PUBLIC ENVIRONMENTAL REVIEW FOR TWO PROPOSALS FOR THE DEVELOPMENT OF A SINGLE BOATING FACILITY AT EITHER MONCK HEAD OR NORTH BILLS BAY, NEAR CORAL BAY

TECHNICAL APPENDICES

Prepared for:

Department for Planning and Infrastructure

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AUGUST 2002

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CORAL BAY BOATING FACILITY
TECHNICAL APPENDICES

Prepared for:

ENVIRONMENTAL PROTECTION AUTHORITY

Prepared on behalf of:

DEPARTMENT FOR PLANNING AND INFRASTRUCTURE

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TECHNICAL APPENDICES

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TECHNICAL APPENDIX 1
CORAL BAY BOATING FACILITY
COASTAL GEOMORPHOLOGY AND PROCESSES

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The Department for Planning and Infrastructure (DPI) is presently investigating the development of a boating facility at Coral Bay that aims to remove all boating activity (except glass-bottomed tour boats) from the southern end of Bills Bay. It is anticipated that this relocation of boating activity will help to minimise the physical damage to the coral formations, reduce the risk of fuel spills and increase the safety of swimmers in the southern end of Bills Bay.

As part of the investigations into the boating facility, the DPI has commissioned DAL Science & Engineering (DALSE—formerly D.A. Lord & Associates Pty Ltd [DAL]) to lead a team of consultants to investigate the biological, physical, cultural and social issues associated with the development of a boating facility near Coral Bay. The study team completed a notice of intent (DAL, 1997) for the boating facility that was submitted on behalf of the DPI to the Environmental Protection Authority (EPA) in December 1997. The EPA determined the level of assessment to be a Public Environmental Review (PER) in mid-January 1998. Three potential sites were identified for the development of this boating facility: Mauds Landing, North Bills Bay and Monck Head. Note that it is proposed that a facility only be developed at one of these sites.

This Technical Appendix present an assessment of the coastal geomorphology and process considerations associated with the siting of the boating facility at each of the three sites. The three sites are all located in the lee of the Ningaloo Reef which results in considerable attenuation of the offshore wave energy. Mauds Landing experiences the most energetic wave conditions of the three sites due to its proximity to the Cardabia Passage (navigable access to the outer reef). The North Bills Bay site is the most exposed to the prevailing southerly winds and waves.

At both North Bills Bay and Monck Head, the net sediment movement is northwards. The shoreline at North Bills Bay is accreting at an average rate of 0.4 m per year; whereas at Monck Head, the shoreline is underlain by a limestone pavement and is relatively stable. The sediment transport rate at Mauds Landing is considered to be small during prevailing conditions, but can be considerable during storms and tropical cyclone events. The net sediment transport direction at Mauds Landing during these events is dependent on the approach of the storm. The shoreline at Mauds Landing is accreting at an average rate of 0.9 m per year.

The principal coastal geomorphology and process considerations at the three sites include the following:

MAUDS LANDING

- A breakwater constructed at Mauds Landing would interrupt longshore sediment transport and occasional sediment bypassing would be required.

NORTH BILLS BAY

- A breakwater constructed at North Bills Bay would interrupt longshore sediment transport and would require occasional bypassing (Egis, 1997);
- It will be necessary to remove some coral communities and limestone pavement (and mark channels) to enable safe boating passage; and
- Care should be taken during construction of the access road to minimise effects of wind erosion.

MONCK HEAD

- The site is relatively well sheltered from the prevailing winds and waves;
- Very little sediment transport along the shoreline; and
- Small section of low limestone cliff along the shoreline may need to be removed.

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1. INTRODUCTION

Coral Bay is a small coastal tourist settlement adjacent to the Ningaloo Reef and situated on the southern shore of Bills Bay, North West Cape (Western Australia) (Figure 1). The settlement represents one of the few focus points for marine-based recreational and commercial activities in this region. At present there are no formal boating facilities in the Coral Bay region and the launching of trailered craft and the mooring of larger commercial vessels is focussed in the Southern Bills Bay area. This is an area of relatively sheltered water and is also a popular swimming beach.

Due to the increase in boating activity in the region there is a need for formalised boating facilities to cater for both the small trailered craft and the larger commercial vessels in the Coral Bay region (MFP, 1996b). The Department for Planning and Infrastructure (DPI) is presently investigating the development of a boating facility that aims to remove all boating activity (except glass bottomed tour boats) from Southern Bills Bay. It is anticipated that this relocation of boating activity will help to minimise the physical damage to the coral formations, reduce the risk of fuel spills and increase the safety of swimmers in Southern Bills Bay.

The following three sites have been investigated for the location of the boating facility: Mauds Landing; North Bills Bay; and Monck Head (Figure 1). Note that it is proposed that a facility be developed at only one of these sites. This report describes the physical environment of Coral Bay and presents an examination of the coastal process issues associated with the development of a boating facility at these three sites.

2. PHYSICAL ENVIRONMENT

2.1 CLIMATE

The Coral Bay area experiences an arid climate with two seasons, a hot summer which extends from October to April and a mild winter from May to September. The nearest weather station is located at Learmonth (100 km north north-west of the Coral Bay settlement) and has a mean annual maximum temperature of 31.6°C and a mean annual minimum temperature of 17.7°C. The hottest month is January with a mean maximum temperature of 37.9° and the coolest month is July with a mean maximum temperature of 24.1°C (Figure 2a).

Average annual rainfall at Learmonth is 267.8 mm; however, this is considerably exceeded by the mean annual average evaporation of 3,137.6 mm. During summer, rainfall is generally associated with tropical cyclones and typically falls between January and March (Figure 2b). During winter, rainfall is more regular, but less intense (Figure 2b).

The prevailing wind conditions of central Western Australia are largely determined by a subtropical high-pressure belt dominated by anticyclones (Gentilli, 1971). This pattern is periodically disturbed by storms generated by mid-latitude and tropical depressions. Strong local sea breezes are also of considerable significance along the coast, particularly in summer.

Tropical cyclones are intense low pressure systems that develop during summer over the warm seas off north-western Australia and typically occur between December/January and March/April (Lourensz, 1981). These systems generate intense winds that blow into the low pressure region in an almost circular clockwise direction. The wind direction at the coast is dependent on the path of the tropical cyclone. In the Coral Bay region, tropical cyclones with wind speeds in excess of 40–50 knots occur every three to five years (Lourensz, 1981; MFP, 1996b). On 22 March 1999 the centre of tropical cyclone Vance passed approximately 80 km to the east of the Coral Bay settlement. At Learmonