Lighting will be managed by implementation of best practice lighting procedures consistent with turtle conservation including the use of sodium vapour lamps in all

public areas. The location of the CCR behind the primary and secondary dune systems will also limit impacts. All aspects of turtle management will be described in a Turtle Management Plan to be developed in consultation the CALM and relevant experts, to be implemented immediately following approval. Additional demands for tourist places on escorted nesting, hatching experiences will require six quad-bikes or 4WD places daily.

Removal of 300m of beachfront is unlikely to be of significance in the context of surrounding values. This will not prevent the turtles from nesting on the adjoining beaches where turtle nesting presently occurs. Additionally, pro-active measures such as waste management, fox control and turtle nest management are envisaged to increase recruitment rates. Redirection of existing boat traffic away from the sensitive back reef area will reduce the possibility of boat strikes in that area.

Vehicle, particularly 4WD access to the beachfront will be prevented from the Mauds Townsite. Vehicle access from adjoining Cardabia Station and onto CALM controlled beaches of the marine park will be the subject of discussions with these parties with a view to minimising impacts on nesting turtles.

L. PREDICTED EXISTING (CORAL BAY) AND ADDITIONAL DEMAND FOR SEASONAL ECOTOURISM AND FISHING EXPERIENCES, CORAL COAST RESORT

TABLE L1
PREDICTED EXISTING (CORAL BAY) AND ADDITIONAL DEMAND FOR SEASONAL ECOTOURISM AND FISHING EXPERIENCES, CORAL COAST RESORT

ACTIVITY	Estimated Participation/Annual Demand				
	Coral Bay and Mauds Landing				[6] Additional Coral Coast Resort (2009)
	Coral Bay Existing		[1]Projected (Mauds 2009)		
	#	% beds	#	% beds	
SCUBA Diving[2]	23100	3.8	14212	3.8	8282 dives
Whale watching[3, 4]	2646	0.4	1628	0.4	949 observers
Whale shark experiences (snorkelling) [3]	1792	0.3	1103	0.3	642 snorkellers
On water manta ray, turtle & dugong interaction (snorkelling) [3]	20790	3.1	12791	3.1	7454 snorkellers
Turtle egg laying /hatching experiences[5]	2234	0.3	782	0.3	801 observers
Fishing Charter	9870	1.7	6073	1.7	3539 fishers

Notes

1 Assumes demand for informal campsites will decrease with additional serviced campsites, and otherwise regulated, and reduction of existing Coral Bay settlement visitation commensurate with the number of official accommodation units available (477), and using accepted tourism industry beds per class of accommodation.

2 Hire and Fill data and Dive Industry statistics.

3 Limited ecotourism operator data, Coral Bay settlement.

4 CALM data.

5 Based on tour participation observations provided by Coral Bay settlement operators.

6 Additional to existing (2001) demands.

M. FOCUS OF DEVELOPMENT ON CORAL BAY & EXMOUTH

The Gascoyne Coast Regional Strategy (Ministry for Planning (1996) highlighted that the coastal area is most at risk of degradation from increased tourism and uncontrolled camping and access. It recognised the need for existing activities to be brought under control and for future development to be located outside of sensitive zones and be supported by appropriate levels of management.

The Gascoyne Coast Regional Strategy (Ministry for Planning (1996) and Coral Bay Planning Strategy (Department of Planning and Urban Development 1992) both recognise that the Coral Bay settlement is heavily constrained currently by lack of adequate services and that only limited growth should be permitted when servicing issues are resolved. More importantly, the Gascoyne Coast Regional Strategy (Ministry for Planning (1996) noted other studies which suggest that the natural resources of the Coral Bay area are already under stress indicating that the location has exceeded its carrying capacity for tourism.

The Gascoyne Coast Regional Strategy (Ministry for Planning (1996) also notes that infrastructure within the settlement is poor and in need of improving, that there is a lack of impetus on the part of present providers to improve accommodation standards and that the most effective method of ensuring improvement in the quality of facilities in the Coral Bay area is to introduce competition to the location.

Most importantly, the Gascoyne Coast Regional Strategy (Ministry for Planning (1996) recognises the need for the Coral Bay settlement to be contained to low-key accommodation and recreational use for visitors to the area so as to contain further physical degradation of the environment of Bills Bay. The Gascoyne Coast Regional Strategy recognises that alternative options need to be found to accommodate tourism growth in the region and supports the channelling of growth to Mauds Landing to assist future management of the Coral Bay settlement.

The Gascoyne Coast Regional Strategy (Ministry for Planning (1996) also recognises that the “Do Nothing” option is not an acceptable alternative.

The Gascoyne Coast Regional Strategy (Ministry for Planning (1996) supports development at Mauds Landing over either Exmouth or Carnarvon as Mauds Landing has a superior climate to Exmouth and better access to the reef. The popularity of the location is evident in the attraction of the Coral Bay area to visitors. The Gascoyne Coast Regional Strategy viewed Carnarvon as a regional administrative and service centre whose principal tourism role is as a gateway and winter recreation area. Carnarvon is also too remote from the attractions of the NMP.

The Gascoyne Coast Regional Strategy (Ministry for Planning (1996) concludes that a quality tourist facility at Mauds Landing would be a major attribute to the Gascoyne Region, providing significant flow on benefits throughout the Region and that Mauds Landing provided the best site for supporting a major tourist resort to accommodate future tourism growth to the Region.

Clearly, the options for expansion of tourism facilities at the Coral Bay settlement and Exmouth as an alternative to Mauds Landing have been closely considered by Government and ruled out as either impractical or undesirable.

N. PROVISION OF SERVICES TO THE CORAL BAY SETTLEMENT

The proponent is committed to working with all parties to facilitate the extension of services, notably water, sewer and power to the Coral Bay settlement. The service infrastructure for the CCR will be designed to allow their expansion at any time to allow connection to the Coral Bay settlement. The Land Development Agreement between Government and CCMD safeguards this commitment.

It is expected that sewer and water extensions to the Coral Bay settlement will be undertaken by the Water Corporation and power connection by Western Power. Costs of upgrading the CCR infrastructure including proportional headworks and amortisation costs will be payable by the Coral Bay settlement provider, likely to be government instrumentalities, to the CCR utility provider.

Both the PER and the Structure Plan are abundantly clear that costs of extension of services to the Coral Bay settlement will be on a user pays basis, as would be the case if the service was provided wholly by Government.

Costs for upgrading of the CCR utilities infrastructure have not been calculated at this stage. Discussion of details of provision of services to the Coral Bay settlement with the Coral Bay community will be the responsibility of the Water Corporation and Western Power.

It is not the province of CCMD to seek to commit either the Water Corporation or Western Power to upgrading supply to the Coral Bay settlement, however the upgrading or provision of these services is consistent with Government policy. CCMD can only commit to facilitating the upgrade of its service infrastructure to enable connection of the Coral Bay settlement. Similarly timing of extension of services to the Coral Bay settlement will be the province of the Water Corporation and Western Power.

Attempts by Government to date in upgrading infrastructure to the Coral Bay settlement have yet to come to fruition. It is noted in the Gascoyne Coast Regional Strategy (Ministry for Planning (1996) that Mauds Landing provides an opportunity for servicing of the Coral Bay settlement. Other than to seek expressions of interest from private utility providers, neither Government nor Council has committed any funds to the upgrading of services infrastructure to the Coral Bay settlement.

Native Title Agreement has been reached between CCMD and the Traditional Owners of Cardabia Station relating to access to Station land for the services area that will include sites for infrastructure. The Agreement is not with Government and should Government wish to install a separate wastewater treatment facility, separate Agreement will need to be reached between Government and the Traditional Owners.

O. LEGISLATIVE COUNCIL SELECT COMMITTEE

The Legislative Council Select Committee on Cape Range National Park and NMP was appointed in December 1994. The Committee considered in considerable detail the then proposed Structure Plan for the CCR (Bowman, Bishaw Gorham 1995) that was subsequently refused by the Minister for Environment.

The Committee noted that tourism development on the Cape can deliver significant economic benefits and that thoughtful planning was required to avoid a proliferation of low key developments along the Cape, the accumulated impact of which would exceed that of a single large scale development. Accordingly, the Committee recommended that there be no resort development on the western side of Cape Range, with the exclusion of the Mauds Landing Townsite.

The Committee expressed concern at the size of the then proposed development and particularly the residential component, but noted the need for a residential component to offset the costs of infrastructure being provided, capable of connection to the Coral Bay settlement. The Committee also noted the urgent need for connection of the Coral Bay settlement to a sewerage system to redress the contamination occurring in Bills Bay and the opportunity presented by the proposed marina based development to relocate recreational boating to remove the dangerous conflict between swimmers and boats in Bills Bay.

P. SEAGRASSES AND MACROALGAE

Seagrasses are highly specialised marine flowering plants adapted to soft sediments of nearshore environments (Butler and Jernakoff 1999). Tropical seagrass meadows provide a nursery habitat for juvenile fish and other animals, as well as providing food for dugong and green turtles (Lanyon et al. 1989). Butler and Jernakoff (1999) consider Shark Bay to be at the centre of the western interlap zone between tropical and temperate seagrass species, with temperate species being more extensively studies.

Specific marine flora habitats close to Mauds Landing have been described in section 4.2.3 and are indicated in Figure 7 of the PER document ATA Environmental (2000a). The seagrass *Posidonia coriacea* is a perennial (ie. long-lived) temperate species considered to be near the northern extent of its distribution and accordingly should be considered as regionally important. Ephemeral (ie. short-lived) genera, such as *H ovalis*, extend beyond the tropics into temperate waters. Habitat surveys carried out by ATA Environmental (ATA Environmental 2000b) and studies reported in Bowman Bishaw Gorham (1995) confirm that *H ovalis* occurs in deeper sands and although not abundant in the NMP, are widespread in nearshore coastal and estuarine environments in tropical and temperate Australia.

Butler and Jernakoff (1999) note *Halophila* and *Halodule* as the preferred food source for dugong and sea turtle grazing. Habitat mapping by CALM and modified by CCMD indicates that these meadows occur as a patchy distribution over an area of approximately 5km^2 or about 1.5% of the total area of the MSMA. *Amphibolis. Antartica,* also a temperate species was recorded at only a few sites to the north of Mauds Landing. *P. coriacea* occurs at low density (<1 to 10% seafloor cover) over parts of Bateman Bay, but was only recorded at higher densities in discrete patches. These are located at depths of 5-10m along 1.5km of shoreline, extending some 600m out to sea and commencing 4km north of Mauds Landing as well as the northern side of Cardabia Passage at depths of 16-18m.

Observation of seagrasses within the MSMA indicate that they are generally in good condition although some localised damage may have occurred due to anchors being set in Bateman Bay. There is no evidence of heavy epiphytic growth on seagrasses at present.

Butler and Jernakoff (1999) describe *Halophila* plants as an ephemeral group having broad distributional ranges with large seed banks and exhibiting rapid reseeding following disturbance. In relation to the ecophysiological traits of the *Halophila*, species show rapid turnover in vegetative material and an open nutrient cycle. *Halophila* plants are known to contribute little detritus and support low epiphyte productions as a consequence of this rapid turnover in vegetative materials, due in part to grazing pressures from such ecologically important animals as dugong. Further important ecological functions of seagrasses have been described in section 5.3.2 of ATA Environmental (2000a).

Walker (1997) has undertaken detailed seagrass distributional research in the Kimberley Region. Sparse seagrasses, including *H ovalis* were recorded from coral reef environments in the Kimberley, and within intertidal lagoons where seawater is ponded during tidal exchanges.

Q. POTENTIAL IMPACTS ON THE VALUES OF NMP RESULTING FROM ADDITIONAL RECREATIONAL FISHING

With the implementation of the CCR, and at 80% occupancy, it is anticipated an additional 2025 visitors, staff and permanent residents will be resident in the CCR. Issues in relation to the increase in visitation to the Coral Bay area are discussed in section 4.3.2. At peak periods it is estimated that in 2009 and following implementation of the CCR, up to 172 boats may be present within the marina in addition to about 55 anticipated to remain at the existing Coral Bay settlement, although using CCR boat ramps. Based on boat count data collected during Easter 2001, up to 50 % of boats may be in use at any time.

Due to overcrowding in Coral Bay during busy holiday periods, it is considered total visitation will not increase proportionally to the number of extra accommodation units provided within the CCR. As for boat based ecotourism demand (see Table 18) it is anticipated that recreational fishing pressure will approximately double, with half of this increase due to the additional capacity provided by the CCR, and the balance due to growth in visitation at the existing Coral Bay settlement.

Jones Lang Wooton (1993) note that in relation to the natural resources of the Coral Bay area, these resources are under stress and that they may have already surpassed their carrying capacity for tourism. Residents of the Coral Bay settlement and tourism operators mirrored these concerns during the initial community consultation.

Notwithstanding periodic overcrowding, the trend for increasing visitation to Coral Bay continues, with Cary et al. (2000) noting in increase of 40% in new arrivals at one of the Coral Bay caravan parks over the period 1994 to 1999. MRWA undertakes annual traffic counts at various locations on the Minilya, Exmouth and Coral Bay Road and elsewhere. Recent count data for the Coral Bay Road indicates the average annual daily counts to have increased by 28% over the period 1996 to 1998.

The Coral Bay area is located in the Gascoyne fisheries management area and is renowned for its outstanding shore based, dingy and recreational fishery based on a diversity of fish. Recreational fishers participation rate increased to 30% of the States population (520,000) in 1996 (Paterson, quoted in FWA 1999). FWA (1999) note that with the development of coastal roads and boat refuges and residential developments such as marinas, waters previously protected from extensive fishing pressure due to isolation are now coming under increasing pressure. Current indicators (both scientific and social) of the 25 fisheries with enough data available to make a critical assessment show that 19 fisheries are fully exploited (in a sustainable manner), five are fully or over exploited and one is under exploited (FWA 1999).

Recreational fisheries management actions to control localised depletion of fish stocks within the Gascoyne have included specific area controls at Ningaloo in 1992, landing limits in Exmouth Gulf in 1993, strict controls on the take of pink snapper in Shark Bay's inner gulfs in 1997, and subsequent bag limits (1998), and the introduction of a management system for the charter and aquatic tour industry in 1999 (FWA, 1999).

A major recreational catch survey was completed for the Gascoyne Region in March 1999. Although species such as golden trevally are most often caught, major concerns

in relation to the sustainability of some of the lesser-caught bottom species such as spangled and red emperor, arise due to the relatively slow growth and recruitment rates of these species.

FWA have recently completed a fisheries environmental management review for the Gascoyne Region (FWA 2000). FWA note that the effects of all forms of fishing in WA are thought to be relatively low when compared with fishing practices overseas and elsewhere in Australia. Difficulty associates with the environmental effects with between and within particular types of fishery are also noted.

A profile of recreational fishing within the Gascoyne Region is presented in FWA (2000). Very little is known at present regarding the exploitation status of most species other than stocks also targeted by commercial fishers, nor has stock or breeding assessment been undertaken. Input (restrictions on fishing methods) and output (bag and size limits) as well as community education management methods are identified. Line fishing, with much being boat based and focussing on reef species such as cod, coral trout and emperors as well as snapper, sharks and pelagic species is identified (FWA 2000).

Significant effects associated with the recreational fishing industry identified FWA (2000) include:

- Ecosystem effects comprising such impacts as;
  - localised over-fishing identified as a decline in catch per unit effort,
  - changes in species abundance, for example the local decline in prize table fish targeted by recreational anglers,
  - depletion of keystone species the activities of which are considered to be critical for ecosystem maintenance,
  - indirect impacts resulting from such the reduction in numbers and resulting alteration of the balance between predators and pests such as *Drupella*,

- Effects of habitat modification, comprising such impacts as;
  - effects on coral and seagrass communities due to propeller scour and anchoring damage,

- Effects of fishing pollution and debris, resulting from each of;
  - Gear loss, and
  - Boat related pollution,

- Terrestrial and coastal effects due to dune and beach erosion, disruption of hydrodynamic patterns, reef trampling; and the increase in wastes and toxicants.

Other environmental impacts attributable to fishing such as changes in genetic composition, benthic impacts, sediment disturbance, resulting from activities such as trawling and marine based aquaculture are considered to result largely from commercial and particularly trawl fishery activities. Influences from natural environmental variability such as the strength of the Leeuwin Current although impacting on Regional scale environmental process occur independent of anthropogenic actions, the resulting

impacts may be compounded to result in a much greater local consequence due to recreational fishing.

Implementation of the CCR proposal will result in increased fishing pressure on fish stocks both in the immediate vicinity of the marina and more widely. Fishing pressures are anticipated to double between 2001 and full implementation of the CCR anticipated in 2009. Demand for fishing charters are likely to increase, and with it pressure on prize and other fish, as indicated in Table E4. It should also be noted that about half of this additional fishing pressure is predicted to occur regardless of the implementation of the CCR.

Implementation of the CCR will also result in a change on the size and type of boat operating in this portion of the NMP. The greater proportion of larger (> 5.5 m) moored boats may result in fishing pressures being extended beyond traditional fishing grounds. The proportion of moored boats as a proportion of total boats operating in the region is predicted to rise from 16% at present to approximately 26% by 2009 as indicated in general response E and anticipated demand for fishing charters is presented in Table E5.

FWA (2000) note that in relation to the effects of fishing, pressure on many fish stocks is increasing in the Region, particularly as a result of the opening of new areas due to improved fishing technology, better gear and tackle and increase in fishing effort and numbers. Specific fishing impacts are summarised in Table Q1.

TABLE Q1
DISCUSSION OF CURRENT ENVIRONMENTAL THREATS RESULTING FROM RECREATIONAL FISHING AT NINGALOO REEF, AND PROPOSED MITIGATION

Impact	Status – Gascoyne Region	Management Response - CCR
Bycatch	∉ Impacts largely limited to net fishing	Input and output measures in place. Public education and monitoring support
Anchor damage	∉ Of concern on coral reefs. ∉ Impacts limited on seagrasses and sandy substrates	∉ Public education and monitoring support; ∉ Relocation of boats from Coral Bay ∉ Reduction in large boats travelling down back reef to Cardabia Passage
Propeller damage	∉ Of concern on coral reefs in high activity areas. ∉ Impacts limited on seagrasses and sandy substrates although larger boats may lift seagrass and increase suspended sediments	∉ Public education and monitoring support; ∉ Relocation of boats from Coral Bay ∉ Reduction in large boats travelling down back reef to Cardabia Passage; ∉ Direct access to deeper water and Cardabia Passage
Litter	∉ A problem mainly around fishing spots and camps	∉ Public education and monitoring support; ∉ Development of a managed landfill site
Human Waste	∉ An isolated problem near un-serviced areas	∉ Public education and monitoring support; ∉ Development of waste water treatment facility; ∉ On-shore sewage pump-out facility
Diver Damage	∉ At popular dive sites, from divers searching for rock lobsters and inexperienced snorkellers and SCUBA divers	∉ Public education and monitoring support; ∉ Marina based diver training opportunities; ∉ Input controls on heavily dived sites

Collisions with marine mammals	∉ Appear rare and unlikely	∉ Public education and monitoring support; ∉ Boating controls as increased impacts noted.
Entanglement of Marine Mammals	∉ Appear rare ∉ Coarseness of line, size of mesh and length of net make it unlikely.	∉ Fishing controls in place (constant attendance)
Beach Erosion	∉ Principally due to beach use by off road vehicles	∉ Public education and monitoring support; ∉ No commercial quad bike activities from CCR; ∉ No beach access from CCR.
Turtle Breeding Impacts – Off Road Vehicle Use	∉ Direct damage to nests; ∉ Laying disturbance due to human observation; ∉ Wheel ruts and depression impacts on hatchlings	∉ Public education and monitoring support; ∉ Not commercial quad bike activities from Resort; ∉ No beach access from CCR. ∉ Appoint turtle management officer ∉ Greater regulatory presence; ∉ Feral animal eradication program and managed landfill site
Fuel spillage	∉ a problem at boat ramps; ∉ an issue is boats are refuelled over at beach	∉ Public education ∉ Marina refuelling facilities; ∉ Emergency response capability

Source – modified from FWA (2000).

Recreational fisheries management will be a significant focus of the SAMMP, with monitoring requirements and priorities for fish management being developed in consultation with FWA. A draft SAMMP was included in section 6 of the PER (ATA Environmental 2000a).

There is a clear need to develop a baseline for fish stocks prior to the CCR being operational. This will require:

∉ *baseline catch and effort data for the area; and*
∉ *biological information for select species being collected.*

The level of protection afforded individual fish species is based on a number of factors including species distribution, abundance, life history and an assessment of the ecological and social importance of the species in the context of the area.

Together with FWA, a program will be developed that will enable the collection of recreational catch, fishing effort and the biology of key fish species with the Ningaloo Reef Tract. This has been identified as a major obstacle to the resolution of fishery management and resource sharing. It should be noted that with the development of a single point of boat entry for the Coral Bay area and additional resources provided to manage recreational fisheries, the development of the marina would provide an opportunity to better manage fisheries within the area.

Extraction patterns would need to be established to anticipate the likely effects on the species in question, as well as the level and manner of protection that will be afforded. It would also be necessary to assess the impact of extraction on the social values of the NMP, as localised depletion may reduce the opportunity for nature appreciation (e.g. viewing of "icon" species), nature photography and the quality of the recreational fishing experience. FWA, in accordance with ecologically sustainable development principles, will manage species for which extraction is considered acceptable. The

remaining species will be protected throughout the NMP using statewide legislation. Finfish are totally protected from extractive activity in Sanctuary Zones of the NMP and in Special Purpose (Scientific Reference) Zones.

R. CETACEANS AND OTHER MARINE MAMMALS

Marine mammals inhabiting the waters near Mauds Landing include dugong, common bottlenose dolphins (*Tursiops truncates*), Indo-Pacific humpback dolphin (*Sousa chinesis*), and a number of different whale species.

The dugong (*Dugong dugon*) inhabits shallow, warm nearshore coastal waters of the Indian and western Pacific oceans (Strahan 1998). Along the Australian coast, this species typically occurs in waters from Shark Bay in Western Australia around the northern coast to Moreton Bay in Queensland. The dugong is herbivorous, feeding almost entirely on seagrasses but occasionally also marine algae and benthic invertebrates. Dugongs indicate a preference for seagrasses pioneer species of the genera *Halophila* and *Halodule*. These are low in fibre, high in available nitrogen and easily digested.

Being mammals, dugongs must surface to breathe and need to do so with greater regularity than other aquatic mammals such as whales and dolphins as they can hold their breath for only a few minutes.

The dugong is long lived, surviving 70 years or more and has a low reproductive rate (Stokes & Dobbs 2001). A female will raise a calf every three to five years. It is estimated that the maximum increase in a population is 5% each year provided all females breed at maximum potential (Wachenfeld, Oliver & Morrissey 1999). A high level of adult survivorship is essential in maintaining populations. Calves are born typically between September and November in shallow waters, away from seagrass meadows.

The dugong population in Australia is estimated to be the largest remaining in the world. About 80 000 dugongs are reported to occur in Australian waters, an estimated 12 000 of which occur in the Great Barrier Reef World Heritage Area, although recent studies suggest the population on the southern Great Barrier Reef is declining. The decline in numbers has been attributed to unsustainable mortality from human-related causes such as habitat loss, commercial mesh nets (fishing nets), shark nets set for bather protection, and hunting (Great Barrier Reef Marine Park Authority 2001).

Dugongs are dispersed along the entire length of the Ningaloo Reef Tract. Based on aerial surveys undertaken in 1989 and 1994, the total population of dugong in the NMP is estimated to be in the order of 1000 individuals (Preen et al. 1997). The density of dugongs within the Park is similar to that of other significant dugong habitats in northern Australia. The dugong in this area probably move freely between NMP and Exmouth Gulf, and perhaps the nearshore waters further east (Bowman Bishaw Gorham 1995). Daily movements of 25km largely in response to tidal flows and accessibility of seagrass meadows are common (Strahan 1998).

Bottlenose dolphins are common along Ningaloo Reef and are expected to regularly occur in the vicinity of Mauds Landing. The density of dolphins in the NMP is similar to that observed elsewhere in tropical Australian areas. Less common are humpback dolphins, which are a tropical species that is rarely sighted south of Exmouth Gulf.

Humpback whales, minke whales (*B acutorostruta*), fin whales (*B. physalis*), blue whales (*B. musculus*), brydes whales (*B. edeni*) and killer whales (*Orca orca*), occur in the offshore waters westward of Ningaloo Reef (May, Lenanton & Berry 1983). Of these, humpback whales regularly pass along the reef during the northern and southern migrations, while the other species are less common.

The humpback whale (*M. novaeangliae*) is a cosmopolitan species that occurs in coastal waters off Australia during winter and spring. The whales feed mainly in nutrient-rich antarctic waters during summer, migrating northwards to winter breeding grounds off the Kimberley coast. Northerly migrating whales can be seen in the Ningaloo region June to August and southward bound whales including calves occur August to November (Commonwealth of Australia 2000). Migration generally occurs within 10 to 20kms of the shore, however areas such as Cape Naturalist, Geographe Bay and Ningaloo Reef are known to attract migrating whales in much closer proximity to the shore. Table R1 presents the occurrence of humpback whales at locations along the Western Australian coastline, and relevant activities taken from WA Department of Minerals and Energy (undated).

TABLE R1
OCCURRENCE OF HUMPBACK WHALES AT LOCATIONS ALONG THE WESTERN AUSTRALIAN COASTLINE

Known Important Locations	Duration												Importance of Areas
	September				October				November				
Campden Sound and adjacent areas	■	■	■	■	■								Calving area
Exmouth Gulf				■	■	■	■	■					Resting area with calves
Shark Bay					■	■	■	■	■	■			Resting area with calves
Geographe Bay									■	■	■	■	Resting area with calves

Mating occurs between about June and October with calving 11 to 11.5 months later during the months of June to October (Environment Australia 2001a). Calving occurs in tropical coastal waters with cows and calves undertaking southern migration to summer feeding grounds in the Antarctic region. During migration pregnant females and cows with calves typically travel last. Cows and calves are known to enter Bateman Bay approximately 10 to 15 times annually (Ashton 2001). Whales may travel up as far as Stanley Pool. Most recorded interactions occur between Cardabia Passage and Point Cloates (see Figure 3).

Commercial whaling substantially reduced humpback whale populations, however, following a ban on whaling, populations are now increasing. The current annual population increase is estimated at about 10% (Environment Australia 2001a). At least six distinct Southern Hemisphere populations are recognised. The population occurring on the west coast of Australia, Group IV, is historically the largest population of humpback whales in the southern hemisphere (Heyward, Revill & Sherwood, 2000). This population is presently estimated to be roughly between 3000 to 4000 animals (Environment Australia 2001a).

Populations of humpback whales are considered to be threatened by direct disturbance along migration path and in breeding areas through whale watching and interactions, defence operations, collision with large vessels, coastal seismic operations, entanglement in fishing nets, marine pollution and debris (Environment Australia 2001a). FWA (2000) note that entanglement of marine mammals in the NMP is rare.

S. MANAGEMENT OF CONSTRUCTION IMPACTS

In relation to construction, the range and scale of these impacts, and accordingly their environmental significance will depend primarily on:

- the sensitivity of impacted environments;
- fauna and flora present;
- the physical characteristics of the area;
- existing water quality;
- type of material to be excavated; and the
- manner of construction.

Matters in relation to all but the final point above (manner of construction) have previously been described in section 5 of the PER document. This section described the manner proposed for the construction of the CCR, specifically as it relates to the management of environmental impacts.

Dredging, wave action, erosion of unstablised dredged banks, and leaching of unconsolidated spoil mounds can increase turbidity. Siltation and suspended turbidity effects result in the burial of benthic organisms, loss of seagrass, and stress on coral reefs.

Mitigation of Construction Impacts

The potential consequences and design features/procedures proposed to mitigate these impacts is summarized in Table S1 below.

TABLE S1
SUMMARY OF POTENTIAL IMPACTS AND MITIGATION OF CONSTRUCTION IMPACTS ARISING FROM THE IMPLEMENTATION OF THE CORAL COAST RESORT

Activity	Consequence to the Environment	Potential Environmental Impacts	Potential Social Impacts	Mitigation
Project Management	∉ Ensure procedures and protocols are in place to minimize impacts	Positive	Positive	∉ Implement health, safety and environmental management systems to OHSAS 18001 and ISO 14001 ∉ Implement a construction management plan
Disposal of dewatering waters	∉ Turbidity ∉ Sedimentation ∉ Smothering ∉ Noise ∉ Air Emissions	∉ Reduced water quality ∉ Habitat loss ∉ Elevated toxicants ∉ Disturbance of fauna ∉ Reduced air quality ∉ Increased turbidity ∉ Smothering benthic fauna	∉ Community impacts: - recreation; - fisheries; and - tourism	∉ Design and siting of the marina ∉ Siltation controls: - Silt curtains; and - Settling ponds ∉ Selection of techniques ∉ Selection of equipment

Activity	Consequence to the Environment	Potential Environmental Impacts	Potential Social Impacts	Mitigation
Dredging/ dredge spoil disposal	∉ Turbidity ∉ Sedimentation ∉ Smothering ∉ Noise ∉ Air Emissions	∉ Reduced water quality ∉ Habitat loss ∉ Elevated toxicants ∉ Disturbance of fauna ∉ Reduced air quality ∉ Increased turbidity ∉ Smothering of benthic fauna	∉ Community impacts: - recreation; - fisheries; and - tourism	∉ Minimisation of dredging (dry excavation) ∉ Siltation controls: - Silt curtains; and - Settling ponds ∉ Selection of equipment ∉ Timing of dredging
Site preparation	∉ High dust load ∉ Contaminated stormwaters ∉ Noise ∉ Air emissions	∉ Soil erosion ∉ Reduced water quality ∉ Direct habitat destruction ∉ Loss of flora and fauna ∉ Disturbance of fauna ∉ Reduced air quality	∉ Loss of archeological sites ∉ Community impacts: - recreation; - fisheries; and - tourism ∉ Aesthetics	∉ Design and siting to avoid sensitive areas known ∉ Archeological material will be undisturbed ∉ Implementation of contemporary dust management measures ∉ Selection of equipment
Construction activities	∉ Dust emissions ∉ Air emissions ∉ Noise ∉ Toxicants ∉ Fertilizer/pesticides	∉ Disturbance of fauna ∉ Elevated toxicants ∉ Reduced water quality ∉ Elevated nutrients	∉ Community impacts: - recreation; - fisheries; and - tourism ∉ Aesthetics	∉ Noise and emission control ∉ Timing of activities ∉ Selection of equipment ∉ Gross pollutant traps ∉ Settling basins ∉ Management and contingency plans ∉ Bunded fuel storage and fuelling stations ∉ Pile driving, not jetting of piles ∉ Site selection
Placement of breakwater stone	∉ Smothering ∉ Turbidity ∉ Habitat destruction ∉ Noise ∉ Toxicants ∉ Air Emissions	∉ Reduced water quality ∉ Habitat loss ∉ Elevated toxicants ∉ Disturbance of fauna ∉ Increased turbidity ∉ Smothering of benthic fauna ∉ Interruption of coastal processes	∉ Community impacts: - recreation; - fisheries; and - tourism	∉ Noise and emission control ∉ Timing of activities ∉ Selection of equipment ∉ Management and contingency plans ∉ Bunded fuel storage and fuelling stations ∉ Site selection

Adapted from Great Barrier Reef Marine Park Authority (1994).

Features of the CCR to Mitigate Impacts

All site construction activities will be regulated through health; safety and environmental management plans to comply with the OHSAS 18001 and ISO 14001 group of standards.

In relation to site selection, the proposed development is located on a degraded salt plan behind the primary dune system. The marina entrance will pass through the dune that

will otherwise remain intact and be managed for ecosystem maintenance. Existing blow-outs will be stabilized, and beach access formalized. The marina has been designed to maximum advantage of the natural attributes of the site including establishment on salt flats adjoining on a north-facing beach in the lee of a significant coastal projection, access to relatively deep and generally protected waters with maximum fetch considerate of prevailing wind and weather conditions.

Marina breakwaters will be constructed on an area comprising thin sands over pavement habitat (Figure 7 ATA Environmental 2000a), and well represented locally. About 4ha will be directly affected, however this loss will be offset by the creation of new habitats suitable for colonisation. Breakwaters are also known to attract fish into an area. No seagrasses or corals were identified during baseline surveys from the area to be disturbed. Baseline surveys included extensive diver trawls.

The marina water body and resort will be constructed using 'dry' techniques (excavation) requiring dewatering. This method will greatly minimize dredging impacts known to result in primary and secondary level effects (Great Barrier Reef Marine Park Authority 1994).

Dewatering waters will be discharged into stilling basins and the quality of overflow will be regulated through the use of silt screens.

Dredging will be limited to the opening of the channel mouth following construction of the marina basins, breakwaters and revetments. The method of construction and design considerations are presented in the Mauds Landing Coastal Engineering Study presented in full in Appendix 8 in the PER document. In relation to the marina design, the need for excavation has been reduced by locating deep draught boat access points and service areas closest to the entrance. Limited dredging will be undertaken using cutter suction techniques, with dredge spoil being deposited on the development area. Silt screens and bunds will again be used to reduce re-suspended sediments in return waters. On the basis of the Coastal Engineering Study undertaken, it is considered the need for maintenance (operational) dredging will be minimal.

Preliminary drilling in support of the geotechnical assessment of the marina site indicates that there will be no need for drill and blast. Piles will be driven into sand and soft calcarenites without a need for blasting.

Dust will be created during construction due to vehicular movement on unsealed roads and ground disturbing construction activities. Dust generated during construction will be minimised by the application of best practice in dust suppression including;

- vegetation retention and re-establishment;
- wind fencing;
- use of water, organic mulches or chemical agents to stabilise disturbed areas; and
- watering of surfaces and rehabilitation of disturbed areas).

The EPA Policies, Guidelines and Criteria for Environmental Impact Assessment No. 18, *Prevention of Air Quality Impacts from Development Sites* (EPA 2000b*)* is applicable to the control of dust from construction activities, and will be applied. As fine dust fractions are not produced in the construction activity located in a rural

setting, other particulate management methods are unlikely to be relevant. The marina basin and construction site will be located behind the largely intact primary and secondary dune systems, and accordingly significant impacts are unlikely to occur on adjacent marine areas.

Fuel delivery and storage systems will be designed and constructed (including bunding) in accordance with Australian Standard AS1940 (Standards Australia, 1993) and requirements of the Department of Minerals and Energy's (DME) Dangerous Goods Division and the *Explosives and Dangerous Goods Act 1961*. All fuelling of construction machinery will be undertaken in a dedicated fully lined and bunded fuelling station. Contingency measures will be developed in the event of any loss of bulk fuels to the environment.

Used oil will be collected and transported off-site by a licensed contractor as required.

Use of fertilisers and pesticides in the construction phase will be limited. Resort stormwater design will be directed away from the marina waterway in all but exceptional rainfall events.

In relation to noise impacts, the principal area of concern (bird roosting and loafing areas at Point Maud) occurs approximately 1.7km from the breakwater construction site. Single point calculations based on free field in noise has been carried out. Based on a measured sound power of 98dB(A) at 7m for generic earth moving plant, free field reduction in sound power will see the level reduced to an L_{A10} of about 40dB(A) within the distance to the bird roosting areas to the west of the development site. Although these daylight noise levels will be above background, they will generally not exhibit any tonal or impact components known to startle or disturb seabirds.

Breakwater material will be transported on public roads from quarries located near Learmonth to Mauds Landing and stockpiled on the southern side of the entrance channel. The impacts of the abstraction of materials from the source quarries are the subject of a separate referral to the EPA. The breakwater material will then be transported to Mauds Landing by truck, with heavy vehicle traffic is anticipated to increase by 60/working day movements during peak construction and 20/working day movements during the operational phase. Breakwater and revetment material will be moved to its final position using land-based equipment. Transport risk is discussed in detail in section 5.3.13 of the PER document.

The core material will be specifically selected to limit fines within practical specifications and so will reduce turbid plumes. The construction of the breakwaters will take about 6 to 8 months to complete, and will be programmed during daylight hours to avoid critical turtle nesting. Matters in relation to the control of dust, noise and fuel management above are also relevant to the construction of breakwaters.

T. MANAGEMENT OF OPERATIONAL IMPACTS

Marina runoff and the discharge of sewage from boats may affect the natural productivity of the receiving environment resulting in the death of stress due to competition to corals, algae and a range of animals. Operation of boats from the marina can result in direct physical changes to shorelines and impacts to sensitive biota such as reefs, seagrasses waterfowl, dugong, turtles and cetaceans.

The potential for environmental impacts however resulting from the operation of a marina is a function of many variables, including marina location, design, services offered, number and type of boats served and marina management and operational performance. As a result, the potential for and degree of environmental change can vary between different marinas.

Mitigation of Operational Impacts

The potential consequences and design features/procedures proposed to mitigate these impacts is summarised in Table T1 below.

TABLE T1
SUMMARY OF POTENTIAL IMPACTS AND MITIGATION OF OPERATIONAL IMPACTS ARISING FROM IMPLEMENTATION OF THE CORAL COAST RESORT

Activity	Consequence to the Environment	Potential Environmental Impacts	Potential Social Impacts	Mitigation
Maritime Wastes and Effluents	∉ Hydrocarbons ∉ Toxicants ∉ Sewage effluents ∉ Antifouling compounds	∉ Reduced water quality ∉ Toxicity impacts on flora and fauna ∉ Habitat loss ∉ Change in ecosystem structure	∉ Public health risk ∉ Community impacts: ∉ recreation; ∉ fisheries; and ∉ tourism ∉ Aesthetic loss ∉ Clear up costs	∉ Dedicated fuelling wharf with intrinsically sale dispensers ∉ Shore side sewage collection facilities ∉ Education ∉ Greater enforcement capability ∉ Emergency response plan ∉ Containment of materials
Oil Spills	∉ Maritime and coastal vessels cannot be supported be facilities proposed for CCR however enhanced response capability for unrelated maritime incidents will result from implementation.			
Coastal Processes	∉ Altered oceanographic processes ∉ High residence times	∉ Beach erosion accretion ∉ Sand transport ∉ Habitat loss ∉ Nutrient enrichment ∉ Accumulation of wastes	∉ Public health risk ∉ Community impacts: ∉ recreation; ∉ fisheries; and ∉ tourism ∉ Aesthetic loss	∉ Pre-design modelling ∉ Design features ∉ Foreshore and coastal management plans

Activity	Consequence to the Environment	Potential Environmental Impacts	Potential Social Impacts	Mitigation
Stormwater Runoff	∉ Sediments /organics: ∉ toxicants ∉ nutrients ∉ litter	∉ Reduced water quality ∉ Toxicity impacts on flora and fauna ∉ Nutrient enrichment ∉ Change in ecosystem structure	∉ Public health risk ∉ Community impacts: ∉ recreation; ∉ fisheries; and ∉ tourism ∉ Aesthetic loss	∉ Drainage control: ∉ direct stormwater away from marina ∉ gross pollutant traps ∉ scheduled maintenance as per EMP
Land and Water Impacts 'People Pressure'	∉ Environmental impacts resulting from urbanisation and resource depletion including impacts on ecotourism species are described in Sections 3.3.5 and 4.4.			
Solid Waste Disposal	∉ Leachate impacts on groundwater ∉ Wind blown rubbish impacts on fauna ∉ Air impacts (burning) ∉ Feral animals or vermin	∉ Water quality degradation ∉ Air quality degradation ∉ Toxicity impacts on flora and fauna ∉ Marine entanglement ∉ Feral animal impacts on fauna	∉ Public health risk ∉ Community impacts: ∉ tourism ∉ Clean up costs	∉ Waste management strategy ∉ Managed landfill site remote from coast ∉ Best practice management of landfill including: ∉ manning ∉ fencing ∉ vermin control ∉ buffer zone ∉ litter control ∉ operation
Liquid Waste Treatment and Disposal	∉ Human pathogens ∉ Toxicants ∉ Organic nutrients ∉ Elevated salt	∉ Water quality degradation ∉ Nutrient enrichment ∉ Toxicity impacts on flora and fauna	∉ Public health risk: ∉ effluents ∉ vermin ∉ Bio-accumulation ∉ Community impacts: ∉ tourism ∉ fisheries ∉ Aesthetics ∉ Clean up costs	∉ Waste management strategy (away from coast) and design of plant ∉ Evaporation, no disposal ∉ Monitoring program and contingency ∉ Manning
Harbour Operations	∉ Noise congestion ∉ Hazardous materials	∉ Reduce amenity ∉ Public safety ∉ Reduce water quality	∉ Public risk ∉ Bio-accumulation ∉ Stress/loss of amenity	∉ EMS ∉ Regulatory control ∉ Service area requirements ∉ Ongoing monitoring

The specification of performance standards for marina equipment will be used to minimise pollutant releases. CCMD will implement health, safety and environmental management systems to OHSAS 18001 and ISO 14001 systems, to be integrated with an environmental management plan to address all aspects of the operation of the marina and CCR. This will include, amongst others, routine maintenance relating to the collection of litter, inspection and maintenance of fuel pumps and liquid waste pump-out facilities, gross pollutant traps and marina structures.

Pollutants in stormwater runoff, spills and discharges from boat can impact water quality, in the marina basin during operation. These pollutants can include suspended sediments, organic and inorganic nutrients, hydrocarbons, metals and bacteria. The stormwater management system will be designed to direct stormwater away from the marina waterbody in all but the most extreme rainfall events. Silt and gross pollutant traps will be installed on all discharge points and basins. Stormwater management will comprise a component of the Environmental Management Plan implemented for the site. The Environmental Management Plan will include education, waste minimization, first flush retention, trapping and management of wastes.

A critical element of management of the environment impacts of operating the CCR and marina is user education. In addition to identifying opportunities to reduce impacts on wildlife and flora through sensitive boat use a focus of the program will be to inform the boating public about the potential health and environmental hazards associated with the discharge of either treated or untreated wastes into the marina basin and adjoining NMP, impacts on phosphate detergents and hydrocarbons spillage.

A fuelling facility will be provided and located on a fixed land backed wharf, and accessible without passing through the main berthing area. Flexible fuel supply lines will connect the fuelling facility and with automatic cut-off valves and nozzles, vacuum operated pumps and dry break couplings. Fuelling will only be undertaken by or under the direction of authorized personnel. Appropriate emergency response procedures will be developed, with ready access to the fuel berth by emergency vehicles and access to clean-up equipment provided. Provision of dedicated fuelling facilities for both private and commercial boats can be offset against the current practice of filling both commercial and private boats ‘over the beach’ at Bills Bay from small containers.

Breakwaters and protective works are described in the Coastal Engineering Study provided in full in Appendix 8 (ATA Environmental 2000a). All are designed to withstand a category 5 cyclone and incorporate an allowance for sea level rise as predicted to results from the ‘Greenhouse Effect’. In comparison, it is recommended that Marinas in the Great Barrier Reef Marine Park be designed to withstand a lesser category 4 cyclone (Great Barrier Reef Marine Park Authority 1994).

Amenities to be provided at the marina include showers, toilets and basins. All amenities will be provided with consideration for ease of use by disabled persons. A marina wide onshore wastewater collection system will be constructed at a centrally located pump-out installation within the marina. Liquid wastes and, dependant on pump-out velocities, bilge water will be directed to the main sewer using differential pressures or on-board grinder pumps. No system for the collection of liquid waste is currently in use at the Coral Bay settlement.

Wastewater will be treated in the services area situated some 2km from the coastline. The services area is located in an interdunal swale that is well screened from all vantage points, and is described in section 2.6 of the PER document. In addition to wastewater treatment, the services area will also include power generation, a landfill disposal site, and a small cell of "industrial" land for development of support and supply facilities including satellite maintenance workshops and cold and dry storage facilities for food and other goods and equipment. This area is required to sustain both the CCR and the

Coral Bay settlement, and will replace that occurring within short stay and residential areas in Coral Bay.

The services area has been sized so that it can also accommodate service and waste disposal requirements for, and offset the impacts of the existing Coral Bay settlement, which currently treats and disposes of its liquid wastes in ponds established on secondary dunes inland from Bills Bay. Treatment of wastewater is proposed by means of either an Upflow Anaerobic Sludge Blanket (UASB) or the more traditional sewerage pond wastewater treatment system with the capacity to treat up to 575kL/day at full development. The plant capacity has been sized to cope with projected residents and visitors, including day visitors on tour, and includes provision for sewage received from a pump-out facility for boats with on-board storage. Disposal will be via sealed evaporation ponds with a gross capacity of 888kL/day, including waste.

The geology and hydrogeology of the proposed CCR site and services area has been considered and is described in section 3.1. 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 low. Environmental bore logs presented in Appendix 1 (ATA Environmental 2001b) indicate the groundwater at the wastewater treatment plant underlie strongly indurated sands at about 15.5m below ground level. Monitoring bores have already been established in the service area. Accordingly in the event that there is a failure of containment of effluents from the evaporation pond, movement of treated effluent towards the coast will be very slow and readily detected in monitoring bores already in place. The potential to impact on marine water quality is considered very low. Contingency plans, such as using monitoring bores to recover contaminated groundwater will be developed.

Solid waste collection and disposal services will be provided to all accommodation units within the CCR. Fish cleaning facilities (including waste disposal) will also be provided. Strategically placed and serviced rain and vermin-proof litter receptacles, convenient to boat users, will be installed and regularly emptied. A managed landfill site will be established within the services area to service both the CCR and Coral Bay settlement. This has been previously described in section 2.4. Provision of secure fencing, waste compaction and the provision of daily cover, removal of standing water and vermin eradication programs will control feral animal numbers. CCR visitors and residents will be provided with education materials in relation to the importance of correct management of litter, and appropriate signage will be provided. The potential impacts of this proposal need to be offset against the impacts of the current landfill site, established on the salt flats near the Coral Bay settlement, that does not meet the WA DEP's minimum specification.

Australian Design Regulations and various Australian Standards specify allowable noise outputs from mobile sources and fixed plant respectively. The Shire of Carnarvon has delegated powers to manage noise from one premise to another or from public places under delegation from the Environmental Protection (Noise) Regulations 1997, although this does not extend to mobile noise sources. Noise from the operation of certain watercraft, particularly where there is a tonal element, are known to be particularly intrusive.

As sound travels across water easily, management of noise is important to limit impacts on sensitive animal groups such as seabirds. Public education will be important in this regard. CCMD will not encourage the use of specific watercraft (jet-skis and speedboats) within the marina waterbody or in Bateman Bay, particularly in view of the presence of seabirds listed under various international agreements (JAMBA and CAMBA) on Point Maud. An area has already been set aside by CALM for recreational watercraft use off shore of Moncks Head.

Off road vehicles currently access beaches at Mauds Landing along unmade roads and informal tracks. There are many off road vehicle tracks through the primary and secondary dunes to access the beach at Bateman Bay and the most commonly used beach access track is indicated in Figure 4. As well as causing damage to coastal landforms, operation of off road vehicles are known to disturb seabirds and increase mortality amongst turtle hatchlings caught in wheel ruts when off road vehicles are used adjacent to turtle nesting areas. Figure 4 also identifies two prohibited areas for vehicles proclaimed under the *Control of Vehicles (off-road areas) Act 1978* designated in part to protect environmental values. CCMD will support a submission for a prohibited area to vehicles at Point Maud west of the proposed CCR under the *Control of Vehicles (off-road areas) Act 1978* specifically for the protection of seabirds and declared flora as indicated in Figure 4.

Implementation of the CCR will result in a physical barrier for off road vehicle movement eastward along the beach from a popular current access point at the former Mauds Landing Jetty. Off road vehicles will no longer be able to access turtle nesting sites from this beach access point. Vehicles are also known to travel along the beach in a westerly direction to Point Maud, and monitoring undertaken by CALM suggests there is some current potential disturbance of seabirds by dogs, walkers and vessels in this area. Management strategies to limit impacts from this beach access point will be identified in the Foreshore Management Plan proposed to be developed and implemented on approval of proposal. As well as identifying opportunities and techniques for the revegetation of bare sand areas and stabilisation of blowouts and sand drifts, management strategies proposed within the Foreshore Management Plan will include:

- restriction of off-road vehicles;
- rebuilding of the incipient dune where required;
- formalisation of pedestrian beach access (including fencing and signage);
- prevention of weed species invading native coastal vegetation;
- installation of informative signage.

Following implementation, CCMD will work together with CALM, the Shire of Carnarvon and the Baiyungu Aboriginal Corporation (lessees of Cardabia Pastoral Station) to limit or exclude access to beaches from and nearby the CCR. Appropriate signage, traffic control devices and education and supplement car parks established behind the dune systems at the former Mauds Landing jetty, a site adjacent to the western breakwater, and at the northern most extremity of the development with a view to limiting vehicle access.

CCMD will support the establishment of a further off road prohibited area comprising the western portion of the Townsite and beaches (see Figure 4) to reduce impacts on

seabirds and protect populations of Acacia ryaniana, a Priority 2 Flora identified under the CALM Declared Rare and Priority Flora List (Atkins 2001), known from the parabolic dunes in this area. CCMD will further prohibit the operation of quad bikes from businesses within the CCR.

CCMD do not have powers to exclude beach access from areas outside the Mauds Landing Townsite. Beach access from Cardabia Station (including the 40m strip above HWM that constitutes a portion of NMP) can only be controlled by the owners of Cardabia Station and CALM respectively. CCMD will work with these parties to educate short-term visitors and residents to the CCR in relation to impacts arising from the use of off road vehicles on beaches.

U. MANAGEMENT ACTIVITIES & COSTS FOR MARINE ASPECTS

The Management Activities for marine aspects of the development that are not privately owned and managed would comprise the following:

- sediment monitoring and maintenance for the ocean beaches and the beaches inside the development;
- marine structures such as the entrance breakwaters, rock revetments, boardwalks and shark nets; and
- water quality monitoring, management and debris removal.

Each of these aspects is discussed below and preliminary cost estimates and frequencies are presented.

Sediment Monitoring & Maintenance

The ocean beaches would need to be monitored by beach surveys each year for the first 5 years, then the frequency for the beach surveys could be reduced to about once every 5 years. These monitoring surveys would consist of beach profiles and nearshore survey lines covering the beach about 1km each side of the breakwaters and the navigation channel between the breakwaters. The surveys would need to be managed and assessed by an Experienced Coastal Engineer. Each beach survey and the analysis of the data is estimated to cost about $12,000.

As outlined above, a significant cyclone can be expected every 5 years on average. These cyclones may cause sand to accumulate in the entrance channel area and it has been estimated that dredging would be required about once each decade. The estimated cost of the dredging of sand from the entrance channel area is $140,000 and on average would be needed about once each decade.

A significant cyclone event may also cause some redistribution of sand on the internal beaches. An initial estimate is that about 2,000m^3 of sand would need to be redistributed each 5 years. This is estimated to cost about $20,000 and is estimated that on average it would be required every 5 years.

Marine Structures

The rubble breakwaters, the revetments, boardwalks and shark nets would need to be inspected every second year to determine if maintenance or repairs were required. The inspections would need to be completed by an Experienced Coastal Engineer. It is estimated that the inspection and condition reports would cost about $20,000 and would be required every second year and after significant cyclone activity.

Following the occurrence of significant cyclones, there may be the need for some minor repair to the rubble mound breakwaters and rock revetments. It has been estimated that the breakwater repairs could cost about $130,000 and the repairs to the rock revetments may cost about $90,000. It has been estimated that such repairs may be needed about every 5 years on average.

The protective coatings and fittings on the boardwalks and the shark netting may need repair about every 5 years due to deterioration over time. It has been estimated that such maintenance and minor repair would cost about $120,000 and be required every 5 years.

The concrete boat ramps and the timber finger jetty would need minor repairs and maintenance every year. This would include damage to chaffers and fittings. It has been estimated that such repair and maintenance would cost about $3,000 each year.

Water Quality

There would be a need for the waterways to be monitored to ensure that there is not unacceptable build up of faecal pollution, nutrients and heavy metals. This would involve a programme of water quality and sediment quality sampling and analysis. Such water quality sampling would be completed twice each year and the sediment sampling would be needed every second year. It has been estimated that the cost of the water and sediment quality sampling and analysis would be about $30,000 each year.

Should the water quality monitoring identify unacceptable conditions then the cause would need to be investigated and rectified. The most likely cause of water quality deterioration would be the illegal discharge of wastes or pollutants into the waterways. The person responsible would be fined and made to alleviate the impact.

There would also be the need for ongoing removal of debris and rubbish that finds its way into the water body. It has been estimated that this would involve two men for one day each week. They would need a dinghy and a utility to be able to complete the work. It has been estimated that this would cost about $50,000 each year.

Summary of Monitoring, Maintenance, Repair & Management

In addition to the above activities and costs, allowance should be made for unknowns and some overall management. These costs, together with those outlined above have been summarised in Table U1. This table covers the first decade and it has been assumed that significant cyclones would occur in years 2 and 7. The average annual expenditure is anticipated to be about $230,000 per year over the decade. Table U1 highlights that the timing of the expenditure is dependent on the timing of significant cyclones.

These types of coastal and marine management activities are being, or are planned to be, completed by the City of Mandurah for a number of marine developments. Also, should the Port Catherine Development proceed, it would be likely that eventually the City of Cockburn would take on the role of Waterways Manager. Contact details for these organisations are provided below:

- City of Mandurah
  Mr Allan Claydon, Manager of Works and Services Phone 08 9550 3777

- City of Cockburn
  Mr Allen Blood, Strategic Planner Phone 08 9411 3598

These contacts may be able to provide comment on the management and maintenance activities and the associated costs.

TABLE U1
ESTIMATED COSTS FOR MONITORING & MAINTENANCE

Activity	Year & Costs in $1,000 units									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Sediment Monitoring Surveys	12	12	12	12	12					12
Dredging Entrance							140			
Maintenance of Internal Beaches		20					20			
Monitoring of Marine Structures	20	20	20		20		20		20	
Repairs to Breakwaters		130					130			
Repairs to Rock Revetments		90					90			
Maintenance to Boardwalks & Shark Nets					120					120
Maintenance to Boat Ramps	3	3	3	3	3	3	3	3	3	3
Monitoring Water & Sediment Quality	30	30	30	30	30	30	30	30	30	30
Removal of Debris & Rubbish	50	50	50	50	50	50	50	50	50	50
Management of Activities	20	20	20	20	20	20	20	20	20	20
Contingencies for Unknowns	20	20	20	20	20	20	20	20	20	20
TOTAL ESTIMATED COST	**155**	**395**	**155**	**135**	**275**	**123**	**523**	**123**	**143**	**255**

Notes:
1. These estimates are preliminary. The average annual costs would be about $230,000.
2. The timing of the expenditure would be dependent on the timing of significant cyclone activity

For the purpose of an initial and conservative estimate of the sediment management activities, it has been assumed that sediment movement along the beach equivalent to that estimated for Tropical Cyclone Hazel would be experienced every 5 years on average. This is appropriate for financial planning, but it should be borne in mind that the actual occurrence is unlikely to be as severe and would not be uniformly spaced. It is estimated that each severe cyclone could move about 10,000 m^3 of sand along the beach towards the breakwaters. Of this about 3,000 m^3 of sand may be deposited near and in the entrance channel. If the deposition area was 100 metres by 100 metres, then the average siltation would be about 0.3 metres. As the entrance channel in this region would have a depth of about 5 metres, it would be possible to tolerate at least two of these severe cyclone events before dredging would be needed to restore the navigable depth. This means that dredging of the entrance area may be required about once every decade on average. It has been estimated that about 6,000 m^3 of sand would be dredged and pumped back onto the beaches adjacent to the development.

The estimated cost of this dredging work is detailed below.

Mobilisation and demobilisation	$60,000
Dredging 6,000 m^3 @ $6/$m^3$	$36,000
Hydrographic surveys	$10,000
Engineering management	$20,000
Contingencies @10%	$13,000
TOTAL ESTIMATED COST OF DREDGING	**$139,000**

It is recommended that this cost of about $140,000 every decade be included in the maintenance budget for the development. This will be sufficient funding to properly maintain the navigable entrance to the Coral Coast Resort.

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FIGURES

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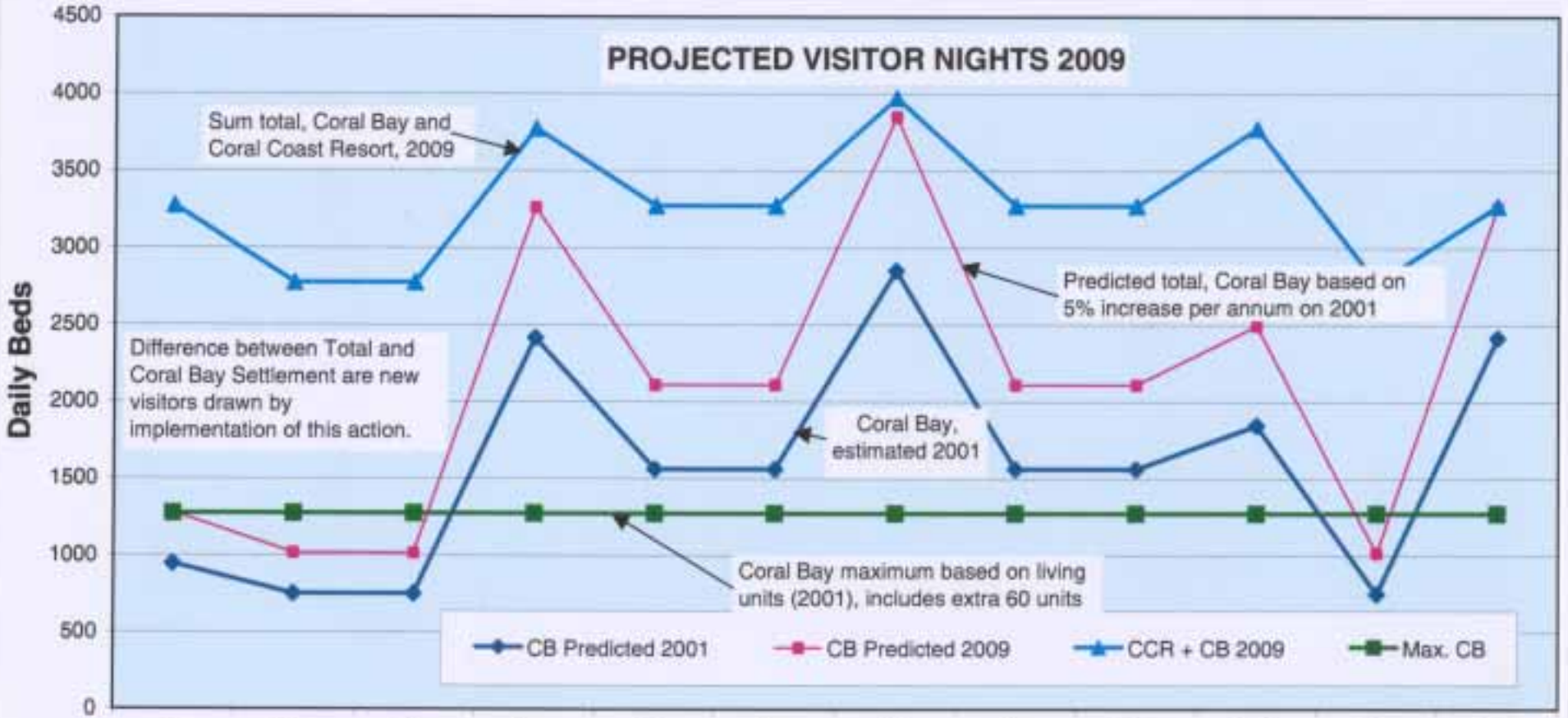
RESPONSE TO PUBLIC SUBMISSIONS
CORAL COAST RESORT (ASSESSMENT No.1322)

PROJECTED VISITOR NIGHTS
CORAL BAY & CORAL COAST RESORT, 2009
FIGURE 1



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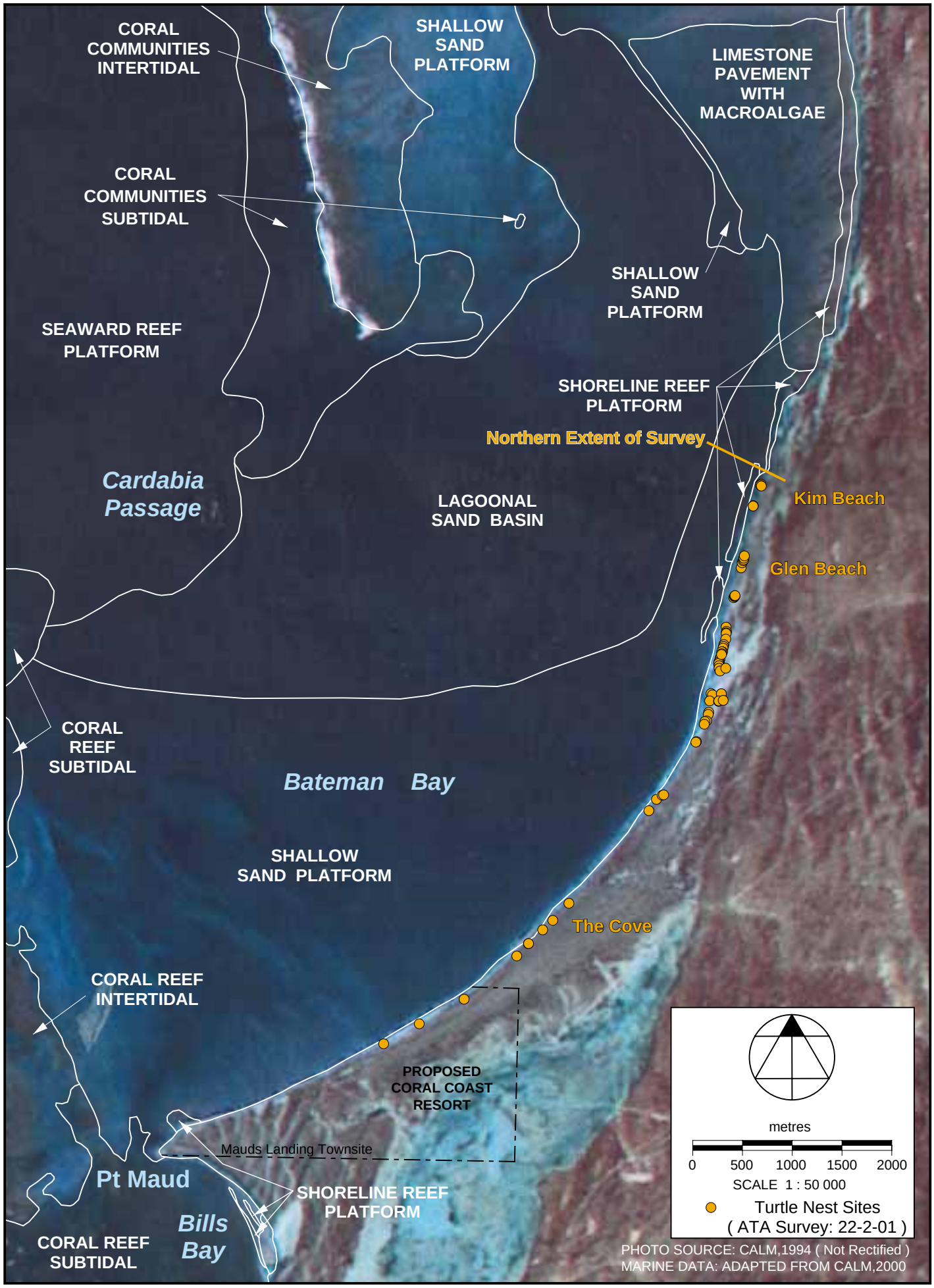

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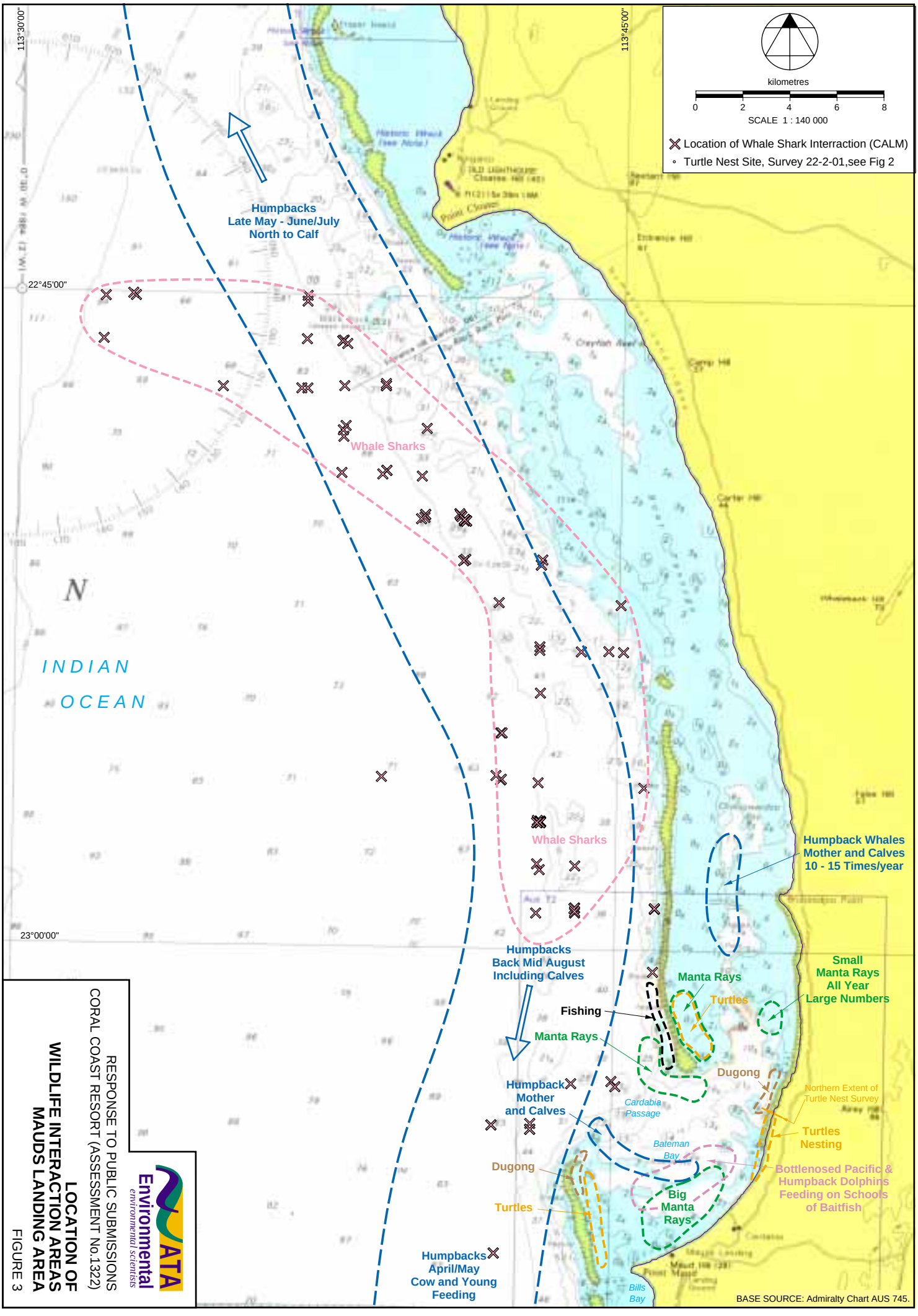
RESPONSE TO PUBLIC SUBMISSIONS
CORAL COAST RESORT (ASSESSMENT No.1322)

TURTLE NESTING SITES, SUMMER 2000 - 2001

FIGURE 2



RESPONSE TO PUBLIC SUBMISSIONS
CORAL COAST RESORT (ASSESSMENT No.1322)

LOCATION OF
WILDLIFE INTERACTION AREAS
MAUDS LANDING AREA

FIGURE 3

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BASE SOURCE: KOLTASZ SMITH & PARTNERS, Sept. 2000
PHOTO SOURCE: DOLA, (Date of Photography 8-8-99)

PRINTED: Tue 20 Nov 01
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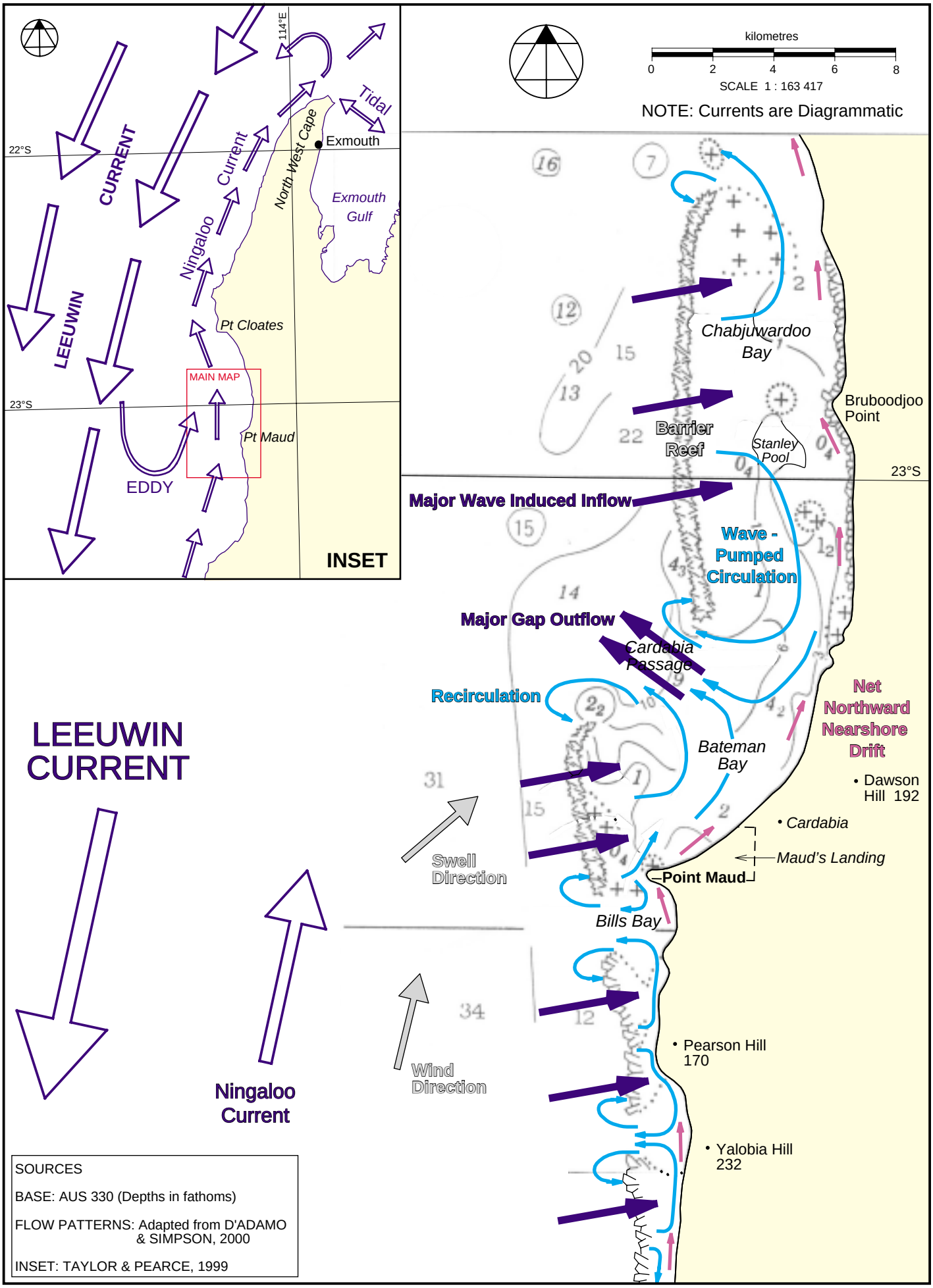
RESPONCE TO PUBLIC SUBMISSION
CORAL COAST RESORT (ASSESSMENT NO. 1322)

OFF ROAD VEHICLE USE PATTERNS

FIGURE 4



SOURCES

BASE: AUS 330 (Depths in fathoms)

FLOW PATTERNS: Adapted from D'ADAMO & SIMPSON, 2000

INSET: TAYLOR & PEARCE, 1999

CHECKED: LM 15-11-01

DRAWN: TE 15-11-01

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RESPONSE TO PUBLIC SUBMISSIONS
CORAL COAST RESORT (ASSESSMENT No.1322)

MAJOR AND NEARSHORE WATER CURRENTS - NINGALOO REEF

FIGURE 5

PLATES

Plate 1 Aerial Photograph of Bateman Bay Showing Informal Camping

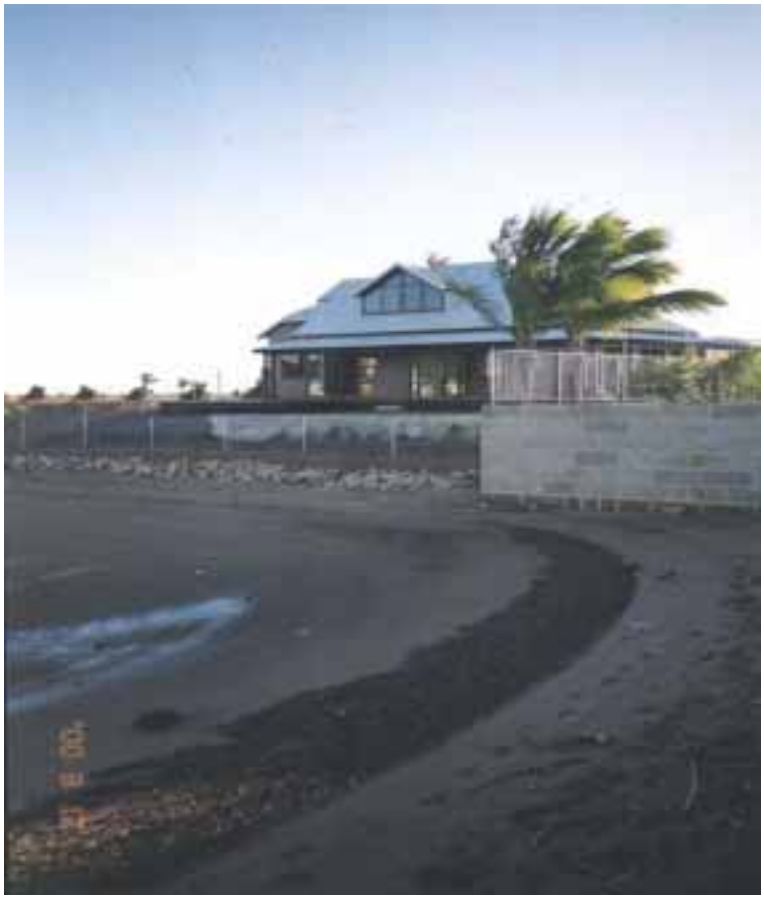

Plate 2 Photograph of Carnarvon Marina Showing Organic Build-up

APPENDICES

APPENDIX 1

STYGOFAUNA ASSESSMENT
CORAL COAST RESORT

CORAL COAST MARINA DEVELOPMENT PTY LTD

STYGOFAUNA ASSESSMENT CORAL COAST RESORT

VERSION 1

SEPTEMBER 2001

REPORT NO: 2001/22

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Checked by: Signed:

Name: Greg Milner Date: 12 September, 2001

Approved by: Signed:

Name: Henk van der Wiele Date: 12 September, 2001

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1. INTRODUCTION

1.1 Overview and Objective

Coral Coast Marina Development (CCMD) propose to develop a serviced resort village providing a broad range of short stay and holiday accommodation at Mauds Landing, a gazetted townsite situated on the North-West Cape of Western Australia approximately 1200km north of the capital city of Perth (Figure 1). Mauds Landing is situated within the Shire of Carnarvon and is positioned between the towns of Carnarvon and Exmouth being approximately 250km north of Carnarvon and 150km south of Exmouth.

The proposed resort will be supported by incidental recreational, tourist and commercial services, a number of which are located at an external services area located approximately two kilometres inland of the Mauds Landing townsite

This report describes the results of a sampling program undertaken by ATA Environmental to assess the shallow aquifer underlying the Coral Coast Resort (CCR) and adjacent services area sites for the presence of subterranean aquatic fauna.

In carrying out this assessment, a series of groundwater monitoring bores were installed in the shallow aquifer at the CCR and Services areas. A total of thirteen monitoring bores were installed comprising eight and five bores at the CCR area, and the Services area respectively.

1.2 Importance of Stygofauna Regionally

Two species of subterranean atyid shrimps, (*Sygiocaris stylifera* and *S. lancifera*) included in Schedule 1 of the *Wildlife Conservation Act 1950* are known from Cape Range. The status of these species is described in Humphreys and Adams (1991).

Stygofauna are known to be widespread within the unconfined aquifer of the coastal plain the Exmouth Peninsula. While most recorded species occur within a shallow lens of fresh to brackish groundwater, some stygofauna are found below the saltwater interface of inland caves connected at depth to sea (Humphreys 1994).

Humphreys and Adams (1991) present a review of the status of the subterranean aquatic fauna of the North West Cape peninsula concluding that a lack of information on the biology and dynamics of the species involved exists. Distribution data presented builds on that provided in Figure 1 and text from Mees (1961), to include important populations recognised as far south as Jarvis Well, inland of Norwegian Bay, approximately 96km south of Exmouth.

Preliminary hydrogeological assessments carried out at the Mauds Landing site indicate it comprises deep sands of recent origin with no limestone or subterranean voids present. A saltwater wedge is known to extend well inland in the Mauds Landing area.

Advice on the likelihood of stygofauna occurring in the general vicinity of the proposed Coral Coast Resort has previously been sought (Dr. B. Knott *pers. comm*.). The review concludes that it is likely stygofauna will be present in the shallow but not deep aquifers underlying Mauds Landing. However as there would not seem to be any local barriers to their movement, it is anticipated that these fauna will be distributed more widely than within the immediate area of Mauds Landing.

2. SITE DESCRIPTION AND PHYSICAL SETTING

2.1 Site Description

The assessment area comprised two separate sites to be developed as part of the overall marina development:

- Marina area; and
- Services area.

Figure 2 illustrates these two areas relative to the existing of Coral Bay settlement.

The Marina area is situated at the Mauds Landing townsite approximately 2.5km to 3km north of the Coral Bay settlement and covers an area of approximately 46.5ha. The marina development proper includes the marina basin, associated infrastructure and land to be subdivided for residential and tourist accommodation. Figure 3 illustrates the proposed layout of the marina development area.

The Services area is situated approximately 2km east of the Coral Bay settlement adjacent to Mauds Landing Road. It covers an area of approximately 62ha and is intended to comprise major utility sites for power, water and effluent treatment as well as a landfill disposal site.

More detailed information on the proposed development at each assessment area is provided in the Coral Coast Public Environmental Review by ATA Environmental (2000).

2.2 Physical Setting

2.2.1 Topography

Marina Area

The Mauds Landing townsite consists primarily of high parabolic dunes behind the Point Maud coastline and low shoreline parallel beach ridges behind the Batemans Bay coast terminating beyond the eastern site boundary at the seaward end of Pleistocene dunes. A large relict tidal flat exists behind the dunes extending eastward. The parabolic dune system within the western part of the site (behind Point Maud) reaches heights of up to 30m (Maud Hill), whilst the beach ridges lying parallel to the coastline occurs at a maximum elevation of approximately 9m at their southern extent, but are more typically 4-6m AHD.

Services Area

The Services area site consists of longitudinal dunes oriented in an approximately north-north-east to south-south-west direction. The dunes tend to be low and undulating with heights between approximately 10m and 20m AHD.

2.2.2 Landforms

Marina Area

The geomorphology at the Marina area, ie. Mauds Landing, is considered by Hesp (1986) to be on the boundary of a geomorphic subregion described as being dominated by Holocene parabolic dunes overlying Holocene relict tidal flats and Pleistocene coastal dunes, alluvial sediments, aeolian plains, dunes and coral terraces.

The predominant landform at Mauds Landing is a relict foredune plain to the seaward side of an extensive relict tidal flat or salt pan. When the sea level was higher than present the topographic low point between the 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. The original tidal entrance may be seen where arcuate, east-west trending dune ridges are present.

Point Maud itself lies on a prominent foreland, dominated by vegetated parabolic dunes and one active parabolic dune. The dunes overlie relict tidal flats 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 that extend to the Point.

Figure 4 illustrates the landforms of the CCR.

Services Area

The services area is dominated by longitudinal desert dunes and associated interdunal swales. The floors of the swales often have calcretised Pleistocene dunes cropping out. Figure 4 illustrates the landform of the services assessment area

2.2.3 Geology

Marina Area

At the Marina area the geology is mapped by Hocking *et al*. (1985) as comprising the Holocene units 'Ql' - Coastal Lacustrine Deposits and 'Qs'. Hocking *et al.* (1985) describes Unit 'Ql' as comprising calcareous and gypsiferous clays, silt and sand and evaporitic deposits (mainly gypsum and halite). Until 'Ql' crops out in the southern and eastern sections of the Marina area that overlap onto the salt pan. Unit 'Qs' is described by Hocking *et al.* (1985) as comprising mostly calcareous sand that is variably quartzose in the form of coastal dunes, beaches and beach ridges. Unit 'Qs' in the Marina area is mapped as being present in the northern and western portions of the area.

Services Area

The geology cropping out at the Services area is mapped by Hocking *et al.* (1985) as comprising the aeolian sandstone Member 'Qbe' of the Bundera Calcarenite. Hocking *et al.* (1985) describes 'Qbe' Member as a variably calcreted calcarenite of Pleistocene

age and aeolian origin with calcrete soils and dune shapes locally preserved. It is also interpreted to be a highly permeable aquifer.

2.2.4 Hydrology

Surface Hydrology

Rainfall on western portion of the Marina area and Services area 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 Marina site east of the dunes is generally flat and low-lying and storm runoff drains to the southeast, generally towards the salt lake areas that form a large shallow basin. The capacity of this shallow basin and salt lake system is sufficiently large so 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 runoff from Mauds Landing and its hinterland and has no oceanic outlet.

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, a shallow unconfined aquifer and a deep confined aquifer known as the Birdrong Sandstone Formation. Although a detailed hydrological study has never been undertaken in the site area, the Birdrong sandstone artesian aquifer is known to be located at a depth of approximately 800m (Rockwater, 1994; 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 10000 to 14000 mg/L total soluble salts (TSS). Salinities increase from east to west, and reach 35000 mg/L at depth near the coast where a wedge of sea-salinity water underlies less saline water. There is also believed to be a shallow thin lens of fresher groundwater in the area, and an old well near Point Maud is reported to have been capable of supply 900L/day (Woodward-Clyde 1993).

The shallow aquifers receive recharge waters at infrequent intervals by direct infiltration of rainfall and run-off from hills and ranges, such as the Giralia Range located 27km 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 6000 mg/L TSS, indicating that saline groundwater is being diluted very slowly, if at all (Rockwater, 2000).

Beneath the Coral Bay/Mauds Landing area, 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 low.

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 town of Denham's water supply as well as for the salt mining operations at Lake MacLeod and Useless Loop (Department of Planning and Urban Development 1992; Woodward-Clyde 1993). The two caravan parks at the Coral Bay settlement each have a bore extracting from this aquifer. These bores provide brackish water (around 5000 mg/L TSS) at approximately 60^{o}C with outflow rates varying from 1670 kL/day ('Bayview') and 2160 kL/day ('Peoples') (Department of Planning and Urban Development 1992; 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 (Department of Planning and Urban Development 1992).

The Waters and Rivers Commission Report – Gascoyne Region Water Review and Development Plan 1996 (WRAP 3 1996) estimates that the renewable resource within the Lyndon – Minilya Basin of the Birdrong Formation is approximately 10.6 million kL/annum. Discussions with the Commission confirm that the proposed total demand is acceptable. The estimated drop in the piezometric head at the Coral Bay settlement, which also draws from the Lyndon – Minilya Basin, is estimated at only 1m on a 42m head.

Recent discussions with the Water and Rivers Commission and Rockwater confirm that the required quantities of water are expected to be available from the Birdrong Formation and that the Commission will issue a licence for groundwater abstraction.

Investigations have indicated that the sustainable yield of the Birdrong Formation will not be compromised by the extraction required to supply the Coral Coast Resort. The full text of the groundwater report relating to the CCR proposal is included in Appendix 5, ATA Environmental (2000).

3. SAMPLING AND ANALYSIS PROGRAM

3.1 Sampling Program

3.1.1 Monitoring Bore Installation

To allow access to the shallow aquifer a series of groundwater monitoring bores were installed at the Marina and Services areas. A total of thirteen monitoring bores were installed with eight (MMW1-8) installed at the Marina area and a further five (SMW1-5) installed at the Services area. Figures 5 and 6 illustrate the location of the bores at each area respectively. Table 1 provides the coordinates and the depth at which groundwater was encountered for each bore.

TABLE 1
MONITORING BORE COORDINATES AND GROUNDWATER DEPTHS

		COORDINATES		DEPTH TO GROUNDWATER (mbgl)	
	BORE NO.	EASTING	NORTHING	INITIAL WATER LEVEL	STANDING WATER LEVEL
MARINA AREA	MMW1	7440601	0786064	1.30	1.30
	MMW2	7441567	0786312	1.15	1.37
	MMW3	7441247	0785907	0.9	0.90
	MMW4	7440732	0785606	0.9	0.91
	MMW5	7440865	0785191	1.3	1.32
	MMW6	7440034	0785284	0.3	0.36
	MMW7	7440440	0784892	1.4	1.47
	MMW8	7440264	0784535	1.95	2.66
SERVICES AREA	SMW1	7437576	0786035	15.6	15.56
	SMW2	7436841	0785747	10.9	10.58
	SMW3	7436969	0786176	10.7	10.69
	SMW4	7436834	0785441	8.2	8.26
	SMW5	7437820	0785582	2.7	2.65

Notes:

The monitoring bores were installed under the supervision of ATA Environmental between 25 and 29 January 2001 using a drill rig equipped with hollow flight augers. Bore construction was similar to that specified by the Water & Rivers Commission (WRC) Water Quality Protection Note - Monitoring Bores (Slotted Casing), with the exception that the width of the slots cut in the PVC screen were 1mm rather than the commonly used width of 0.4m. The greater slot width was designed to allow the ingress of stygofauna potentially present in the groundwater into the monitoring well, and in the knowledge of the particle sizes previously encountered in limited test hole excavation at the respective sites.

Logs for each of the monitoring bores are presented as Appendix 1.

Bores were marked, capped and locked with envirocaps following development.

3.1.2 Sample Collection

Bores were allowed to stand for a minimum 23 days following construction before sampling (February 22, 2001). Samples were taken using a disposable bailer, and reduced in volume by passed through a 100 micron bolting silk net into a plastic 100ml centrifuge tube. A minimum 2 l of water was collected in each case. Sample volumes were made up to 95 ml, and 5ml formaldehyde solution added as a preservative. Samples were labelled, stored and transported to the University of Western Australia (UWA) for analysis.

3.2 Sample Analysis

Preserved samples were examined by Dr Brenton Knott of the Zoology Department, UWA. Samples were sorted under a dissecting microscope at 120-250 times magnification.

Sample descriptions and fauna recovered are summarised in Section 4 below.

4. RESULTS

Table 2 below presents the results of the microscopic analysis of shallow bore samples taken at the Marina and nearby Services areas.

TABLE 2
RESULTS OF FAUNAL ASSESSMENT OF SHALLOW BORE WATER SAMPLES TAKEN AT THE MARINA AND SERVICES AREAS

SAMPLE	SEDIMENT VOLUME (mL)	SEDIMENT	FAUNA
MMW 1	27.5	fine dark silt with some detritus	1 foraminifera ; 0 metazoans
MMW 2	7.5	sand with some detritus	foraminifera; 0 metazoans
MMW 3	8.5	sand with some detritus	few foraminifera; 0 metazoans
MMW 4	3	sand with some detritus	few foraminifera; 0 metazoans
MMW 5	2.5	sand with some detritus	2 oligochaetes; few foraminifera
MMW 6	10	sand; considerable flocculent detritus	1 oligochaete; few foraminifera
MMW 7	5	sand with some detritus	few foraminifera; 0 metazoans
MMW 8	10	sand; no silt; small fragments of rope	1 oligochaete; very few foraminifera
SMW 1	5	3 mL light brown silt, with plant detritus; 2 mL sand	0 foraminifera; 0 metazoans
SMW 2	10	light brown silt, with plant detritus	1 pseudoscorpion; 0 aquatic forms
SMW 3	10	light brown silt, with plant detritus	0 foraminifera; 0 metazoans
SMW 4	35	7.5 mL light brown silt, with plant detritus; 27.5 mL sand	0 foraminifera; 0 metazoans
SMW 4	4.0	flocculent silt; ∃1 mL sand	0 animals; 0 foraminifera
SMW 5	9.5	1 mL light brown silt, with plant detritus; 8.5 mL sand;	0 foraminifera; 0 metazoans

Notes:
MMW denotes Marina Area (Mauds Landing Townsite) stygofauna monitoring bores.
SMW denotes Services area stygofauna monitoring bores.

In all samples labelled MMW, there was also a white substance to greater or lesser extent, presumably fragments of plant material covered in $CaCO_3$ precipitate. The silt in the samples labelled SMW was very fine.

5. DISCUSSION

No species of stygofauna were identified in the samples collected.

Identification has yet to confirm whether the oligochaete specimens collected at the townsite (samples MMW 5 and 6) are tubificids or niaids. These samples have been referred for further identification. The single oligochaete specimen from MMW 6 differs in setal morphology and presumably represents a different species, possibly even family from those collected from MMW5.

Dr Knott notes that there is no way of knowing whether the foraminifera were alive or simply empty tests; with the latter possibility the more likely. Pseudoscorpions are not aquatic, and the specimen in SMW 2 undoubtedly represents an 'accidental'.

In all samples labelled MMW, there was also a white substance to greater or lesser extent, presumably fragments of plant material covered in $CaCO_3$ precipitate. The silt in the samples labelled SMW was very fine. Given the small particle size, Dr Knott considers that it is likely animals occurring within the host subterranean formations would have difficulty finding adequate living space, and would likely be unable to keep body surfaces sufficiently clean for gas exchange. Sands from the Marina area samples are slightly angular, and with the occasional pieces of plant detritus, and accordingly present some scope for habitation by stygofauna.

Only three animal specimens were recovered, all oligochaetes. Based on setal morphology, the two specimens in MMW 5, despite being different in size, likely belong to the same species.

6. CONCLUSION AND RECOMMENDATIONS

No stygofaunal species were identified in the samples collected. Given the areas sampled include the proposed development sites and extend into adjoining areas, it is highly unlikely that important stygofaunal populations within the superficial aquifer will be impacted by the development of the CCR. This paucity of subterranean fauna generally is a likely consequence of the deep fine sands and silts of recent origin encountered, and absence of limestone or subterranean voids.

It is recommended that oligochaete specimens collected at the townsite (samples MMW 5 and 6) be referred for further identification.

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FIGURES

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DRAWN: GLM 12-9-01

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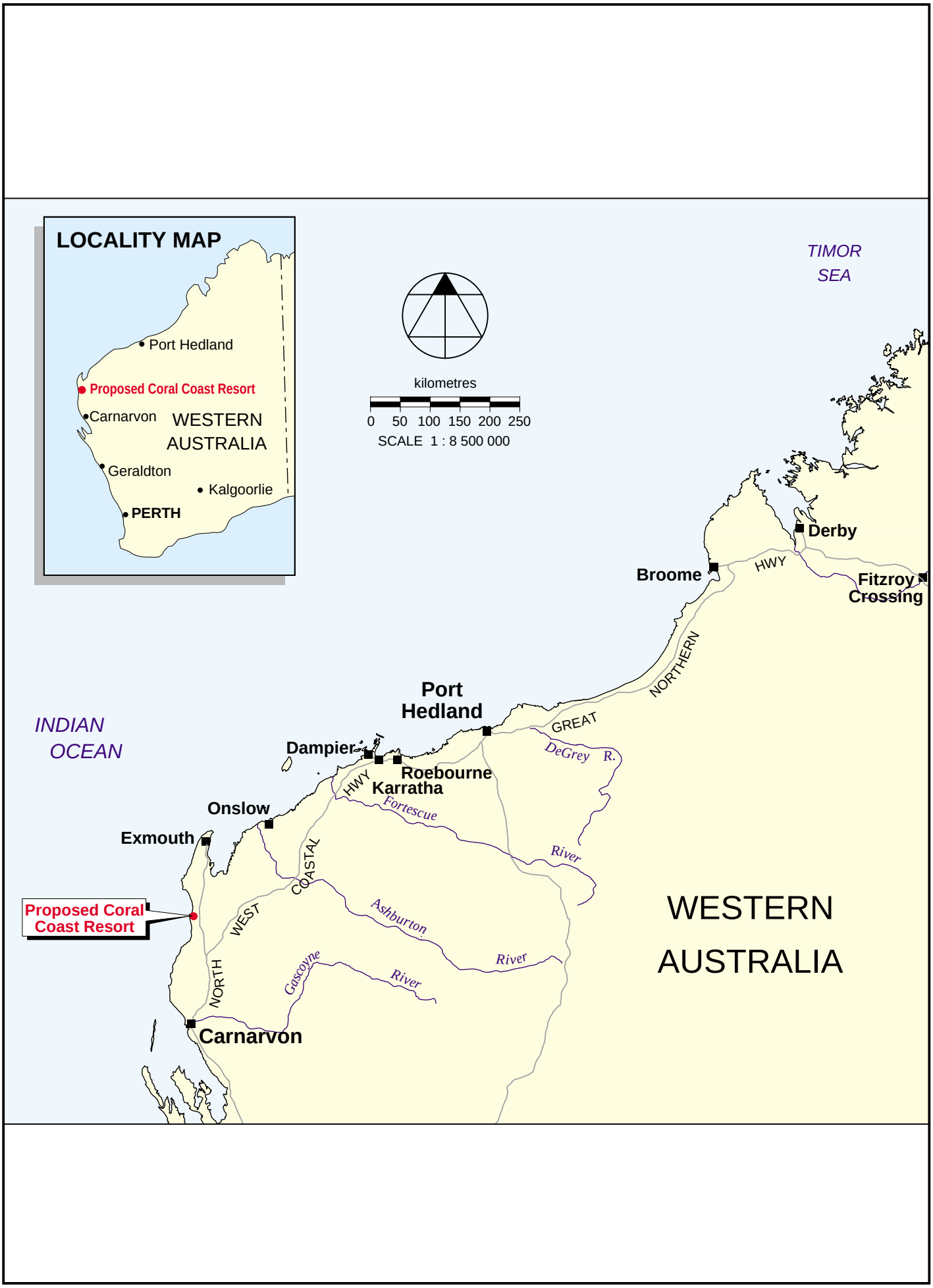

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STYGOFAUNA ASSESSMENT - CORAL COAST RESORT

REGIONAL LOCATION

FIGURE 1

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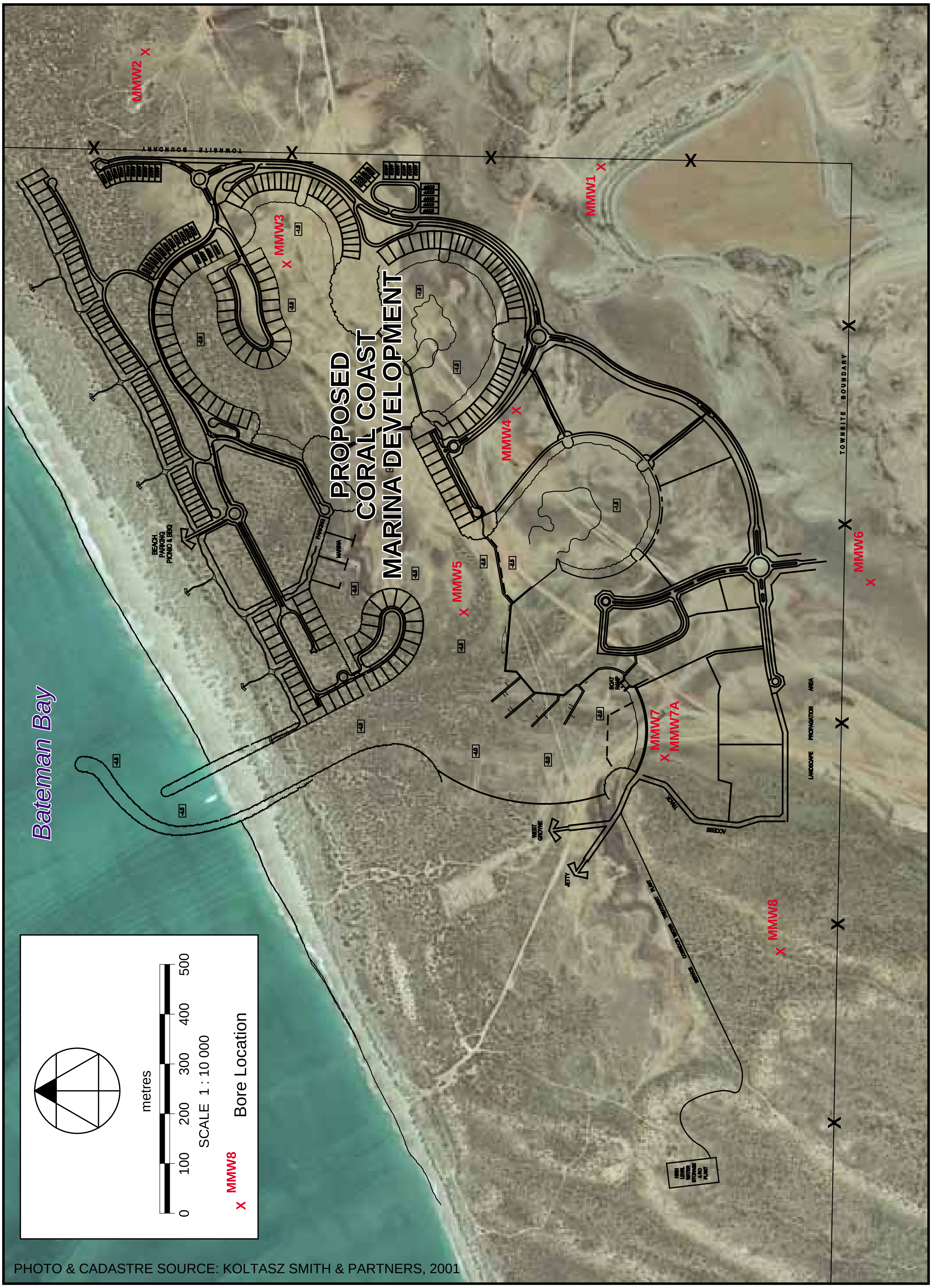

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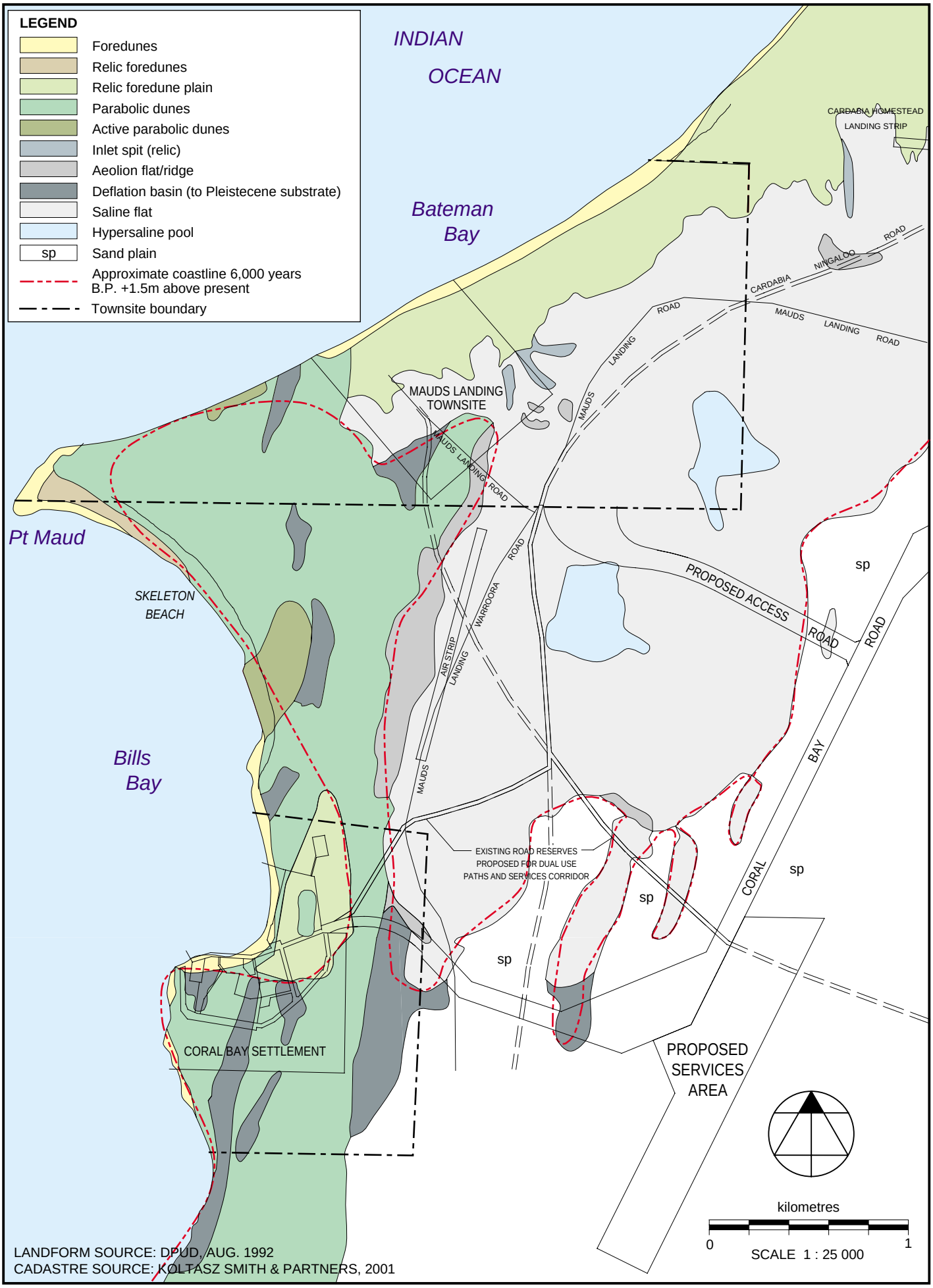
STYGOFAUNA ASSESSMENT - CORAL COAST RESORT

BORE LOCATIONS - RESORT AREA

FIGURE 5



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STYGOFAUNA ASSESSMENT - CORAL COAST RESORT

LANDFORMS - MARINA & SERVICES AREA

FIGURE 4

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STRUCTURE PLAN

CORAL COAST RESORT

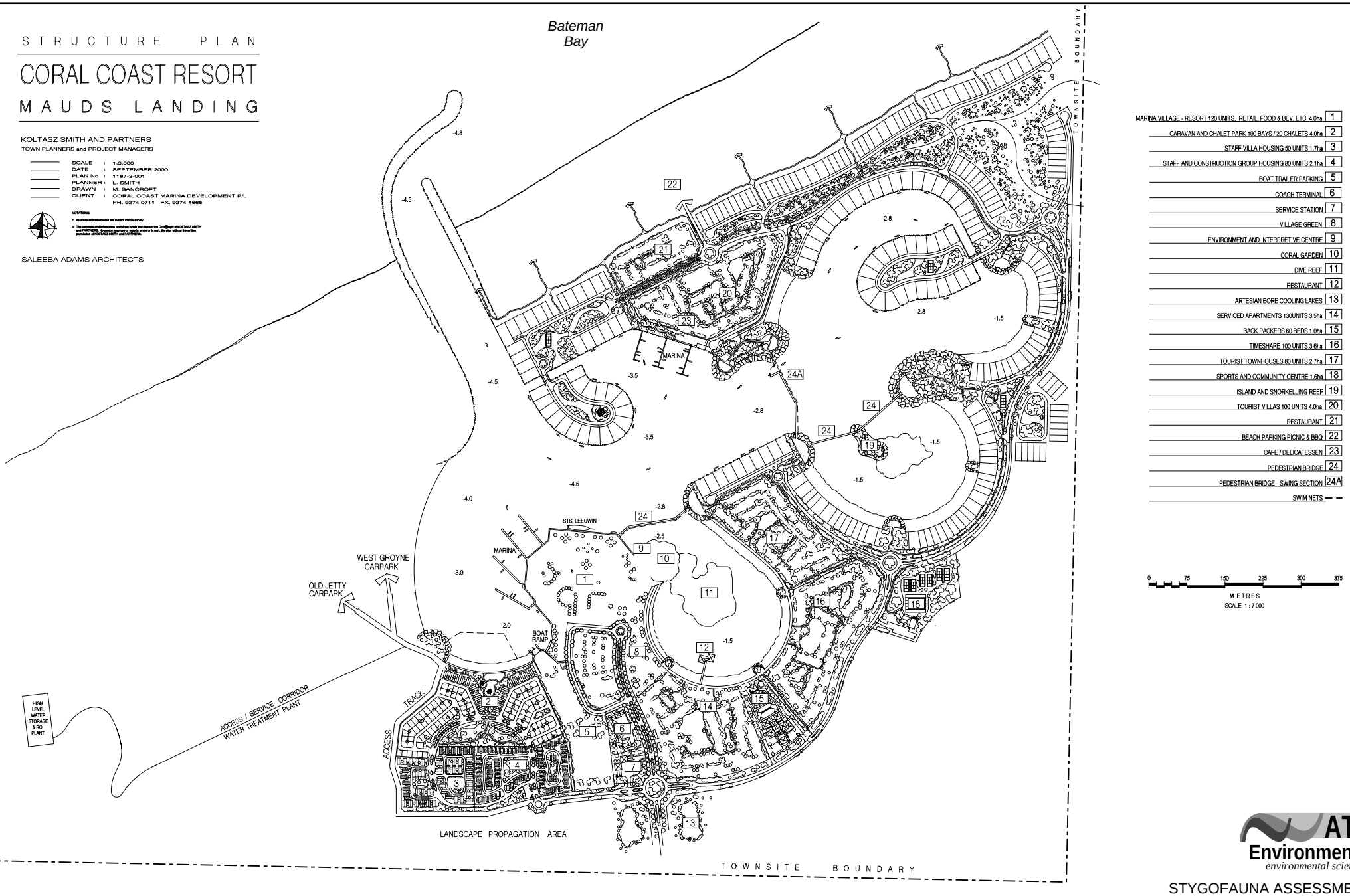
MAUDS LANDING

KOLTASZ SMITH AND PARTNERS
TOWN PLANNERS and PROJECT MANAGERS

SCALE : 1:3,000
DATE : SEPTEMBER 2000
PLAN No : 1187-2-001
PLANNER : L. SMITH
DRAWN : M. BANCROFT
CLIENT : CORAL COAST MARINA DEVELOPMENT P/L
PH. 9274 0711 FX. 9274 1665

NOTATIONS:
1. All areas and dimensions are subject to final survey.
2. The concepts and information contained in this plan remain the Copyright of KOLTASZ SMITH and PARTNERS. No person may use or copy in whole or in part, the plan without the written permission of KOLTASZ SMITH and PARTNERS.

SALEEBA ADAMS ARCHITECTS



MARINA VILLAGE - RESORT 120 UNITS, RETAIL, FOOD & BEV. ETC 4.0ha	1
CARAVAN AND CHALET PARK 100 BAYS / 20 CHALETS 4.0ha	2
STAFF VILLA HOUSING 50 UNITS 1.7ha	3
STAFF AND CONSTRUCTION GROUP HOUSING 80 UNITS 2.1ha	4
BOAT TRAILER PARKING	5
COACH TERMINAL	6
SERVICE STATION	7
VILLAGE GREEN	8
ENVIRONMENT AND INTERPRETIVE CENTRE	9
CORAL GARDEN	10
DIVE REEF	11
RESTAURANT	12
ARTESIAN BORE COOLING LAKES	13
SERVICED APARTMENTS 130UNITS 3.5ha	14
BACK PACKERS 60 BEDS 1.0ha	15
TIMESHARE 100 UNITS 3.6ha	16
TOURIST TOWNHOUSES 80 UNITS 2.7ha	17
SPORTS AND COMMUNITY CENTRE 1.6ha	18
ISLAND AND SNORKELLING REEF	19
TOURIST VILLAS 100 UNITS 4.0ha	20
RESTAURANT	21
BEACH PARKING PICNIC & BBQ	22
CAFE / DELICATESSEN	23
PEDESTRIAN BRIDGE	24
PEDESTRIAN BRIDGE - SWING SECTION	24A
SWIM NETS	

0 75 150 225 300 375
METRES
SCALE 1 : 7 000

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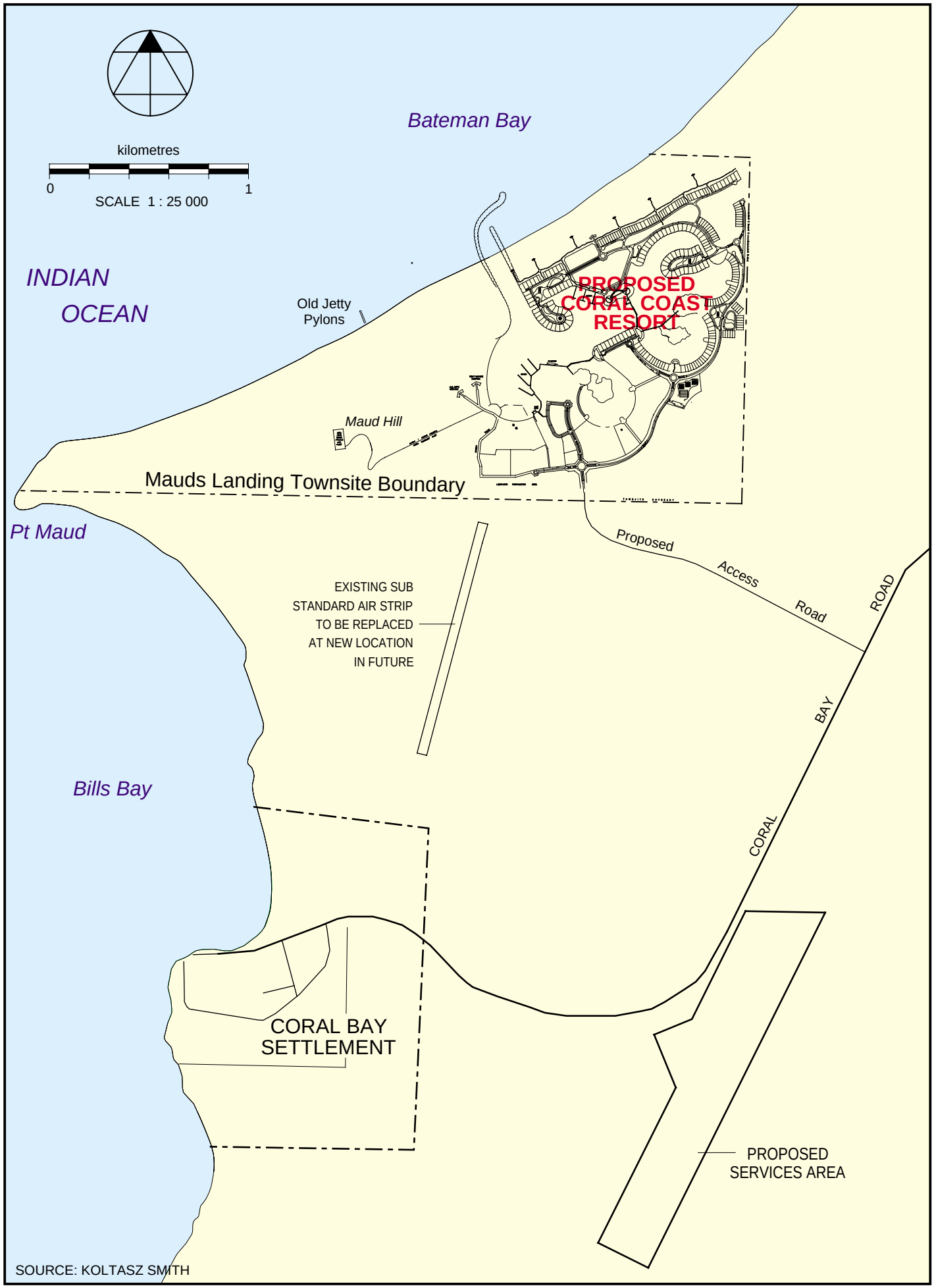
STYGOFAUNA ASSESSMENT
- CORAL COAST RESORT

CORAL COAST RESORT STRUCTURE PLAN

FIGURE 3

SOURCE: KOLTASZ SMITH & PARTNERS, SEPT 2000



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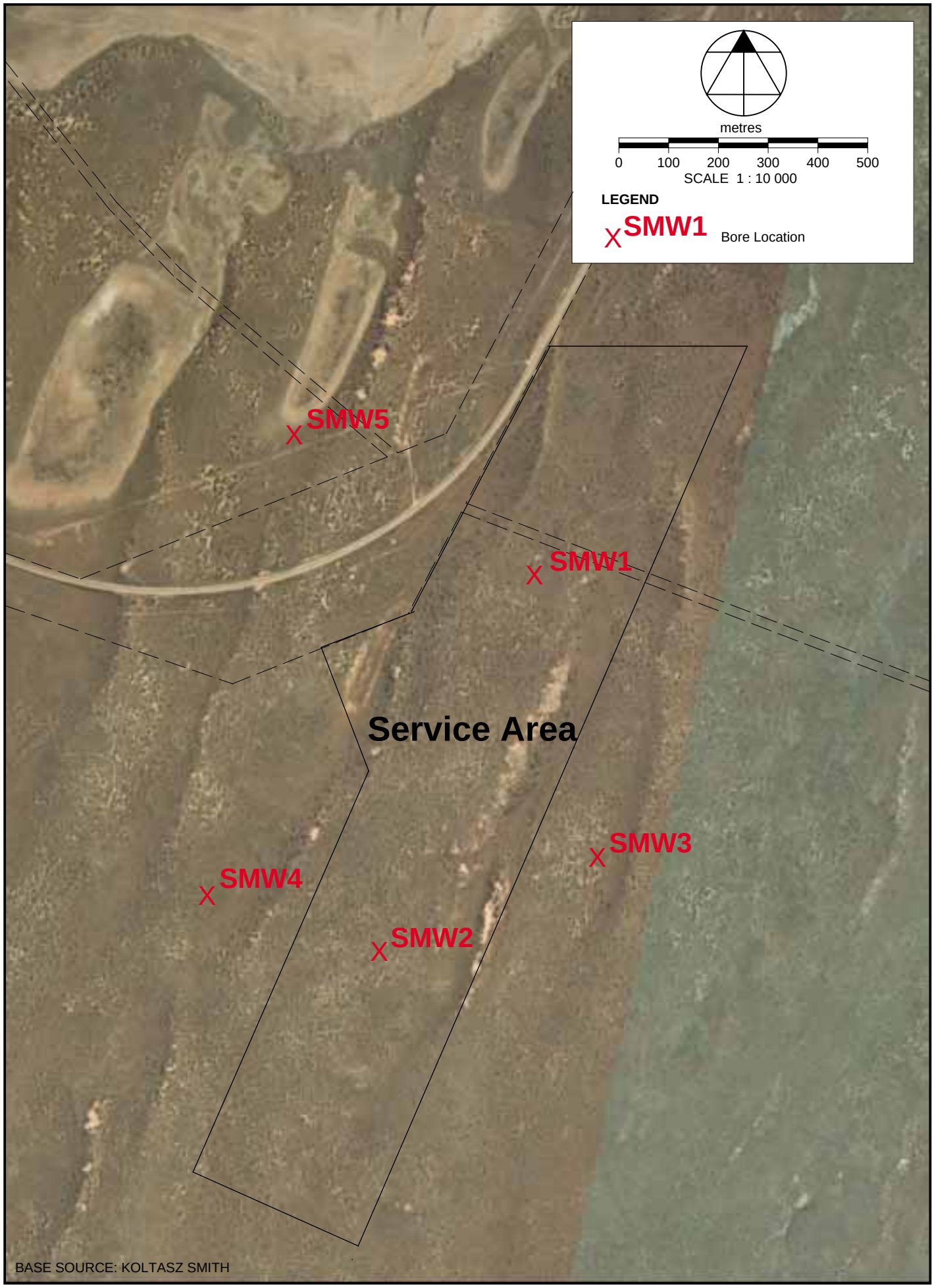
STYGOFAUNA ASSESSMENT - CORAL COAST RESORT

SITE LOCATION

FIGURE 2



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STYGOFAUNA ASSESSMENT - CORAL COAST RESORT

BORE LOCATIONS - SERVICES AREA

FIGURE 6

APPENDICES

APPENDIX 1

MONITORING BORE LOGS

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ATA ENVIRONMENTAL
BORE LOG

BORE HOLE No.: MMW1

Project:	CCMD	*Client:*	CCMD Pty Ltd
Location:	Marina Area	*Job No:*	20057/SF

Elevation:	- m, AHD		*Logged By:*	G. Milner	
Coordinates:	N: 7440601	E: 0786064	*Date Logged:*	28/1/2001	
Drill Method:	Hollow Stem Auger		*Checked By:*		
Driller:	GS Drilling		*Initial Water Level:* 1.3m BGL	*Static Water Level:* 1.3 m BGL	

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%; Little 10%-20%; Some 20%-30%)
	-0.5	Cap; Class 12 50mm PVC				
	0.0				SP	SAND - White, very fine grain size, well sorted, gypsum?
Coastal Dunes (Qs)	0.5				SM	SILTY SAND - Light brown, very fine grain size, well sorted, well rounded grains, gypsum? ▽ 28/1/2001 Conductivity = 18.8 mS/cm ▼ 12/3/2001
	1.0					
	1.5				SM	SILTY SAND - Grey to light grey, fine, well sorted, subrounded to rounded grains, quartz and carbonate grains.
	2.0					
						End of hole @ 2.2m.

LEGEND

——— denotes interface between soil types inferred from drilling information

– – – – – denotes interface between soil types inferred from drilling information. Low level of confidence in actual depth of interface.

Well Construction Details: Bentonite; Sand Fill; Slotted Screen; 1-2mm Gravel

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ATA ENVIRONMENTAL
BORE LOG

BORE HOLE No.: MMW2

Project:	CCMD	*Client:*	CCMD Pty Ltd
Location:	Marina Area	*Job No:*	20057/SP

Elevation:	- m, AHD		*Logged By:*	G. Milner	
Coordinates:	N: 7441567	E: 0786312	*Date Logged:*	28/1/2001	
Drill Method:	Hollow Stem Auger		*Checked By:*		
Driller:	GS Drilling		*Initial Water Level:*	1.15m BGL	*Static Water Level:* 1.57m BGL

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%; Little 10%-20%; Some 20%-30%)
	-0.5	Cap; Class 12 50mm PVC				
	0.0					
Coastal Dunes (Qs)	0.5				SP	SAND - Light brown, fine to medium grain size, moderately sorted, subangular to well rounded grains, quartz and carbonate.
	1.0					▽ 28/1/2001 Conductivity 15-40 mS/cm
	1.5					▼ 22/2/2001
	2.0					End of Hole @ 2.1m

LEGEND

denotes interface between soil types inferred from drilling information

denotes interface between soil types inferred from drilling information. Low level of confidence in actual depth of interface.

Well Construction Details: Bentonite; Sand Fill; Slotted Screen; 1-2mm Gravel

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ATA ENVIRONMENTAL
BORE LOG

BORE HOLE No.: MMW3

Project:	CCMD	*Client:*	CCMD Pty Ltd
Location:	Marina Area	*Job No:*	20057/SP

Elevation:	- m, AHD		*Logged By:*	G. Milner	
Coordinates:	N: 7441247	E: 0785907	*Date Logged:*	28/1/2001	
Drill Method:	Hollow Stem Auger		*Checked By:*		
Driller:	GS Drilling		*Initial Water Level:* 0.9m BGL		*Static Water Level:* 0.9m BGL

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%; Little 10%-20%; Some 20%-30%)
	-0.5 0.0	Cap; Class 12 50mm PVC				
Coastal Dunes (Qs)	0.5 1.0 1.5 2.0				SP	SAND - Light brown, fine to medium grain size, moderately sorted, subangular to well rounded grains, quartz and carbonate. 28/1/2001 Conductivity 17.10 mS/cm 23/2/2001
						End of Hole @ 2.0m

LEGEND

denotes interface between soil types inferred from drilling information

denotes interface between soil types inferred from drilling information. Low level of confidence in actual depth of interface

Well Construction Detail: Bentonite; Sand Fill; Slotted Screen; 1-2mm Gravel

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ATA ENVIRONMENTAL
BORE LOG

BORE HOLE No.: MMW4

Project:	CCMD	Client:	CCMD Pty Ltd
Location:	Marina Area	Job No:	20057/SF

Elevation:	- m, AHD	Logged By:	G. Milner
Coordinates:	N: 7440732 E: 0785606	Date Logged:	28/1/2001
Drill Method:	Hollow Stem Auger	Checked By:	
Driller:	GS Drilling	Initial Water Level: 0.9m BGL	Static Water Level: 0.91m BGL

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%; Little 10%-20%; Some 20%-30%)
	-0.5	Cap; Class 12 50mmØ PVC				
	0.0				SM	SANDY SILT - Light brown very fine, well sorted, trace fine to medium quartz sand, trace organic matter, trace clay.
Coastal Lacustrine Deposits (Ql)	0.5				SM	SANDY SILT - White to very light brown, fine grain size, little sand, fine to medium grain size, carbonate?
Coastal Dunes (Qs)	1.0				SP	SAND - Grey, medium to coarse grain size, poorly moderately sorted, sub angular to rounded grains, quartz, and carbonate (shell) material. ▽ 28/1/2001 Conductivity 19.40 mS/cm ▼ 22/2/2001
	1.5					
	2.0					End of Hole @ 2.0m

LEGEND

denotes interface between soil types inferred from drilling information

denotes interface between soil types inferred from drilling information. Low level of confidence in actual depth of interface

Well Construction Details: Bentonite; Sand Fill; Slotted Screen; 1-2mm Gravel

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ATA ENVIRONMENTAL
BORE LOG

BORE HOLE No.: MMW5

Project:	CCMD	Client:	CCMD Pty Ltd
Location:	Marina Area	Job No:	20057/SF

Elevation:	- m, AHD	Logged By:	G. Milner
Chordinates:	N: 7440865 E: 0785191	Date Logged:	28/1/2001
Drill Method:	Hollow Stem Auger	Checked By:	
Driller:	GS Drilling	Initial Water Level: 1.3m BGL	Static Water Level: 1.32m BGL

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%; Little 10%-20%; Some 20%-30%)
	-0.5	Cap; Class 12 50mm PVC				
	0.0				SP	SAND - Brown, fine to medium grain size, subrounded to rounded, moderately well sorted, calcareous grains and quartz, trace organic matter.
Coastal Dunes (Qs)	0.5				SM	SANDY SILT - Light brown, very fine grain size, trace sand, medium grain size, carbonate?
	1.0				SP	SAND - Grey, medium to coarse grain size, poorly to moderately sorted, subrounded to rounded grains, quartz and carbonate material.
	1.5					▽ 28/1/2001 Conductivity 16.70 mS/cm ▼ 12/2/2001
	2.0					
						End of Hole @ 2.3m

LEGEND

denotes interface between soil types inferred from drilling information

denotes interface between soil types inferred from drilling information. Low level of confidence in actual depth of interface.

Well Construction Detail: Bentonite; Sand Fill; Slotted Screen; 1-2mm Gravel

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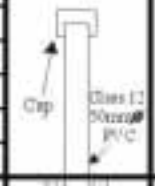
ATA ENVIRONMENTAL
BORE LOG

BORE HOLE No.: MMW6

Project:	CCMD	*Client:*	CCMD Pty Ltd
Location:	Marina Area	*Job No:*	20057/SF

Elevation:	- m, AHD	*Logged By:*	G. Milner
Chordinates:	N: 7440034 E: 0785284	*Date Logged:*	28/1/2001
Drill Method:	Hollow Stem Auger	*Checked By:*	
Driller:	GS Drilling	*Initial Water Level:* 0.5m BGL	*Static Water Level:* 0.36m BGL

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%; Little 10%-20%; Some 20%-30%)
	-0.5					
	0.0				SM	SILTY SAND - Light brown, very fine grain size, quartz & lacustrine precipitates, trace shell material, orange & green mottling
Coastal Lacustrine Deposits (Qlc)					SM	SILTY SAND - White, fine grain size, carbonate? ▽ 28/1/2001 Conductivity> 19.90mS/cm
					SP	SAND - Brown, coarse, well sorted, subrounded, gypsum? ▼ 22/2/2001
Coastal Dunes (Qs)	0.5				SM	SILTY SAND - Brown, fine to medium grain size, rounded to angular, quartz with lacustrine precipitates (halite?, gypsum?)
	1.0				SP	SAND - Grey, medium to coarse grain size, poorly to moderately sorted, subangular to rounded grains, quartz with carbonate (shell) material, trace silt.
						End of Hole @ 1.3m

LEGEND

——— denotes interface between soil types inferred from drilling information

– – – – – denotes interface between soil types inferred from drilling information. Low level of confidence in actual depth of interface.

Well Construction Details: Bentonite; Sand Fill; Slotted Screen; 1-2mm Gravel

ATA Environmental
environmental scientists

ATA ENVIRONMENTAL
BORE LOG

BORE HOLE No.: MMW7

Project:	CCMD	Client:	CCMD Pty Ltd
Location:	Marina Area	Job No:	20057/SF

Elevation:	- m, AHD	Logged By:	G. Milner
Coordinates:	N: 7440440 E: 0784892	Date Logged:	28/1/2001
Drill Method:	Hollow Stem Auger	Checked By:	
Driller:	GS Drilling	Initial Water Level: 1.4m BGL	Static Water Level: 1.44m BGL

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%; Little 10%-20%; Some 20%-30%)
	-0.5	Cap; Class 12 50mm PVC				
	0.0					
Coastal Dunes (Qs)	0.5				SP	SAND - Light brown to grey, fine to medium grain size, subrounded to rounded grains, well sorted, calcareous, trace calcrefisation 0.5m to 0.8m, poorly developed.
	1.0					
	1.5					▽ 28/1/2001 Conductivity = 10.90 mS/cm ▼ 2/2/2001
	2.0					
						End of Hole @ 2.4m

LEGEND

——— denotes interface between soil types inferred from drilling information

- - - - - - denotes interface between soil types inferred from drilling information. Low level of confidence in actual depth of interface.

Well Construction Details: Bentonite; Sand Fill; Slotted Screen; 1-2mm Gravel

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BORE HOLE No.: MMW7A

Project:	CCMD	Client:	CCMD Pty Ltd
Location:	Marina Area (4m South of MMW7)	Job No:	20057/SF

Elevation:	- m, AHD		Logged By:	G. Milner	
Coordinates:	N: 7440433	E: 0784889	Date Logged:	29/1/2001	
Drill Method:	Hollow Stem Auger		Checked By:		
Driller:	GS Drilling		Initial Water Level:	1.4m BGL	Static Water Level: - m BGL

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%, Little 10%-20%, Some 20%-30%)
	-0.5					
	0.0					
Coastal Dunes (Qs)	0.5				SP	SAND - Light brown to grey, fine to medium grain size, subrounded to rounded grains, well sorted, abundant calcareous grains (shell material), calcretised from 0.5m to 0.8m, poorly developed, rubbly.
	1.0					▽ 29/1/2001 Conductivity = 19.90 mS/cm
	1.5					
	2.0					
	2.5					
	3.0					

LEGEND

——— denotes interface between soil types inferred from drilling information

– – – – – – denotes interface between soil types inferred from drilling information. Low level of confidence in actual depth of interface.

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BORE HOLE No.: MMW7A

Project:	CCMD	Client:	CCMD Pty Ltd
Location:	Marina Area (4m South of MMW7)	Job No:	20057/SF

Elevation:	- m, AHD		Logged By:	G. Milner	
Coordinates:	N: 7440433	E: 0784889	Date Logged:	29/1/2001	
Drill Method:	Hollow Stem Auger		Checked By:		
Driller:	GS Drilling		Initial Water Level: 1.4m BGL	Static Water Level: - m BGL	

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%, Little 10%-20%, Some 20%-30%)
Coastal Dunes (Qs)	3.0				SP	SAND - continued
	3.5					
	4.0					
	4.5					
	5.0					
	5.5					
	6.0					
	6.5					

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BORE LOG

BORE HOLE No.: MMW7A

Project:	CCMD	Client:	CCMD Pty Ltd
Location:	Marina Area (4m South of MMW7)	Job No:	20057/SF

Elevation:	- m, AHD		Logged By:	G. Milner	
Coordinates:	N: 7440433	E: 0784889	Date Logged:	29/1/2001	
Drill Method:	Hollow Stem Auger		Checked By:		
Driller:	GS Drilling		Initial Water Level: 1.4m BGL	Static Water Level: - m BGL	

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%, Little 10%-20%, Some 20%-30%)
Coastal Dunes (Qs)	6.5				SP	SAND - continued
	7.0					
	7.5					
	8.0					Trace coarse shell material
Bunderra Calcarenite (Qbe)?	8.5				-	CALCARENITE - White to cream, fine to medium grain size, subrounded to rounded, moderately sorted, mostly carbonate grains with carbonate cement, patchy cementation, strongly indurated (8.1m to 8.2m) to poorly indurated, upper surface marked with dark staining (weathering surface?)
	9.0					
	9.5					
	10.0					
						End of Hole @ 10.0m

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BORE HOLE No.: MMW8

Project:	CCMD	*Client:*	CCMD Pty Ltd
Location:	Marina Area	*Job No:*	20057/SF

Elevation:	- m, AHD	*Logged By:*	G. Milner
Coordinates:	N: - E: -	*Date Logged:*	28/1/2001
Drill Method:	Hollow Stem Auger	*Checked By:*	
Driller:	GS Drilling	*Initial Water Level:* 1.93m BGL	*Static Water Level:* 2.66m BGL

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%; Little 10%-20%; Some 20%-30%)
	-0.5	Cap; Class 12 50mm PVC				
	0.0					
Coastal Dunes (Qs)	0.5				SP	SAND - Brown to light brown, fine to medium grain size, subrounded to rounded grains, well sorted, common calcareous grains, trace quartz, patchy cementation 0.5m - 1.2m, poorly developed, rubbly.
	1.0					
	1.5					
	2.0					▽ 28/1/2001 Conductivity 14.40 mS/cm
	2.5					▼ 12/2/2001
	3.0					
						End of Hole @ 3.0m

LEGEND

denotes interface between soil types inferred from drilling information

denotes interface between soil types inferred from drilling information. Low level of confidence in actual depth of interface

Well Construction Details: Bentonite; Sand Fill; Slotted Screen; 1-2mm Gravel

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BORE HOLE No.: SMW1

Project:	CCMD	*Client:*	CCMD Pty Ltd
Location:	Services Area	*Job No:*	20057/SF

Elevation:	- m, AHD		*Logged By:*	G. Milner	
Coordinates:	N: 7437576	E: 0786035	*Date Logged:*	25/1/2001	
Drill Method:	Hollow Stem Auger		*Checked By:*		
Driller:	GS Drilling		*Initial Water Level:* 15.6m BGL	*Static Water Level:*	15.56m BGL

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	**Description** (Trace <10%, Little 10%-20%, Some 20%-30%)
	-0.5 0.0	Steel Wellhead Class 12 PVC				
Bunderra Calcarenite (Qbe)	0.5 1.0 1.5 2.0 2.5 3.0				SP	SAND - Brown to light brown, fine to medium grain size, subrounded to rounded grains, quartz with calcareous cement (calcrete), poorly to strongly indurated, soft to very hard, loose to 3.6m then varying degrees of calcretisation at depth.

LEGEND

——— denotes interface between soil types inferred from drilling information

- - - - - denotes interface between soil types inferred from drilling information. Low level of confidence in actual depth of interface.

Well Construction Details: Bentonite; Sand Fill; Slotted Screen; 1-2mm Gravel

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BORE LOG

BORE HOLE No.: SMW1

Project:	CCMD	Client:	CCMD Pty Ltd
Location:	Services Area	Job No:	20057/SF

Elevation:	- m, AHD		Logged By:	G. Milner	
Coordinates:	N: 7437576	E: 0786035	Date Logged:	25/1/2001	
Drill Method:	Hollow Stem Auger		Checked By:		
Driller:	GS Drilling		Initial Water Level: 15.6m BGL	Static Water Level: 15.56m BGL	

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%, Little 10%-20%, Some 20%-30%)
Bunderra Calcarenite (Qbc)	3.0				SP	SAND - continued
	3.5					
	4.0					Strongly indurated 3.6m to 4.2m, very hard
	4.5					
	5.0					
	5.5					
	6.0					
	6.5					

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BORE HOLE No.: SMW1

Project:	CCMD	Client:	CCMD Pty Ltd
Location:	Services Area	Job No:	20057/SF

Elevation:	- m, AHD		Logged By:	G. Milner	
Coordinates:	N: 7437576	E: 0786035	Date Logged:	25/1/2001	
Drill Method:	Hollow Stem Auger		Checked By:		
Driller:	GS Drilling		Initial Water Level: 15.6m BGL	Static Water Level: 15.56m BGL	

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%, Little 10%-20%, Some 20%-30%)
Bunderra Calcarenite (Qbc)	6.5				SP	SAND - continued
	7.0					
	7.5					
	8.0					
	8.5					
	9.0					
	9.5					
	10.0					

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BORE LOG

BORE HOLE No.: SMW1

Project:	CCMD	Client:	CCMD Pty Ltd
Location:	Services Area	Job No:	20057/SF

Elevation:	- m, AHD		Logged By:	G. Milner	
Coordinates:	N: 7437576	E: 0786035	Date Logged:	25/1/2001	
Drill Method:	Hollow Stem Auger		Checked By:		
Driller:	GS Drilling		Initial Water Level: 15.6m BGL	Static Water Level: 15.56m BGL	

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%, Little 10%-20%, Some 20%-30%)
Bunderra Calcarenite (Qbc)	10.0				SP	SAND - continued
	10.5					
	11.0					
	11.5					
						Strongly indurated 11.8m to 14.4m, very hard
	12.0					
	12.5					
	13.0					
	13.5					

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BORE LOG

BORE HOLE No.: SMW1

Project:	CCMD	Client:	CCMD Pty Ltd
Location:	Services Area	Job No:	20057/SF

Elevation:	- m, AHD	Logged By:	G. Milner
Coordinates:	N: 7437576 E: 0786035	Date Logged:	25/1/2001
Drill Method:	Hollow Stem Auger	Checked By:	
Driller:	GS Drilling	Initial Water Level: 15.6m BGL	Static Water Level: 15.56m BGL

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%, Little 10%-20%, Some 20%-30%)
Bunderra Calcarenite (Qbc)	13.5				SP	SAND - continued
	14.0					
	14.5					Strongly indurated 11.8m to 14.4m, very hard
	15.0					
	15.5					▼ 25/1/2001
	16.0					▽ 25/1/2001 Conductivity 9.20 mS/cm
	16.5					
	17.0					

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BORE HOLE No.: SMW1

Project:	CCMD	Client:	CCMD Pty Ltd
Location:	Services Area	Job No:	20057/SF

Elevation:	- m, AHD	Logged By:	G. Milner
Coordinates:	N: 7437576 E: 0786035	Date Logged:	25/1/2001
Drill Method:	Hollow Stem Auger	Checked By:	
Driller:	GS Drilling	Initial Water Level: 15.6m BGL	Static Water Level: 15.56m BGL

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%, Little 10%-20%, Some 20%-30%)
Bunderra Calcarenite (Qbe)	17.0 17.5 18.0				SP	SAND - continued
						End of Hole @ 18.0m

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BORE HOLE No.: SMW2

Project:	CCMD	*Client:*	CCMD Pty Ltd
Location:	Services Area	*Job No:*	20057/SF

Elevation:	- m, AHD		*Logged By:*	G. Milner	
Coordinates:	N: 7436841	E: 0785747	*Date Logged:*	25/1/2001, 26/1/2001	
Drill Method:	Hollow Stem Auger		*Checked By:*		
Driller:	GS Drilling		*Initial Water Level:* 10.9m BGL	*Static Water Level:* 10.58m BGL	

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%; Little 10%-20%; Some 20%-30%)
	-0.5 0.0	Cap Class 12 Slotted PVC				
Bunderra Calcarenite (Qbe)	0.5 1.0 1.5 2.0 2.5 3.0				SP	SAND - Brown, fine to medium grain size, well sorted, rounded to subrounded grains, quartz

LEGEND

denotes interface between soil types inferred from drilling information

denotes interface between soil types inferred from drilling information. Low level of confidence in actual depth of interface.

Well Construction Details: Bentonite; Sand Fill; Slotted Screen; 1-2mm Gravel

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BORE LOG

BORE HOLE No.: SMW2

Project:	CCMD	Client:	CCMD Pty Ltd
Location:	Services Area	Job No:	20057/SF

Elevation:	- m, AHD		Logged By:	G. Milner	
Coordinates:	N: 7436841	E: 0785747	Date Logged:	25/1/2001, 26/1/2001	
Drill Method:	Hollow Stem Auger		Checked By:		
Driller:	GS Drilling		Initial Water Level: 10.9m BGL	Static Water Level: 10.58m BGL	

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%, Little 10%-20%, Some 20%-30%)
Bunderra Calcarenite (Qbc)	3.0				SP	SAND - continued
	3.5					
	4.0					
	4.5					
	5.0					
	5.5					
	6.0					
	6.5					

ATA ENVIRONMENTAL
BORE LOG

BORE HOLE No.: SMW2

Project:	CCMD	Client:	CCMD Pty Ltd
Location:	Services Area	Job No:	20057/SF

Elevation:	- m, AHD		Logged By:	G. Milner	
Coordinates:	N: 7436841	E: 0785747	Date Logged:	25/1/2001, 26/1/2001	
Drill Method:	Hollow Stem Auger		Checked By:		
Driller:	GS Drilling		Initial Water Level: 10.9m BGL	Static Water Level: 10.58m BGL	

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%, Little 10%-20%, Some 20%-30%)
Bunderra Calcarenite (Qbc)	6.5				SP	SAND - continued 6.5m - 7.2m rare indurated bands (<20cm thick), bands poorly indurated, calcrete?
	7.0					
	7.5				-	SAND STONE - Light brown, hard to very hard, fine grain size, well sorted, subrounded to angular, secondary calcareous cement (calcrete?), moderately indurated to strongly indurated.
	8.0					
	8.5					
	9.0					
	9.5					Strongly indurated 9.8m to 10.6m, very hard
	10.0					

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BORE LOG

BORE HOLE No.: SMW2

Project:	CCMD	Client:	CCMD Pty Ltd
Location:	Services Area	Job No:	20057/SF

Elevation:	- m, AHD		Logged By:	G. Milner	
Coordinates:	N: 7436841	E: 0785747	Date Logged:	25/1/2001, 26/1/2001	
Drill Method:	Hollow Stem Auger		Checked By:		
Driller:	GS Drilling		Initial Water Level: 10.9m BGL		Static Water Level: 10.58m BGL

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%, Little 10%-20%, Some 20%-30%)
Bunderra Calcarenite (Qbc)	10.0				-	SANDSTONE - continued
	10.5					Strongly indurated 9.8m to 10.6m, very hard ▼ 22/2/2001
	11.0					▽ 26/1/2001 Conductivity 11.80 mS/cm
	11.5					
	12.0					
	12.5					
	13.0					End of Hole @ 13.0m

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BORE LOG

BORE HOLE No.: SMW3

Project:	CCMD	*Client:*	CCMD Pty Ltd
Location:	Services Area	*Job No:*	20057/SF

Elevation:	- m, AHD	*Logged By:*	G. Milner
Coordinates:	N: 7436969 E: 0786176	*Date Logged:*	27/1/2001
Drill Method:	Hollow Stem Auger	*Checked By:*	
Driller:	GS Drilling	*Initial Water Level:* 10.7m BGL	*Static Water Level:* 10.69m BGL

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%; Little 10%-20%; Some 20%-30%)
	-0.5					
	0.0					
Bunderra Calcarenite (Qbc)	0.5				SP	SAND - Brown to light brown, fine to medium grain size, well sorted rounded to subrounded grains, quartz, loose, mostly poorly to moderately indurated trace calcrete pebbles to 1cm diameter.
	1.0					strongly indurated 0.9m to 1.4m (calcrete?), hard
	1.5					
	2.0					
	2.5					
	3.0					

LEGEND

——— denotes interface between soil types inferred from drilling information

- - - - - - - denotes interface between soil types inferred from drilling information. Low level of confidence in actual depth of interface.

Well Construction Details: Bentonite; Sand Fill; Slotted Screen; 1-2mm Gravel

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BORE LOG

BORE HOLE No.: SMW3

Project:	CCMD	Client:	CCMD Pty Ltd
Location:	Services Area	Job No:	20057/SF

Elevation:	- m, AHD		Logged By:	G. Milner	
Coordinates:	N: 7436969	E: 0786176	Date Logged:	27/1/2001	
Drill Method:	Hollow Stem Auger		Checked By:		
Driller:	GS Drilling		Initial Water Level: 10.7m BGL	Static Water Level: 10.69m BGL	

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%, Little 10%-20%, Some 20%-30%)
Bunderra Calcarenite (Qbc)	3.0				SP	SAND - continued
	3.5					
	4.0					
	4.5					
	5.0					
	5.5					
	6.0					
	6.5					

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BORE LOG

BORE HOLE No.: SMW3

Project:	CCMD	Client:	CCMD Pty Ltd
Location:	Services Area	Job No:	20057/SF

Elevation:	- m, AHD		Logged By:	G. Milner	
Coordinates:	N: 7436969	E: 0786176	Date Logged:	27/1/2001	
Drill Method:	Hollow Stem Auger		Checked By:		
Driller:	GS Drilling		Initial Water Level: 10.7m BGL		Static Water Level: 10.69m BGL

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%, Little 10%-20%, Some 20%-30%)
Bunderra Calcarenite (Qbe)	6.5				SP	SAND - continued
	7.0					
	7.5					
	8.0					
	8.5					
	9.0					Moderately to strongly indurated 9.0 - 13.0m (calcrete?), hard
	9.5					
	10.0					

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BORE HOLE No.: SMW3

Project:	CCMD	Client:	CCMD Pty Ltd
Location:	Services Area	Job No:	20057/SF

Elevation:	- m, AHD	Logged By:	G. Milner
Coordinates:	N: 7436969 E: 0786176	Date Logged:	27/1/2001
Drill Method:	Hollow Stem Auger	Checked By:	
Driller:	GS Drilling	Initial Water Level: 10.7m BGL	Static Water Level: 10.69m BGL

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%, Little 10%-20%, Some 20%-30%)
Bunderra Calcarenite (Qbc)	10.0				SP	SAND - continued
	10.5					Moderately to strongly indurated 9.0 - 13.0m (calcrete?), hard
	11.0					▽ 27/1/2001 Conductivity 13.50 mS/cm ▼ 22/2/2001
	11.5					
	12.0					
	12.5					
	13.0					End of Hole @ 13.0m

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BORE LOG

BORE HOLE No.: SMW4

Project:	CCMD	Client:	CCMD Pty Ltd
Location:	Services Area	Job No:	20057/SF

Elevation:	- m, AHD		Logged By:	G. Milner	
Coordinates:	N: 7436834	E: 0785441	Date Logged:	27/1/2001	
Drill Method:	Hollow Stem Auger		Checked By:		
Driller:	GS Drilling		Initial Water Level: 8.2m BGL	Static Water Level: 8.26m BGL	

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%; Little 10%-20%; Some 20%-30%)
	-0.5	Steel Wellhead				
	0.0	Class 12 Natural PVC				
Bunderra Calcarenite (Qbe)	0.5				SP	SAND - Brown to cream, fine to medium grain size, well sorted, subrounded to rounded, loose, trace calcareous cement (calcrete?), poorly indurated, poorly developed
	1.0					
	1.5					
	2.0					
	2.5					
	3.0					

LEGEND

denotes interface between soil types inferred from drilling information

denotes interface between soil types inferred from drilling information. Low level of confidence in actual depth of interface.

Well Construction Details: Bentonite; Sand Fill; Slotted Screen; 1-2mm Gravel

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BORE LOG

BORE HOLE No.: SMW4

Project:	CCMD	Client:	CCMD Pty Ltd
Location:	Services Area	Job No:	20057/SF

Elevation:	- m, AHD		Logged By:	G. Milner	
Coordinates:	N: 7436834	E: 0785441	Date Logged:	27/1/2001	
Drill Method:	Hollow Stem Auger		Checked By:		
Driller:	GS Drilling		Initial Water Level: 8.2m BGL	Static Water Level: 8.26m BGL	

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%, Little 10%-20%, Some 20%-30%)
Bunderra Calcarenite (Qbc)	3.0				SP	SAND - continued
	3.5					
	4.0					
	4.5					
	5.0					
	5.5					
	6.0					
	6.5					

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BORE HOLE No.: SMW4

Project:	CCMD	*Client:*	CCMD Pty Ltd
Location:	Services Area	*Job No:*	20057/SF

Elevation:	- m, AHD		*Logged By:*	G. Milner	
Coordinates:	N: 7436834	E: 0785441	*Date Logged:*	27/1/2001	
Drill Method:	Hollow Stem Auger		*Checked By:*		
Driller:	GS Drilling		*Initial Water Level:* 8.2m BGL	*Static Water Level:* 8.26m BGL	

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%; Little 10%-20%; Some 20%-30%)
Bunderra Calcarenite (Qbe)	6.5				SP	SAND - continued
	7.0					
	7.5					
	8.0					▽ 27/1/2001 Conductivity 14.60 mS/cm
	8.5					▼ 22/2/2001
	9.0					
	9.5					
	10.0					
						End of Hole @ 10.2m

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BORE HOLE No.: SMW5

Project:	CCMD	*Client:*	CCMD Pty Ltd
Location:	Services Area	*Job No:*	20057/SF

Elevation:	- m, AHD		*Logged By:*	G. Milner	
Coordinates:	N: 7437820	E: 0785582	*Date Logged:*	28/1/2001	
Drill Method:	Hollow Stem Auger		*Checked By:*		
Driller:	GS Drilling		*Initial Water Level:* 2.7m BGL	*Static Water Level:* 2.65m BGL	

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%; Little 10%-20%; Some 20%-30%)
	-0.5	Steel Wellhead				
	0.0	Class 12 Medium PVC				
Bunderra Calcaremite (Qbe)?	0.5				SP	SAND - Brown to light brown/cream, fine grain size, well sorted, rounded to subangular grains, quartz and carbonate, poorly to strongly indurated, trace to some calcareous cementation (calcrete).
	1.0					
	1.5					Strongly indurated 1.5m to 1.8m, hard
Coastal Dunes (Qs)	2.0				SP	SAND - Light brown/cream, fine to coarse grain size, subrounded to rounded grains, quartz and carbonate grains, trace shell material (gastropod), trace calcrete, poorly indurated.
	2.5					22/1/2001 ▼ 28/1/2001 ▽ Conductivity 5 300 mS/cm
	3.0					

LEGEND

——— denotes interface between soil types inferred from drilling information

- - - - - - denotes interface between soil types inferred from drilling information. Low level of confidence in actual depth of interface.

Well Construction Details: Bentonite; Sand Fill; Slotted Screen; 1-2mm Gravel

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BORE HOLE No.: SMW5

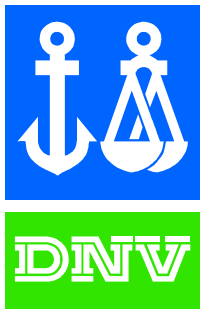
Project:	CCMD	Client:	CCMD Pty Ltd
Location:	Services Area	Job No:	20057/SF

Elevation:	- m, AHD	Logged By:	G. Milner
Coordinates:	N: 7437820 E: 0785582	Date Logged:	28/1/2001
Drill Method:	Hollow Stem Auger	Checked By:	
Driller:	GS Drilling	Initial Water Level: 2.7m BGL	Static Water Level: 2.65m BGL

Geological Unit	Depth (m)	Well Construction	Samples/Measurements	Graphic Log	Unified Soil Classification	Description (Trace <10%, Little 10%-20%, Some 20%-30%)
Coastal Dunes (Qs)	3.0				SP	SAND - continued
	3.5					
	4.0					
	4.5					
						End of Hole @ 4.6m

APPENDIX 2

QUALITATIVE RISK ASSESSMENT
CORAL COAST RESORT



CORAL BAY / CORAL COAST QUALITATIVE RISK ASSESSMENT

Prepared for

Coral Coast Marina Development Pty Ltd

Det Norske Veritas

(DNV Project Number 21310062, June 2001)

Client:	Coral Coast Marina Development Pty Ltd	**Client Contract No:** 21310062
Title of Report:	Qualitative Risk Assessment of Coral Bay and the Proposed Coral Coast Resort Development	
Indexing Terms:	Coral Coast Resort, Coral Bay, Risk Assessment	
Summary:	A Qualitative Risk Assessment of Coral Bay as existing and also for the facilities proposed at Coral Coast Resort in terms of the risk to human life.	
Work Carried Out By:	Leonard Santana, Stephen Robertson & Stephanie de Grauw.	

DNV Project No.	**Prepared by:**	**Approved by:**
21310062	S.A. de Grauw	M.F. Cross

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Rev No	Issue Date	Reason for Issue	Prepared by	Approved by
0	18 June 01	Issue for comment	LJS	SJR
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2	22 June 01	Additional client comments incorporated.	SDG	MFC

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CONTENTS

APPENDIX I: RISK RANKING TABLE

EXECUTIVE SUMMARY

Coral Bay is a small coastal town located approximately 140 kilometres south of Exmouth and adjoins the Ningaloo Marine Park. Coral Bay exists mainly to service commercial, recreation and tourism activities such as coral viewing, fishing, snorkelling, diving and whale watching.

Coral Coast Marina Development Pty Ltd (CCMD) proposes to construct a resort – Coral Coast Resort (CCR) at Mauds Landing north of the existing Coral Bay settlement. Det Norske Veritas (DNV) have been engaged by CCMD to undertake a Qualitative Risk Assessment of Coral Bay to examine those areas of current risk that would be alleviated by Coral Coast Resort.

The hazardous events associated with the Coral Bay facilities have been identified and then ranked according to the risk to human life, and where necessary, the environment. An assessment of the reduction of the risk due to the proposed Coral Coast Facilities has then been conducted. The scope of the qualitative risk assessment was based on Coral Bay and the effect of the proposed controls at Coral Coast Resort on the settlement. The risks associated with the Coral Coast Marina Development were not assessed.

The significant hazards identified by the risk assessment are:

Human Life Hazards:	**Environmental Hazards:**
• Cyclone damage to infrastructure and buildings.	• Cyclone damage to maritime.
• Fire/Explosion within Public and Staff accommodation.	• Damage to Coral reef from boats.
• Traffic accidents.	• Landfill - Ground & water pollution.
• Obstacles/collision at the airstrip.	• Sewage.
• Fuel contamination at the airstrip.	• Storm Surge.
• Flooding of the airstrip.	
• Storm Surge.	

The Risk Assessment has identified a number of areas of considerable risk within the existing Coral Bay settlement, which have the potential to be exacerbated by additional development or increased population within the settlement.

Construction of the proposed Coral Coast Resort will reduce the level of existing risk within Coral Bay and further reductions could be achieved by the institution of proper management controls. The risks associated with the above mentioned hazards should be reviewed by all relevant parties involved to ensure the likelihood is reduced and procedures put in place to reduce or control the consequences of such events.

CCMD's commitment to establish Health, Safety, Quality and Environmental Management systems for Coral Coast Resort, which can be certified to International standards, is supported as it demonstrates management commitment to a safe and environmentally sustainable development.

1. INTRODUCTION

1.1 Background

Coral Bay is a small coastal town located approximately 140 kilometres south of Exmouth and adjoins the Ningaloo Marine Park. Coral Bay exists mainly to service commercial, recreation and tourism activities such as coral viewing, fishing, snorkelling, diving and whale watching. CCMD is committed to ensuring the proposed Resort meets international standards for health, safety and the environment. Coral Coast Marina Development Pty Ltd is also cognisant that the proposed CCR will alleviate current pressures within Coral Bay. DNV have been engaged by CCMD to undertake a Qualitative Risk Assessment of Coral Bay to examine those areas of current risk that could be alleviated by the proposed Resort.

1.2 Scope

The objective of this study is to determine the level of risks to human life due to the current facilities at Coral Bay for the following hazards:

- Coral Bay Airstrip
- Boats and Swimmers
- Sewage Effluent
- Water Supply and Equipment for Fire Fighting
- Staff Accommodation
- Police and Traffic Controls
- Public Accommodation

The level of risk was determined qualitatively. The effects on risks to human life for the same hazards at Coral Bay as a consequence of the construction of CCR were then determined. Any variations in risk levels between Coral Bay and the Coral Coast Resort Project were identified. Where environmental hazards associated with the above hazards were identified, then the level of risk for each hazard was assessed.

1.3 Abbreviations

AHD	Australian Height Datum
CALM	Conservation and Land Management
CASA	Commercial Air Safety Authority
CCMD	Coral Coast Marina Development Pty Ltd
CCR	Coral Coast Resort
DNV	Det Norske Veritas

2. METHODOLOGY

Public risk and safety was assessed using the Australian/New Zealand Standard AS/NZS 4360: 1999 "Risk Management". Terms and categorisations used in this document are the same as those in AS/NZS 4360.

2.1 Risk Management AS/NZS 4360:1999

Management of risk is defined by AS/NZS 4360 as an iterative process consisting of well defined steps which, taken in sequence, support better decision making by contributing a greater insight into risks and their impacts. The risk management process can be applied to any situation where an undesired or unexpected outcome could be significant or where opportunities are identified.

In general, risk management may be seen as a multifaceted process with appropriate aspects best being carried out by a multidisciplinary team.

Elements of risk management considered during this project included:

- Identification of risks for the existing Coral Bay facilities; what, why and how events can arise as a basis for further analysis.
- Identification of the effect on existing risks in Coral Bay with CCR; what, why and how events can arise as a basis for further analysis.
- Analysis of the risks; analysis of risks in terms of likelihood and consequence in the context of existing and proposed controls.
- Assessment and prioritisation of risks; through a process of risk comparison between Coral Bay as existing and with CCR, risks are ranked to identify management priorities.

2.2 Relative Risk Ranking

Risk is usually considered as a function of likelihood (frequency of event) and consequence (severity).

Relative ranking is a qualitative evaluation of relative criticality. This should not be confused with issues relating to acceptability of risk or not. Evaluation of acceptability of risk is outside the scope of this report. Relative ranking assists with the prioritisation of activities to reduce potential adverse risk impacts.

The relative rank of events identified in each subdivision was determined through direct multiplication of the likelihood and severity.

Where relative risk ranks have been calculated for multiple segments the segment with the highest relative risk has been reflected in the risk matrix in Appendix I.

The following categories have been adopted to allow relative ranking of identified risks.

TABLE 2-1: LIKELIHOOD CATEGORIES FOR RISK ASSESSMENT

CATEGORY		LIKELIHOOD
SCORE	RATING	
1	Rare	Event may occur but only under exceptional circumstances. Occurs once every 1,000 – 10,000 years
2	Unlikely	Event could occur at some time. Occurs once every 100 – 1,000 years.
3	Possible	Event should occur at some time. Occurs once every 10 – 100 years.
4	Likely	Event will probably occur in most circumstances. Event does occur, has a history, occurs once every 1 – 10 years.
5	Almost Certain	Event expected to occur in most circumstances. High frequency of occurrence – occurs more than once per year.

TABLE 2-3: CONSEQUENCE CATEGORIES FOR RISK ASSESSMENT

LEVEL		HUMAN LIFE	ENVIRONMENT
SCORE	RATING		
5	Catastrophic	Multiple fatalities or significant irreversible human health effects to >50 persons.	Catastrophic, long term environmental harm.
4	Major	Single fatality and/or severe irreversible disability or impairment to one or more persons.	Major release of pollutants. Significant, long term environmental harm.
3	Moderate	Irreversible disability or impairment to one or more persons.	Significant release of pollutants. Measurable environmental harm, with mid-term recovery.
2	Minor	Injuries requiring medical treatment. Reversible disability/impairment.	Transient release of pollutants. Minor/transient environmental harm. Required to inform EPA/other Environmental Regulators.
1	Insignificant	Low level short-term inconvenience or symptoms. No injuries or medical treatment.	Brief transient pollution with no environmental harm. Not required to inform EPA/other Environmental Regulators.

Consequences are divided into the categories of human life and environment; whichever may be applicable to the hazardous event.

Indicative levels of risk determined the risk level. When comparing the values in the risk matrix at the extremes, a value of "25" in the risk matrix (refer to Table 2-5) indicates a hazardous event that is expected to occur in most circumstances and that has potentially catastrophic consequences. A value of "1" in the risk matrix indicates a hazardous event that may occur but only under exceptional circumstances and has potentially insignificant consequences.

In other cases a value of "9" in the risk matrix indicates that the hazardous event should occur at some time but have moderate consequences. A value of "16" in the risk matrix indicates a hazardous event that will probably occur in most circumstances with potentially major consequences.

The hazards identified for the existing Coral Bay facilities and the effect of the proposed Coral Coast Resort facilities have been assessed for likelihood and consequence with regard to the identified controls that either exist for Coral Bay, or are included in the CCR proposal. This information has been tabulated in worksheets consisting of the hazard number, hazard description, possible consequences, the existing or proposed controls, comments, and the risk ranking results. These tables are documented in Appendix I.

It should be noted that the levels of consequence and frequency are broad and therefore the level of risk determined is broadly based. For example, the consequence level for multiple fatalities is the same for 2 or 100 fatalities.

A broad based risk assessment is appropriate at the early stages of a project so as to identify those hazardous events that warrant detailed analysis and risk reduction considerations.

TABLE 2-5: RISK RANKING MATRIX

LIKELIHOOD / CONSEQUENCE	RARE (1)	UNLIKELY (2)	POSSIBLE (3)	LIKELY (4)	ALMOST CERTAIN (5)
INSIGNIFICANT (1)	1	2	3	4	5
MINOR (2)	2	4	6	8	10
MODERATE (3)	3	6	9	12	15
MAJOR (4)	4	8	12	16	20
CATASTROPHIC (5)	5	10	15	20	25

2.3 Site Visit

In order to determine the extent of the hazardous events associated with the existing Coral Bay facilities, DNV undertook a site visit on 14 May to 16 May 2000. The site visit consisted of interviewing key personnel, residents, inspection of various buildings, services and activities within Coral Bay and specifically:

- Exmouth Police Station
- CALM (Conservation and Land Management)
- Commercial/Recreational Vessel Operators
- Bayview Coral Bay Caravan Park and Peoples Park Caravan Village
- Bayview Backpackers
- Airstrip
- Landfill Site
- Service Station
- Filtration evaporation ponds
- Power Station
- Residential Housing Estate (Lot 46 and 52)
- Ningaloo Reef Resort Hotel
- Bills Bay
- Coral Bay Shopping Centre
- Mauds Landing
- Proposed Services Area

2.4 Sources of Data and Associated Documentation

The following information has been reviewed in the assessment:

- Structure Plan Coral Coast Resort Mauds Landing (Reference 1).
- Coral Coast Resort Public Environmental Review Documents (References 2 and 3).
- Saleeba Adams Architects risk issues associated with Category 5 Cyclones (Reference 4).
- Pro Micro Pty Ltd Microbiological Water Report (Reference 5).
- Caravan Parks and Camping Grounds Regulations (Reference 6).
- MP Rogers and Associates Pty Ltd- Design Parameters and Management Documentation (Reference 7).

- Ningaloo News articles (Reference 8).
- Gascoyne -Murchison, Climatic Survey, Bureau of Meteorology (Reference 9).
- Extract from Gascoyne Coast Regional Strategy (Reference 10).
- Photographs of Coral Bay.
- AS/NZS 4360:1999- Risk Management (Reference 11).

3. ASSUMPTIONS

In determining the level of risk for each identified hazard, the following assumptions were made.

- All commercial, community and domestic buildings within Coral Coast Resort be designed to withstand Category 5 cyclones in the Region and capable of accommodating all residents of Coral Bay in the event of a severe cyclone.
- The provision of infrastructure facilities will be staffed by appropriate personnel, for example, police station and police officers.
- The Coral Coast Resort will provide volunteer-based emergency services, such as fire and emergency services, nursing station and first aid, sea search and rescue, able to also assist people in Coral Bay in the event of an emergency.
- The construction of the marina facilities will result in the majority of boating activities being shifted from Bills Bay to the marina.
- The construction of a boat launching facility in the North Bills Bay Sanctuary zone is unlikely due to environmental problems and the impact of breakwater construction.
- The Government will close Bills Bay to all boats except those operating as coral reef viewing boats.
- The inclusion of safe swimming and snorkelling facilities within the marina will reduce overcrowding at Coral Bay during periods of peak visitor demand.
- CCMD will relocate the existing airstrip and comply with CASA requirements including the nomination of a reporting officer for the relocated airstrip.
- The deep sewage and wastewater treatment plant will have provision for upgrading to accommodate the connection to Coral Bay.
- The proposed services area will provide bulk storage for fuels and chemicals in bunded areas.
- Some staff from Coral Bay will be accommodated in the new resort development, i.e. business and commercial operators relocating to CCR.
- A two-man Police Station will be provided at CCR for law enforcement. An Environmental Centre will also be provided to accommodate full-time CALM and Fisheries WA officers.
- A landfill site with a site area to provide a minimum 25 years capacity will be established in accordance with the requirements of the Shire and Waste Management WA. Services will be sized to accommodate service and waste disposal requirements of the Coral Bay town site.

The derivation of the results is also based on the assumption that controls such as a Safety Management System, Risk Based Assessment, and an Environmental Management Plan are implemented as soon as CCR commences. For the validity of the results to show a reduction in the risk of Coral Bay facilities resulting from CCR facilities, these controls must be verified during the design, construction, commissioning stages of the project and throughout the life of the project. The controls should also be certified where applicable to standards such as ISO 9001, ISO 14001 and OHSAS 18001.

The population of Coral Bay during peak season and the 'off' season is important when determining the number of people exposed to the hazards for the existing Coral Bay facilities and how this will be reduced when the Coral Coast Resort comes into operation. The daily population of Coral Bay at peak times during school holidays and Easter is approximately 2,500 people (Reference 10). It is estimated that this may be closer to 3000 people in peak season with approximately 100 permanent residents. The Coral Coast Resort, based on 80% average peak occupancy, has an estimated total population at full development of approximately 2025 persons, comprising 1330 tourists and 695 residents and staff.

4. RESULTS

The following tables summarise the risk ranking results for the existing facilities of Coral Bay and the effect on current risk levels of the proposed Coral Coast Resort. The scope of the project was to identify the risk to human life, but as some hazards had a significant environmental impact, they were also included in the assessment.

The tables below summarise the risk ranking results from the detailed worksheets provided in Appendix I. Table 4-1 summarises the risk ranking results for human life and Table 4-2 summarises the risk ranking results for the environment.

TABLE 4-1: SUMMARY OF RISK RANKING RESULTS FOR HUMAN LIFE

HAZARD	Existing Coral Bay Facilities Risk Ranking	Coral Bay Facilities with Proposed Coral Coast Facilities Risk Ranking	Risk Reduction (Y/N)
Cyclones – Damage to Infrastructure	20	16	Y
Cyclones – Damage to Buildings	20	16	Y
Staff Accommodation/Caravan Parks - Fire/Explosion Hazard	20	15	Y
Public Accommodation (Hotels/Backpackers) - Fire/Explosion Hazard	20	16	Y
Police & Traffic Controls - Caravan Park	16	16	N
Police & Traffic Controls- Public Road	16	12	Y
Airstrip - Flooding	16	8	Y
Airstrip – Obstacles/Collision	15	10	Y
Airstrip - Fuel Contamination	15	10	Y
Cyclones - Storm Surge	15	12	Y
Coral Bay Beach / Boat Channel – Collision Between Boats & Swimmers	12	8	Y
Coral Bay Beach / Boat Channel – Sharks	12	8	Y
Sewage Effluent - Health Hazards	9	6	Y
Airstrip - Fuel Fire	9	6	Y
Coral Bay Beach / Boat Channel – Exposed beach Moorings, Chains or Ropes	8	4	Y

TABLE 4-2: SUMMARY OF RISK RANKING RESULTS FOR ENVIRONMENT

HAZARD	Existing Coral Bay Facilities Risk Ranking	Coral Bay Facilities with Proposed Coral Coast Facilities Risk Ranking	Risk Reduction (Y/N)
Cyclones – Damage to Maritime	20	16	Y
Coral Bay Beach / Boat Channel – Damage to Coral Reef from Boats	20	4	Y
Landfill - Ground & Water Pollution	16	8	Y
Sewage – Environmental Impact	16	8	Y
Cyclones - Storm Surge	15	9	Y
Airstrip - Soil Contamination	10	4	Y

5. DISCUSSION OF RESULTS

The results of the Risk Ranking Tables are reviewed in this section in terms of the hazards associated with the existing Coral Bay facilities, the effect that the proposed Coral Coast facilities will have on Coral Bay, and the conclusions. The hazards are reviewed in the order of risk ranking level as shown in Table 4-1.

5.1 Cyclones

The North West Cape/Exmouth region is vulnerable to Category 4 and 5 cyclones which have winds in excess of 225 km/h. From 1910 to 1997, over 40 cyclones affected the Gascoyne coastline, i.e. on average one cyclone will affect the North West Cape/Exmouth region every 2 to 3 years. Of these, approximately 25 crossed the coast. Cyclones have occurred from December to May although they are most frequent in February and March. The cyclone records show that in the period 1964 to 2000, 7 Cyclones were category 3 or more and approached the western side of Coral Bay. This equates to one severe cyclone on an adverse track approximately every 5 years.

5.1.1 Buildings and Infrastructure

The buildings and infrastructure at the Coral Bay settlement may be vulnerable to cyclone damage. A preliminary review of the buildings considered that it is doubtful that buildings are designed for a Category 5 cyclone rating (Reference 4). Power is provided by above ground power poles, which are well known to be able to weather a cyclone.

During the site visit it was observed that many windows are without cyclone shutters and many buildings have structures that are not securely fastened. Further, there is a lack of refuge or a designated assembly point capable of withstanding a severe cyclone (Reference 4).

In times of heavy rainfall, it is reported that Coral Bay is isolated and the roads to Carnarvon and other areas are cut off by flooding. Disaster, evacuation and recovery plans were not available for review during the site visit and this assessment. Residents reportedly indicated that they were not aware of any formal emergency plans. There were no boat ramp facilities or facilities for the protection of boats.

CCMD will provide a number of control measures to reduce the potential damage to infrastructure and human life during cyclones. These are:

- An underground power supply.
- Assembly areas.
- Formal Emergency and Disaster Recovery plans and procedures.
- Buildings designed to withstand Category 5 cyclones.
- Trained Fire and Emergency services.
- Nursing Station and First Aid.
- Sea Search and Rescue teams.
- The construction of the inland marina with provision of marina facilities for secure anchorage of vessels. This will also allow the majority of boating activities to be shifted from Bills Bay.

- Formal boat ramps to allow boats to be taken out of the water and moved to the services area and tied down in the event of a cyclone.

The above services will be available to assist the people of Coral Bay evacuate to a safe area in the event of a cyclone, which would therefore reduce the risk of injury and the number of fatalities. However, the inherent risk of a Category 5 cyclone would still result in the destruction of existing buildings and infrastructure within Coral Bay.

5.1.2 Storm Surge (Ocean Flooding)

Storm surge is potentially a destructive aspect of a tropical cyclone, which is capable of inundating low lying coastal areas such as the Coral Bay settlement. It is experienced as an increase in the tide level and occurs from a combination of low pressure and high winds. In addition to the normal tidal variation, the height of the surge also depends on the cyclone's intensity, the shape of the coastline and sea-bed, the orientation of the coastline and the angle of the cyclone to the shore. The worst conditions arise when the surge peak coincides with high tide.

Much of the existing development at Coral Bay is significantly lower than the minimum ocean side storm surge development level proposed for the Coral Coast Resort of 4.7m AHD (Australian Height Datum). The AHD of power generation, sewage treatment and water supply within Coral Bay is considered to be potentially less than the High Tide Level and so these critical infrastructure facilities may be susceptible to inundation in storm surge.

CCMD will provide a number of control measures to reduce the potential damage to infrastructure and loss of human life from a storm surge.

- The final finished floor levels will be 6.0m above AHD (Ocean side) and 3.65 m above AHD (lagoon side). This would be above the water levels caused by a cyclone of similar category to Vance (Category 5) in the region.
- Design of resort structures and buildings will meet 1 in a 100-year return period storm event with contingencies.
- If requested, the existing settlement of Coral Bay could be connected to the new sewage treatment plant, which will alleviate any pollution in to the bay.

The above services will be available to assist the people of Coral Bay evacuate to a safe area in the event of a cyclone, which would therefore reduce the risk injury and the number of fatalities. However, the inherent risk of a storm surge in the area of Coral bay would still result in damage to infrastructure.

5.2 Public Accommodation (Hotels/Backpackers) - Fire/Explosion Hazard

A visit of the hotel and backpackers highlighted a lack of controls that may contribute to a fire/explosion hazardous event. The lack of fire blankets in the rooms (for the stoves), the absence of an emergency evacuation plan or display of emergency numbers, and evidence of fire equipment not being maintained, may contribute to a fire/explosion hazard. Other scenarios where this hazardous event could occur involve fuel drums, gas cylinders, barbecues, bush fires, and general occupancy at the area.

Fire fighting equipment, such as fire hoses and extinguishers, were available as well as a mobile fire truck, however there was no evidence of a maintenance and inspection program for these items of equipment. Currently the SES Volunteer group are the first point of call in an emergency.

It is reported that residents are not aware of designated assembly areas in the event of a fire and/or natural disasters.

CCMD will provide a number of control measures to reduce the potential for a fire/explosion such as:

- A services area with the provision for bulk storage of fuels and chemicals in bunded areas as per relevant Australian Standards and WA Legislation.
- Equipped and trained volunteer-based emergency services personnel to be provided to assist with fire scenarios.

The risk of a fire/explosion may be reduced with above control measures in place, however the level of risk is still significant, i.e. the event is still likely to occur with the potential for major consequences (a single fatality).

5.3 Staff Accommodation/Caravan Parks – Fire/Explosion Hazard

A visit of the staff accommodation at one of the caravan parks highlighted a lack of controls that may contribute to a fire/explosion hazardous event. The lack of firebreaks not being maintained, the lack of a maintenance and inspection program for fire hoses and extinguishers, and a lack of a formal fire management plan, may contribute to a fire/explosion. Other scenarios where this hazardous event could occur involve fuel drums, gas cylinders, barbecues, bush fires, and general occupancy at the area.

The control measures proposed by CCMD to reduce the potential for a fire/explosion are listed in Section 5.2.

The risk of a fire/explosion may be reduced due to the control measures in place, however the level of risk is still significant, i.e. the event should occur at some time with the potential for catastrophic consequences (multiple fatalities). The number of fatalities, however, may be reduced as some staff will be accommodated in the new Coral Coast Resort development. Tourists may also choose to stay in the accommodation at Coral Coast Resort, reducing the amount of overcrowding at the caravan parks.

5.4 Sewage Effluent into Coral Bay – Health Effects

Effluent disposal for the Coral Bay settlement is via septic tanks, leach drains and evaporation ponds.

A visit to the filtration evaporation ponds on the north side of the town site revealed effluent overflowing from the dams into the nearby environment. The septic tanks are reported to have overflowed on several occasions, particularly during the peak season. Samples taken from the beach, although showing minor ecoli/coliform counts, indicated that there has been faecal contamination (Reference 5). From this information it is possible that sewage is leaching from the septic tanks in the caravan parks into Bills Bay, elevating the nutrient levels and potentially affecting people's health. It was also noticed that there are no ground water bores for water quality monitoring.

CCMD will construct a sewage treatment plant approximately two kilometres inland of Coral Bay. The plant will provide deep sewage and wastewater treatment to service the Mauds Landing town site, with provision for upgrading to accommodate the connection to Coral Bay. Other control measures include:

- A series of groundwater monitoring bores established prior to construction to commence the characterisation of the superficial groundwater quality.

- A shallow groundwater-monitoring program developed prior to construction to establish a baseline. This will continue for 5 years post operation followed by a review.
- The development of contingencies for failures in containment within the services and town site areas.
- A sewage pump-out facility in the Marina, which includes the requirement of all boats with onboard sullage tanks, to discharge to the facility.

The above controls will not eliminate the existing leaching from the septic tanks and leaching drains. Assuming that Coral Bay is connected to the proposed sewage treatment plant the risk level will be reduced, i.e. the probability that Coral Bay will be exposed to health and environmental effects due to sewage effluent is unlikely.

5.5 Police and Traffic Control

The public road runs along the foreshore of Coral Bay with the caravan parks, hotel shopping centre, first aid post, commercial operators and housing settlement on either side. There is a potential hazard of vehicle and pedestrian collisions as pedestrians cross the road to access the beach, shopping amenities or commercial operators. Current controls are signage and a speed limit of 25 kph, with reportedly minimal (if any) law enforcement.

There is no police station in close proximity to Coral Bay and police officers from Exmouth visit Coral Bay approximately once per month for the day. In an emergency the response time by Exmouth Police is approximately one and half-hours.

The proposed CCMD development, if requested by the Government, will provide a two-man Police Station, with accommodation and lock up, for law enforcement at CCR and Coral Bay. There is still inherent risk associated with vehicle and pedestrian collisions at Coral Bay but the likelihood of incidents would be expected to be reduced due to the permanent police presence.

From the two Caravan Parks visited, it was observed that one has little traffic controls in place. The second Caravan Park has a number of controls to reduce traffic problems, such as speed humps, a 5-kilometre per hour speed restriction, signage and controlled access boom gates.

The proposed CCMD development will have no direct influence on the traffic hazards at the Caravan Parks; i.e. the risk level will remain unchanged. However, the number of fatalities may be reduced as some staff and tourists will be accommodated at the Coral Coast Resort, decreasing the amount of overcrowding at the caravan parks.

5.6 Coral Bay Airstrip

The hazardous events that were identified for the Airstrip are obstacles/collision, flooding, fuel and soil contamination, and fire/explosion.

5.6.1 Obstacles/Collision

The presence of obstacles such as waste material, kangaroos, goats and emus on the airstrip has the potential to damage an incoming or outgoing aircraft and cause fatal injuries to the occupants onboard.

Although the airstrip is classified as an authorised landing area, the existing situation shows that there is no responsibility taken for the airstrip, hence there is little control over who enters it or the activities that occur there. In addition to this there is a lack of security fencing and patrols to limit access to the airstrip and a lack of signage to prohibit public access to the airstrip.

CCMD propose to extend or relocate the existing airstrip and take responsibility for insurance, management and maintenance to CASA standards. As a minimum, the front area of the airstrip would be fenced off to limit access to the site.

The risk level will be reduced slightly as the damage to aircraft and injury to passengers due to an obstacle on the airstrip is unlikely to occur if the proposed control measures are put in place.

5.6.2 Flooding

The airstrip is situated on a salt pan and a flat terrain that does not allow for rapid evaporation or drainage of rainwater. Currently the pilot of the aircraft assesses the condition of the airstrip from the air before landing. There is no formal control reliance on contacting a specific individual at Coral Bay with regard to weather information provided by the Bureau of Meteorology.

CCMD propose to extend or relocate the existing airstrip and take responsibility for insurance, management and maintenance to CASA standards. If flooding of the airstrip occurs, the airstrip would be closed as per CASA requirements.

The risk level will be reduced as the damage to aircraft and injury to passengers due to flooding of the airstrip is unlikely to occur if the proposed control measures are put in place.

5.6.3 Fire/Explosion & Contamination

Whilst undertaking a site visit of the airstrip, a number of hazardous events were observed with regard to the storage of fuel. These observations included: unsecured fuel drums located outside in an unbunded area, lack of segregation between the different types of fuels (e.g. jet fuel and boat fuel), lack of fire fighting and spillage clean-up equipment or safety/precautionary signs, such as “No Smoking” signs near the fuel drums, the lack of scheduled inspections of the airstrip site and the absence of a reporting officer. These lack of controls may lead to a fire or explosion, a plane disaster due to jet fuel contamination, and contamination of soil.

CCMD propose to extend or relocate the existing airstrip and take responsibility for insurance, management and maintenance to CASA standards, as well as providing lock-up facilities, fire fighting and spillage clean-up equipment, signage, bunding and approved storage facilities.

With the above control measures in place, the level of risk associated with a fire/explosion, fuel contamination and soil contamination will be reduced, i.e. the probability of these scenarios occurring is unlikely.

5.7 Coral Bay Beach / Boat Channel

The hazardous events that have been determined for the Coral Bay Beach / Boat Channel area are collision between swimmers/snorkellers and marine traffic, injuries due to beach moorings, chains and ropes, shark attacks, and damage to the coral reef.

5.7.1 Boats and Swimmers

The majority of snorkelling/swimming occurs off the west and north west facing beaches within the boating corridor or channel. Swimmers and snorkellers utilise this area during daylight hours and there can be up to fifty swimmers/snorkellers in the channel waters at peak times.

The number of recreational vessels may vary during the peak winter months and it is estimated that an average of 20-30 recreational vessels access this area, peaking at 50

vessels during school holidays. The number of commercially operated vessels moored in the bay at the time of the site visit was approximately 10 -12 vessels. A few fishing boats were also seen in the vicinity.

At the time of the site visit there were no records from the first aid post indicating that there had not been incidents where boats had caused injuries to swimmers and snorkellers; however, there is antidote evidence from residents indicating that there have been incidents or near misses in the past that have been unreported.

A safe swimming area on the south-east side of the bay is marked by yellow markers to prohibit vessels from entering the area. During the site visit it was noticed snorkellers were swimming off the west and north-west facing beaches, an area within the vessel traffic corridor. It is reported that coral is more abundant in this area.

On the beach there is signage to make boaters and swimmers more aware of their presence in the bay, however the signs are not visible from all locations on the beach. Beacons indicating a 5-knot speed limit are also located in the channel.

CCMD will provide a number of control measures to reduce the risk associated with swimmers and boats. These are:

- Funding to support a regulatory agency function.
- Construction of an inland marina with provision of marina facilities that will allow the majority of boating activities to be moved from Bills Bay.
- Inclusion of safe swimming and snorkelling facilities within the marina.

With the additional control measures in place, the risk level will be reduced for those using the marina. There will be continued risk to personnel using the beach at Bills Bay. However, the total risk is expected to reduce, as the total number of people exposed to this hazard will decrease. This is due to a significant percentage of people currently using Coral Bay electing to use the Facilities at the Coral Coast Resort.

5.7.2 Beach Moorings/Chains or Ropes

Beach moorings, chains and ropes are exposed during low tides, which may pose a danger to people walking in this area. The beach is used for launching boats; i.e. there is no separate boat launching facility with restricted access. As the Bills Bay Sanctuary is protected, it is unlikely that a boat launching facility will be developed due to environmental problems and the impact of breakwater construction (Reference 2).

CCMD proposes to construct an inland marina with provision of marina facilities that will allow the majority of boating activities to be moved from Bills Bay, hence reducing the risk level, i.e. it is unlikely that an injury will occur.

5.7.3 Sharks

There has been no reported shark attacks in Coral Bay. Experienced fishermen at Coral Bay reportedly indicated that sharks have been sighted in the Bills Bay area, particularly at dusk and dawn.

It is reported that commercial and recreational vessels have been sighted throwing fillets and offal into the water , which would attract sharks to this area. As there are no shark nets at Coral Bay there is a possibility that a shark attack could occur.

CCMD will provide a protected beach with shark nets at the proposed resort. Relocation of commercial and recreational vessels from Bills Bay to the new facilities will reduce the risk

of sharks being attracted to this area. The exposed populations at risk, based on current estimates, will therefore be reduced with people and boats using the new facilities.

5.7.4 Damage to the Coral Reef

There is no full time control over the marine traffic on the Coral Bay marine waters.

Anchor drops, anchor or boat dragging damaging coral were observed during the boat trip at Bills Bay. Further evidence of this was also observed on video footage and photographs of damaged coral reef. As the Bills Bay Sanctuary is protected, it is unlikely that a boat launching facility will be developed due to environmental problems and the impact of breakwater construction (Reference 2). Anchors, and vessels will continue to damage the coral unless controls are implemented.

CCMD will provide a number of control measures to reduce the risk associated with damage to the reef caused by vessels. These are listed in Section 5.7.1.

With the additional control measures in place, the risk will be significantly reduced; i.e. the probability of vessels damaging the coral reef is unlikely with minor environmental harm.

5.8 Landfill

The existing landfill site is situated outside the Coral Bay settlement. It is a general waste site, using the trench method to bury the waste. There is no evidence that the landfill site is lined. The landfill site consists of designated areas for different types of solid waste, however much of the waste is not covered and there is little compaction of the waste materials. There is no evidence of a water-monitoring program on the site, i.e. boreholes, leachate or storm water management. There is the potential that leachate will enter the water table and eventually migrate into Bills Bay.

CCMD will provide a number of control measures to reduce the potential environmental damage to Coral Bay. These include:

- A landfill site with a site area to provide an estimated minimum 25 years' capacity established according to the requirements of the Shire of Carnarvon and Waste Management WA.
- A service area sized to accommodate service and waste disposal requirements of the existing Coral Bay town site.

Therefore, it can be concluded that with the proposed closure of the existing Coral Bay sanitary landfill site and its relocation to the services area, the pollution risk levels to Coral Bay will be reduced, i.e. the probability that ground and water pollution will occur is unlikely.

6. PROPOSED HEALTH, SAFETY & ENVIRONMENTAL MANAGEMENT SYSTEMS

It is proposed that health; safety and environmental management plans for CCR will comply with OHSAS 18001 and ISO 14001. This system will facilitate the management of the Occupational Health, Safety and Environmental risks associated with the business of CCR. This includes the organisational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the proposed Occupational Health, Safety and Environmental policy.

In order to eliminate, reduce, control and manage the identified risks and possible impacts the HSE management system to be developed will:

- Establish and maintain procedures for the ongoing identification of hazards and impacts, the assessment of risks, and the implementation of necessary control measures. These include design and construction; the operational activities of all personnel having access to the workplace including subcontractors and visitors; facilities at the workplace whether provided by CCMD or others.
- Establish and maintain a procedure for identifying and accessing the legal and other Occupational Health, Safety and Environmental requirements that are applicable to it and keep this information up to date.
- Establish Occupational Health, Safety and Environmental objectives.
- Maintain an Occupational Health, Safety and Environmental programme(s) for achieving its objectives.
- Provide the structure and resources with roles, responsibilities and authorities of personnel who will manage, perform and verify activities having effect on Occupational Health, Safety and Environment.
- Provide training and awareness of all risks and impacts.
- Ensure that procedures are established for the dissemination of Health, Safety and Environmental information to employees and other interested parties.
- Establish and maintain procedures for controlling all documents and data required by the standards.
- Establish and maintain plans and procedures to identify the potential for and responses to incidents and emergency situations, and for preventing and mitigating the likely illness, injury or environmental impact that may be associated with them. Specific emergency plans and response for example to cyclones, fire, floods, continuity of services, boat moorings etc.
- Review plans and procedures after the occurrence of incidents or emergencies and periodically test procedures where practicable.
- Establish and maintain procedures to monitor and measure HSE performance on a regular basis.
- Provide procedures for the handling, investigation of incidents and accidents including corrective and preventive actions.
- Establish procedures for the identification, maintenance and disposition of HSE records as well as the results of audits and reviews.

- Develop an audit program and procedures for periodic HSE management system audits to be carried out.
- Review the HSE management system to ensure its continuing stability, adequacy and effectiveness and commitment to continual improvement at appropriate intervals.

7. CONCLUSION

The review has established that significant risks exist within the Coral Bay settlement and that the overall level of risk to human life due to the hazards listed in this report is reduced as a consequence of the proposed Coral Coast Resort and associated facilities and services.

This is primarily due to the additional preventative and mitigative risk reduction control measures that are incorporated into the CCR proposal. Although it is recognised that the Coral Bay facilities will continue to function along side the CCR facilities, and therefore there is an element of inherent risk associated with the Coral Bay facilities that could not be mitigated by CCR. However, it is considered that the number of people exposed to these inherent risks will be reduced when the CCR facilities are available.

It is significant to note also that further reductions to risk within Coral Bay could be achieved by the respective authorities through the preparation and implementation of appropriate management measures, such as Emergency Evacuation Plans for cyclones.

The risks identified within the existing settlement need to be addressed and procedures put in place to ensure that the likelihood of occurrence and the consequences of the event are reduced.

CCMD is committed to ensuring the proposed Resort meets international standards for health, safety and the environment and has engaged DNV to advise on management systems. The design philosophies which have been adopted for Coral Coast Resort are in accordance with good practice and management systems can be implemented which would ensure that CCR complies with international benchmarks, such as OHSAS 18001 and ISO 14001.

8. REFERENCES

1. "Structure Plan Coral Coast Resort Mauds Landing, Executive Summary", October 2000.
2. "Coral Coast Resort Public Environmental Review Document Volume 1", November 2000.
3. "Coral Coast Resort Public Environmental Review Appendices Volume 11", November 2000.
4. "Saleeba Adams Architects", 2 May 2001-05-31.
5. Pro Micro Pty Ltd, "Microbiological Water Report", 26 February 2001-05-31.
6. "Caravan Parks and Camping Grounds Regulations", 1997.
7. MP Rogers and Associates Pty Ltd, "Design Parameters and Management", 9 March 2001-05-31.
8. Ningaloo News articles, April and May 2001.
9. Bureau of Meteorology, Western Australia, "Gascoyne - Murchison Climatic Survey", October 1998.
10. Extract from Gascoyne Coast Regional Strategy, March 1996.
11. AS/NZS 4360:1999- Risk Management.

APPENDIX I
RISK RANKING TABLES

APPENDIX I: RISK RANKING TABLE - EXISTING FACILITIES CORAL BAY RISK RANKING AND PROPOSED FACILTIES CORAL COAST RESORT

EXISTING FACILITIES – CORAL BAY

Area: Coral Bay Airstrip

Date: 14/05/2001

Hazard No.	Hazard Description	Possible Consequences	Existing/Lack of Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
1	Obstacles on the airstrip, such as waste material, kangaroos, goats, and emus. Collision with obstacles.	• Damage to aircraft and passenger fatalities. • Damage to the airstrip by wildlife and humans (vandalism).	• No security fencing or control/ patrols to limit access to the airstrip. • No signage to indicate that people are not permitted on site. • No scheduled inspection of the airstrip. Pilots check the conditions before landing or take off. • No reporting officer.	• Classified as an Authorised Landing Area. • No one accepts liability or responsibility for the airstrip. (Baiyungu Aboriginal Corporation are the owners of the land).	3	Human Life 5	**15**

PROPOSED FACILITIES – CORAL COAST

Area: Coral Bay Airstrip

Date: 14/05/2001

Hazard No.	Hazard Description	Consequences	Existing/Proposed Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
1	Obstacles on the airstrip, such as waste material, kangaroos, goats, and emus. Collision with obstacles.	Damage to aircraft and passenger fatalities. Damage to the airstrip by wildlife and humans (vandalism).	• Relocation of the existing airstrip and provision of safe access to the homestead and controlled public access to the airstrip, **however the airstrip will not be fenced.** (Interim measure until a new airport is established.) • Air strip to be extended or relocated with advice from Connell Wagner and to the approval of the Baiyungu Aboriginal Corporation and Cardabia Pastoral Station. • CCMD will comply with CASA requirements including the function of reporting officer.	Alternatively, the strip could be nominated as a public airstrip, such as an ALA, registered airstrip or licensed airstrip. CCMD would assume responsibility for insurance, management and maintenance to CASA standards. Regional Airport Development of Transport Scheme (RADS) may have funding available to fence the relocated airstrip.	2	Human Life 5	**10**

Hazard No.	Hazard Description	Consequences	Existing/Proposed Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
			• Third parties will be allowed to use the Cardabia airstrip under practices to be established by BAC, CCMD and Connell Wagner, which will include safety, access, refuelling and cleanliness. • No structures or hangars will be permitted. • Subject to advise from Conell Wagner and Transport, the strip could be classified as a private strip, with a third party users agreeing to conditions of use to be set by BAC and CCMD.				

EXISTING FACILITIES – CORAL BAY

Area: Coral Bay Airstrip

Date: 14/05/2001

Hazard No.	Hazard Description	Possible Consequences	Existing/Lack of Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
2	Flooding.	Damage to aircraft and a single fatality and/or serious injury to occupants.	• No formal control reliance on contacting a specific individual at Coral Bay with regard to weather information provided by Meteorology office. • Airstrip on a salt pan, Flat terrain water does not evaporate or drain easily. • Air pilot to assess the situation by flying over the airstrip and check the strip from the air before landing.	Difficult to detect at night-time. Flooding may close airstrip for some time.	4	Human Life 4	**16**

PROPOSED FACILITIES – CORAL COAST

Area: Coral Bay Airstrip

Date: 15/05/2001

Hazard No.	Hazard Description	Consequences	Existing/Proposed Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
2	Flooding.	Damage to aircraft and a single fatality and/or serious injury to occupants.	• Air strip will be extended or relocated with advice from Connell Wagner and to the approval of the Baiyungu Aboriginal Corporation and Cardabia Pastoral Station. • Third parties will be allowed to use the Cardabia airstrip under practices to be established by BAC, CCMD and Connell Wagner, which will include safety, access, refuelling and cleanliness.	Should flooding occur the airstrip would be closed as per CASA requirements.	2	Human Life 4	**8**

EXISTING FACILITIES – CORAL BAY

Area: Coral Bay Airstrip

Date: 14/05/2001

Hazard No.	Hazard Description	Possible Consequences	Existing/Lack of Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
3	Fire/explosion	Moderate injury. Damage to property.	• No fire equipment or safety/precautionary signs available on the site.	No jet fuel supply at Coral Bay, only petrol provided.	3	Human Life 3	**9**
	Fuel Contamination	Jet fuel contamination may lead to an aircraft crash. Potential for multiple fatalities.	• No secure facilities.	Jet fuel supplied at Exmouth and Carnarvon.	3	Human Life 5	**15**
	Soil Contamination	Minor environmental harm.	• No bunding however drums placed horizontally on trailers. Evidence of some spillage on the ground. • No spillages clean up kit. • No designated /segregation between types of fuel.		5	Environment 2	**10**

PROPOSED FACILITIES – CORAL COAST

Area: Coral Bay Airstrip

Date: 14/05/2001

Hazard No.	Hazard Description	Consequences	Existing/Proposed Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
3	Fire/explosion	Moderate injury. Damage to property.	• Fire equipment and signage to be provided.		2	Human Life 3	**6**
	Fuel Contamination	Jet fuel contamination may lead to an aircraft crash. Potential for multiple fatalities.	• Lock up facilities to be provided.		2	Human Life 5	**10**
	Soil Contamination	Minor environmental harm.	• Bunding and approved storage facilities to be provided (spill emergency kit).		2	Environment 2	**4**

EXISTING FACILITIES – CORAL BAY

Area: Coral Bay Beach / Boat Channel: Boats and Swimmers

Date: 15/05/2001

Hazard No.	Hazard Description	Possible Consequences	Existing/Lack of Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
1	Collision between snorkellers and marine traffic.	Single fatality and/or serious injury.	• Currently there is signage on the beach indicating boaters and swimmers to look out for each other at the vessel launching area and lookout point.	Not effective as marine vessels and swimmers do not necessarily see the signage. No information for the public on what the yellow markers are for.	3	Human Life 4	**12**

Hazard No.	Hazard Description	Possible Consequences	Existing/Lack of Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
			• There is a gazetted "vessels prohibited area", for safe swimming, is marked by yellow markers on the south east side of coral bay. • There is a gazetted 5-knot speed zone.	Majority of the swimmers and snorkellers tend to swim off the west and north-west facing beaches within the vessel traffic corridor because there is more coral to view in this area. Some vessels observed entering the channel at high speed before slowing down. The boating channel is not clearly marked. It was mentioned that some divers use a flagged buoy however this was not observed during the visit. There have been a number of near misses involving boats and swimmers.			

PROPOSED FACILITIES – CORAL COAST

Area: Coral Bay Beach / Boat Channel: Boats and Swimmers

Date: 15/05/2001

Hazard No.	Hazard Description	Consequences	Existing/Proposed Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
1	Collision between snorkellers and marine traffic.	Single fatality and/or serious injury.	• Funding to support regulatory agency function. • Construction of an inland marina with provision of marina facilities that will allow the majority of boating activities to be shifted from Bills Bay. • Inclusion of a constructed snorkelling artificial reef.	Potential to reduce overcrowding at Coral Bay during periods of peak visitor demand. Opportunity for the relevant authorities, notably the department of Conservation and Land Management (CALM) and Fisheries WA, to develop and institute more effective management controls as a consequence of a permanent on site presence. Government to close Coral Bay to all boats except coral viewing boats.	2	Human Life 4	**8**

EXISTING FACILITIES – CORAL BAY

Area: Coral Bay Beach / Boat Channel: Boats and Swimmers

Date: 15/05/2001

Hazard No.	Hazard Description	Possible Consequences	Existing/Lack of Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
2	Exposed beach moorings, chains.	Minor Injuries.	• Beach used for launching boats no separate constructed boat launching facility with restricted access.	A boat launching facility in the Bills Bay Sanctuary (a protected area) is unlikely due to environmental problems and the impact of breakwater construction.	4	Human Life 2	**8**

PROPOSED FACILITIES – CORAL COAST

Area: Coral Bay Beach / Boat Channel: Boats and Swimmers

Date: 15/05/2001

Hazard No.	Hazard Description	Consequences	Existing/Proposed Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
2	Exposed beach moorings, chains	Minor Injuries.	• Construction of an inland marina with provision of marina facilities that will allow the majority of boating activities to be shifted from Bills Bay.		2	Human Life 2	**4**

EXISTING FACILITIES – CORAL BAY

Area: Coral Bay Beach / Boat Channel: Boats and Swimmers

Date: 15/05/2001

Hazard No.	Hazard Description	Possible Consequences	Existing/Lack of Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
3	Sharks.	Single Fatality and/or serious injury.	• No shark nets.	Commercial/recreational vessels throwing fillets, offal in to the reef attracting sharks and polluting the environment.	3	Human Life 4	**12**

PROPOSED FACILITIES – CORAL COAST

Area: Coral Bay Beach / Boat Channel: Boats and Swimmers

Date: 15/05/2001

Hazard No.	Hazard Description	Consequences	Existing/Proposed Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
3	Sharks.	Single fatality and/or serious injury.	• Shark nets to be provided in the marina area.	Commercial/recreational vessels will no longer be permitted in Bills bay therefore reducing the pollution factor and attraction of sharks to this environment. Awareness program on times and where to swim.	2	Human Life 4	**8**

EXISTING FACILITIES – CORAL BAY

Area: Coral Bay Beach / Boat Channel: Boats

Date: 15/05/2001

Hazard No.	Hazard Description	Possible Consequences	Existing/Lack of Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
4	Damage to coral by commercial and recreational/ fishing boats.	Significant environmental damage to the coral reef due to anchor drops, dragging and dropping of objects. Vessel damaging coral.	• No full-time policing of the marine waters.	Anchorage, chains have and will continue to damage coral. A boat launching facility in the Bills Bay Sanctuary (a protected zone) is unlikely due to environmental problems and the impact of breakwater construction.	5	Environment 4	**20**

PROPOSED FACILITIES – CORAL COAST

Area: Coral Bay Beach/Channel: Boats

Date: 15/05/2001

Hazard No.	Hazard Description	Consequences	Existing/Proposed Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
4	Damage to coral by commercial/ recreational and fishing boats.	Minor environmental damage to the coral reef due to anchor drops, dragging and dropping of objects. Vessel damaging coral.	• Construction of an inland marina with provision of marina facilities that will allow the majority of boating activities to be shifted from Bills Bay. • CCMD to allow full-time CALM and Fisheries WA officers with control over the marina and boat launching and a boat for offshore patrols.	It is unlikely that the large commercial and pleasure boats will relocate out of Bills Bay until a marina is provided at Mauds Landing. CCMD will develop code of practice for all boats and fishers.	2	Environment 2	**4**

EXISTING FACILITIES – CORAL BAY

Area: Sewerage Effluent into Coral Bay

Date: 15/05/2001

Hazard No.	Hazard Description	Possible Consequences	Existing/Lack of Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
1	Health hazard, pollution of the bay due to overflow and leaching of effluent.	Water borne diseases affecting peoples health (Typhoid, cholera).	• Exiting septic tanks/leach drains and evaporation ponds (Filtration pond system).	Due to the overload especially during peak season septic tanks may overflow. Overflow observed from filtration pond system located north of the townsite.	3	Human Life 3	**9**
		Leaching into Bills bay, impact on the marine environment elevated nutrient levels (phosphorus, nitrogen). Significant, long term environmental harm.	• No ground water monitoring bores for water quality monitoring.	Past evidence of grey/black soil on the beach sand indicates possible contamination. Minor ecoli/coliform counts from beach samples taken by NATA accredited Laboratory.	4	Environment 4	**16**

PROPOSED FACILITIES – CORAL COAST

Area: Sewerage Effluent into Coral Bay

Date: 15/05/2001

Hazard No.	Hazard Description	Consequences	Existing/Proposed Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
1	Health hazard, pollution of the bay due to overflow and leaching of effluent.	Water borne diseases affecting peoples health (Typhoid, cholera).	• A sewerage treatment plant will be designed and installed in the services area, in consultation with the Water Corporation and Shire of Carnarvon. • Deep sewerage and construction of a waste water treatment plant to service the Mauds Landing townsite, with provision for upgrading to accommodate the connection to Coral Bay.	Lined ponds are proposed and will be sized to allow for total evaporation of all treated effluents. The sewerage treatment plant will be 2-km inland of Coral Bay.	2	Human Life 3	**6**

Hazard No.	Hazard Description	Consequences	Existing/Proposed Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
		Leaching into Bills bay, impact on the marine environment elevated nutrient levels (phosphorus, nitrogen). Significant, long term environmental harm.	• A series of groundwater monitoring bores will be established prior to construction commencing to characterise the superficial groundwater quality. • A shallow groundwater-monitoring program will be developed prior to construction and baseline established. • Shallow groundwater monitoring program will continue for 5 years post operation, followed by a review. • Development of contingencies for failures in containment within the services and townsite areas.	A sewage pumpout facility will be provided in the Marina and all boats with onboard sullage tanks will be required to discharge to the facility.	2	Environment 4	**8**

EXISTING FACILITIES – CORAL BAY

Area: Staff Accommodation/Caravan Parks

Date: 15/05/2001

Hazard No.	Hazard Description	Possible Consequences	Existing/Lack of Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
1	Fire/Explosion	Multiple fatalities.	• Fire hoses and fire extinguishers. No evidence of maintenance program. • Fuel drums and boats situated in one of the caravan parks. • Firebreaks are not maintained. • A formal maintenance and inspection program had not been established. • No formal fire management plan developed and reviewed on a regular basis. • People not informed of assembly areas. • Some electricity supplied to sites by extension cords. • Potential gas leak ignition sources in close proximity to accommodation facilities.	Possible non-compliance with the Caravan Parks and Camping Grounds Regulations 1997. Distances between caravans, annexes and camp sites not separated as per regulation. Water is from artesian supply. Pressure would normally burst all piping, sprinklers are left running continuously.	4	Human Life 5	**20**

Hazard No.	Hazard Description	Possible Consequences	Existing/Lack of Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
			• No formal emergency plan or procedures for relocating people. • No designated assembly area.(Various opinions of where an assembly point might be). • Mobile fire truck available. • SES Volunteer group.				

PROPOSED FACILITIES – CORAL COAST

Area: Staff Accommodation/Caravan Parks

Date: 15/05/2001

Hazard No.	Hazard Description	Consequences	Existing/Proposed Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
1	Fire/Explosion	Single fatality and/or serious injury.	• Light Industrial area to be developed and will provide storage and bunded facilities for fuels and chemicals. • Well equipped and trained emergency services and facilities to be provided which can assist with fire hazard.	• Gas storage for power station at the industrial area could make provision for Coral Bay if requested. • Alternative accommodation can alleviate the overcrowding in the caravan parks especially in peak season by providing alternative tourist accommodation (Caravan and Chalet Park, Backpackers Hostel, Tourist Villa and Townhouse sites).	4	Human Life 4	**16**

EXISTING FACILITIES – CORAL BAY

Area: Public Accommodation (Hotel/Backpackers)

Date: 15/05/2001

Hazard No.	Hazard Description	Possible Consequences	Existing/Lack of Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
1	Fire/Explosion Hazard.	Multiple fatalities.	• Smoke detectors. • No emergency or evacuation plan or emergency numbers displayed. • No fire blankets in the rooms (stove). • Fire equipment not maintained.		4	Human Life 5	**20**

PROPOSED FACILITIES – CORAL COAST

Area: Public Accommodation (Hotel/Backpackers)

Date: 15/05/2001

Hazard No.	Hazard Description	Consequences	Existing/Proposed Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
1	Fire/Explosion Hazard.	Single fatality and/or serious injury.	• A services area with the provision for bulk storage of fuels and chemicals in bunded areas as per relevant Australian Standards and WA Legislation. • Equipped and trained volunteer-based emergency services personnel to be provided to assist with fire scenarios.	Be able to assist in an emergency due to the provision of resources and emergency services.	4	Human Life 4	**16**

EXISTING FACILITIES – CORAL BAY

Area: Police and Traffic Controls – Coral Bay

Date: 15/05/2001

Hazard No.	Hazard Description	Possible Consequences	Existing/Lack of Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
1	Vehicle/pedestrian collisions.	Single fatality and/or serious injury.	• Police response time from Exmouth is one and half hours by road. • Main public road speed limits 25 kph. • Children crossing signs. • No footpaths. • Unlicensed motorcycles and drivers.	No police station in close proximity to Coral Bay. Exmouth police visit Coral Bay once a month. In peak season 2 policeman operation. People commuting in the back of Utilities and trailers. Increased crime rate. Limited law enforcement.	4	Human Life 4	**16**

PROPOSED FACILITIES – CORAL COAST

Area: Police and Traffic Controls – Coral Bay

Date: 15/05/2001

Hazard No.	Hazard Description	Consequences	Existing/Proposed Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
1	Vehicle/pedestrian collisions.	Single fatality and/or serious injury.	• CCR can provide a two-man station, accommodation and lockup.	Increased law enforcement due to permanent police presence.	3	Human Life 4	**12**

EXISTING FACILITIES – CORAL BAY

Area: Police and Traffic Control – Caravan Parks

Date: 15/05/2001

Hazard No.	Hazard Description	Possible Consequences	Existing/Lack of Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
2	Vehicle/pedestrian collisions.	Single fatality and/or serious injury.	• Controls exist for the one caravan park for example speed hump at the entrance. • 5 kph speed restriction. • Controlled access boom gates. • Signage "No" 2,3 or 4 wheel bikes. • No visitor vehicles beyond this point. Second caravan park: • No speed humps evident. • Wheel bikes and vehicles driving over the speed limit. • No controlled access.		4	Human Life 4	**16**

PROPOSED FACILITIES – CORAL COAST

Area: Police and Traffic Controls - Caravan Parks

Date: 15/05/2001

Hazard No.	Hazard Description	Consequences	Existing/Proposed Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
2	Vehicle/pedestrian collisions.	Single fatality and/or serious injury.	• Designated pedestrian footpaths. • No 2,3 or 4 wheel motorcycles. • Speed humps. • Speed Restrictions. • Dual path system. • Cyclist network.	Possibly reduced traffic flow due to the proposed Marina Development however it would have to be up to the existing Caravan owners and the Shire to provide further controls and enforcement.	4	Human Life 4	**16**

EXISTING FACILITIES – CORAL BAY

Area: Cyclones

Date: 15/05/2001

Hazard No.	Hazard Description	Possible Consequences	Existing/Lack of Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
1	Damage to infrastructure.	Multiple fatalities. Damage to roads, power supply, sewerage treatment, water supply, vehicles, boats etc.	• Disaster/Evacuation and recovery plans were not available during the assessment. People interviewed were not aware of any formal emergency plans.	Overhead power lines – risk of distribution damage even if power plant survives. Are communications capable of with standing a cyclone? Coral Bay is isolated and the roads can be cut off by heavy rainfall.	4	Human Life 5	**20**
2	Damage to Buildings.	Multiple fatalities. Disintegration of buildings. Flying debris. Shattered glass-increasing risk to occupants. Buildings "exploding".	• No designated assembly points general lack of safer refuges for occupants and management. No area capable of withstanding a Cat 5 cyclone to provide shelter for occupants and to manage a relief operation. • SES (State Emergency Services) Rely on Volunteers. • No cyclone shutters on windows.	Suspect buildings, windows, tanks would not withstand a Category 5 cyclone.	4	Human Life 5	**20**

PROPOSED FACILITIES – CORAL COAST

Area: Cyclones

Date: 15/05/2001

Hazard No.	Hazard Description	Consequences	Existing/Proposed Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
1	Damage to infrastructure.	Single fatality and/or serious injury. Damage roads, power supply, sewerage treatment, water supply, vehicles etc.	• Power supply buried underground. • Assembly areas. • Formal Emergency and Disaster Recovery plans and procedures will be developed.	It is proposed that volunteer-based emergency services will be provided to the resort comprising of : • Fire and Emergency services. • Nursing Station and First Aid. • Sea Search and Rescue.	4	Human Life 4	**16**
2	Damage to buildings.	Single fatality and/or serious injury. Disintegration of buildings. Flying debris. Shattered glass increasing risk to occupants.	• Buildings designed to withstand Category 5 cyclones.	The above services will be available to assist people in Coral Bay.	4	Human Life 4	**16**

EXISTING FACILITIES – CORAL BAY

Area: Cyclones

Date: 15/05/2001

Hazard No.	Hazard Description	Possible Consequences	Existing/Lack of Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
3	Damage to Maritime.	Multiple fatalities. Catastrophic, long-term environmental harm.	• No boat ramping facilities or facilities for the protection of boats. • No environmental disaster recovery plan. • Lack of boat ramp facilities will delay removal of small boats. • Lack of safe anchorage direct danger for boats and crew. • Capsizing boats will damage coral. • Anchors and moorings dragging and damaging the coral. • Fuel spillage's impacting on corals and fish sanctuary.		4 4	Human Life 5 Environment 5	**20** **20**

PROPOSED FACILITIES – CORAL COAST

Area: Cyclones

Date: 15/05/2001

Hazard No.	Hazard Description	Consequences	Existing/Proposed Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
3	Damage to Maritime.	Single fatality and/or serious injury. Significant, long-term environmental harm.	• Construction of the inland marina with provision of marina facilities will allow the majority of boating activities to be shifted from Bills Bay. • Designed for boats to moor in the area. • Formal boat ramps to allow boats to be taken out of the water and moved to the industrial area and tied down.	The experiences of Exmouth have been taken into consideration.	4 4	Human Life 4 Environment 4	**16** **16**

EXISTING FACILITIES – CORAL BAY

Area: Cyclones

Date: 15/05/2001

Hazard No.	Hazard Description	Possible Consequences	Existing/Lack of Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
4	Storm Surge (Ocean flooding).	Severe flooding, multiple fatalities. Pollution, damage to infrastructure. Catastrophic, long term environmental harm.	• Much of the existing development is significantly lower than the development level proposed for the Coral Coast Resort. • No formal evacuation plan. • No environmental disaster or recovery plan.	Is there any early warning system? (Learmonth Meteorological office). AHD (Australian Height Datum) of power, sewerage treatment and water supply need to be reviewed may be susceptible to inundation in storm surge.	3 3	Human Life 5 Environment 5	**15** **15**

PROPOSED FACILITIES – CORAL COAST

Area: Cyclones

Date: 15/05/2001

Hazard No.	Hazard Description	Consequences	Existing/Proposed Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
4	Storm Surge (Ocean flooding).	Severe flooding, single fatality and/or serious injury. Damage to infrastructure. Significant release of pollutants. Measurable environmental harm.	• People can evacuate to the resort. • If requested the exiting settlement of coral bay could be connected to the new sewerage treatment plant, which will alleviate any pollution in to the bay.	The final finished floor levels will be 6.0m above AHD (Ocean side) and 3.65 m above AHD (lagoon side). This would be above the water levels caused by a direct hit on Coral Bay by a cyclone similar to Vance. Design of resort structures and buildings will meet 1-in 100-year return period storm events with contingencies.	3 3	Human Life 4 Environment 3	**12** **9**

EXISTING FACILITIES – CORAL BAY

Area: Landfill

Date: 15/05/2001

Hazard No.	Hazard Description	Possible Consequences	Existing/Lack of Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
1	Ground and water pollution.	Leaching and nutrient movement into Bills Bay. Significant, long term environmental harm.	• No water monitoring program (Stormwater and leachate management, boreholes). • Designated areas for different waste materials. • Uncovered waste, trench method used. • Little compaction of waste materials.		4	Environment 4	**16**

PROPOSED FACILITIES – CORAL COAST

Area: Landfill

Date: 15/05/2001

Hazard No.	Hazard Description	Consequences	Existing/Proposed Controls	Comments	Likelihood Category	Consequence Category	Risk Ranking
1	Ground and water pollution.	Leaching and nutrient movement into Bills bay. Significant, long term environmental harm.	• A landfill site with a site area to provide a minimum 25 years capacity will be established to the requirements of the Shire of Carnarvon and Waste Management WA. • The services area has been sized so that it can also accommodate service and waste disposal requirements of the existing Coral Bay townsite.		2	Environment 4	**8**

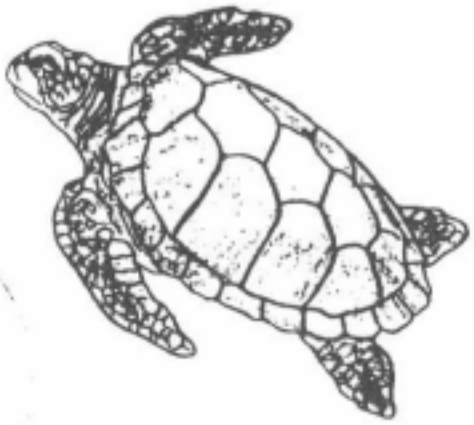
APPENDIX 3

CORRESPONDENCE FROM THE BAIYUNGU PEOPLE PROVIDING AN UNDERTAKING TO ASSIST IN TURTLE AND CETACEAN MANAGEMENT

Baiyungu Aboriginal Corporation

Phone: (08) 9941 3814
Fax: (08) 9941 3814
email:

PO Box 180, Carnarvon, WA, 6701



ATA Environmental
21 Howard Street
PERTH WA 6000

Attention: Mr Henk VanDer Wiele

Dear Sir

TURTLE MANAGEMENT - BATEMAN BAY

We wish to advise you that the Baiyungu people are the traditional owners of the land and sea in the Bateman Bay / Coral Bay area and the Baiyungu Aboriginal Corporation in lessee of Cardabia Pastoral Station.

The Gnulli Claimants, representing the Baiyungu People, and the Baiyungu Aboriginal Corporation have signed a Native Title Agreement with Coral Coast Marina Development Pty Ltd (CCMD) pertaining to development of the Coral Coast Resort at Mauds Landing.

This Agreement provides significant long term employment, training and business development opportunities for the Baiyungu People.

In particular, it includes development of cultural and environmental tourism opportunities based at Cardabia Pastoral Station.

Of significant interest to Environment Australia is that the Baiyungu People will be provided with the necessary support to manage visitors and control access along the Bateman Bay shore and to monitor and manage the turtle population in this area.

To date, turtle monitoring and management has been carried out solely through the voluntary efforts of Mr Peter Mack.

Through the resources to be provided by (CCMD), we will have young people trained by Mr Mack and CALM and employed in long term management of the turtle population, commencing in the near future, with the assistance of CALM, a program of baiting on Cardabia Station to reduce the threat by foxes and feral animals.

We believe that the development of Coral Coast Resort is essential to provide the proper resources for environmental management of our land and sea, which to date has been sadly neglected by under funded Government Agencies.

Yours Faithfully

Mary Franklin
For Baiyungu Aboriginal Corporation

3 April 2001

APPENDIX 4

BOAT LANDING PROPOSALS, DEPARTMENT FOR PLANNING AND INFRASTRUCTURE, COASTAL FACILITIES BRANCH

Department for Planning and Infrastructure

TRANSPORT

Public Transport
Transport Planning
Road Safety
Licensing Services
School Buses
Cycling
Travel Subsidies
Taxi Regulation
Marine Safety

Facsimile

To:	Henk Van der Wiele ATA Environmental	Fax: 9481 3435 Phone: 9481 3434
From:	Martin Baird Planning Manager, Coastal Facilities	Fax: 9216 8983 Phone: 9216 8843
Date:	14 September 2001	No.of pages (incl this): 3
If you do not receive all pages, please phone (08) 9216 8838		
Coral Bay - Proposed Boating Facility		

Henck

I refer to your facsimile 11 September requesting information about the above.

Departmental Reference

Maritime Transport is now a part of the Department for Planning and Infrastructure (DPI). For the time being we are operating under a similar structure as before. For the purpose of your report, I suggest that you refer to us as the Coastal Facilities branch of the Department for Planning and Infrastructure.

Brief Summary of Options

DPI is investigating the provision of a boating facility to permit relocation of the majority of boating activity away from the town beach at Coral Bay. Provision of the boating facility will improve swimmer safety at the town beach and assist in ongoing management of the areas natural attractions. Two sites have been considered in detail: north Bills Bay and north Monck Head.

A boating facility at north Bills Bay, which is 2.5 km to the north of the Coral Bay town site, would consist of small breakwaters, pens for charter vessels, a small service wharf, boat ramps, parking for cars with boat trailers and onshore amenities. From a boating perspective the site would achieve the aim of relocating boating activity. However, the north Bills Bay site is situated in a Sanctuary Zone of the Ningaloo Marine Park and as such would be a non-permitted use under the Park's management plan.

North Monck Head is 1.5 km to the south of the Coral Bay town site (and just north of Monck Head). A boating facility here would consist of boat ramps, a small service jetty, parking for cars with boat trailers and onshore amenities. The boat ramps would be located on an offshore formation with access via a small road bridge. The ramps would be positioned on the northern side of the formation to afford shelter for launch and retrieval during most conditions.

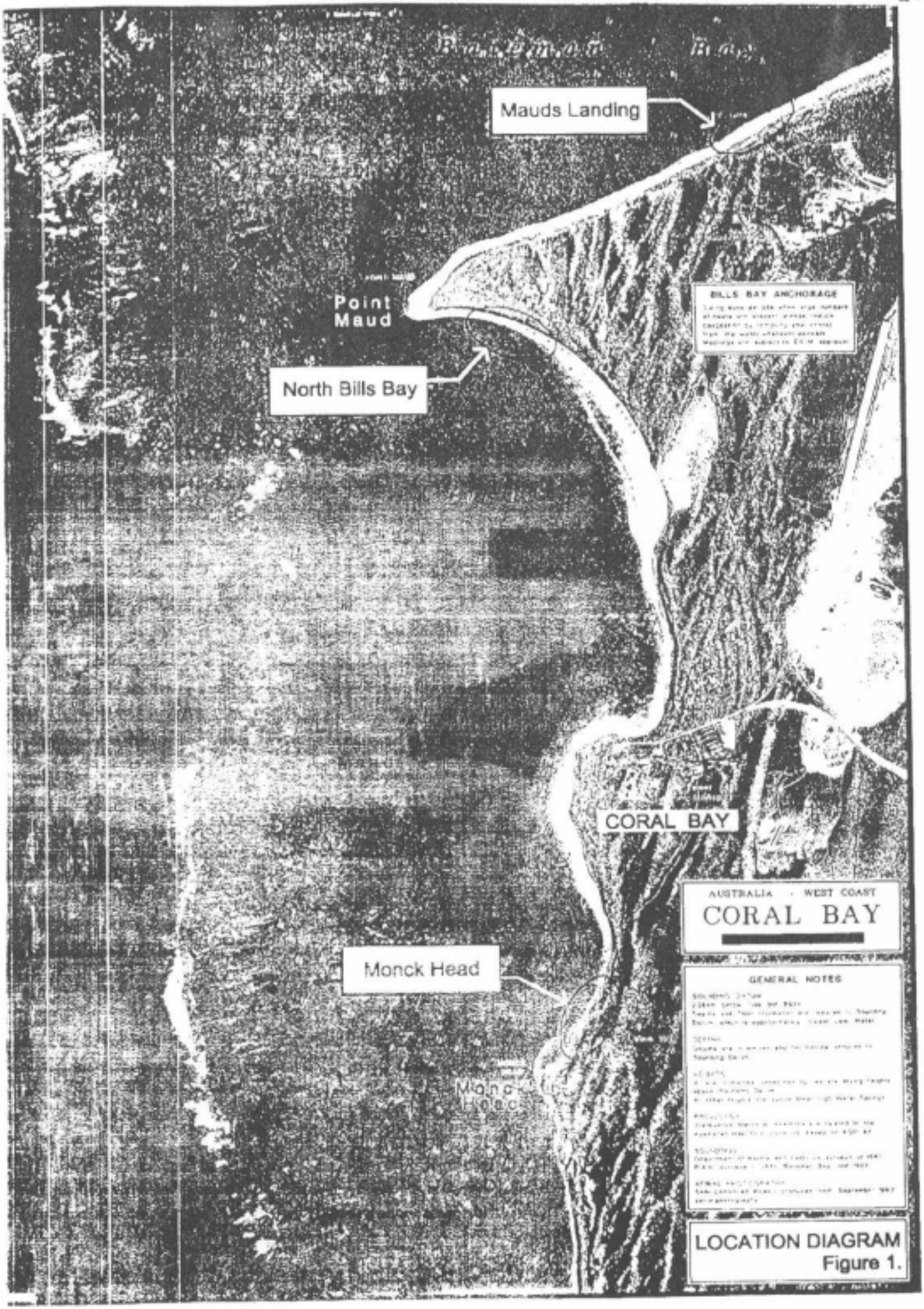
Marine House
1 Essex Street, Fremantle
Western Australia 6160
www.transport.wa.gov.au
ABN 79 924 477 610

A boating facility at north Monck Head would compliment boating facilities provided at a boat harbour near Mauds Landing. Boats heading south could launch from north Monck Head, while boats heading north could launch from the boat harbour near Mauds Landing. The two sites are about 8km apart via the recognised boating route, mostly through Sanctuary Zone waters.

A locality plan showing the boating facility sites is enclosed.

regards

M. Baird.


Mauds Landing
Point Maud
North Bills Bay
BILLS BAY ANCHORAGE
CORAL BAY
AUSTRALIA - WEST COAST
CORAL BAY
Monck Head
GENERAL NOTES
LOCATION DIAGRAM
Figure 1.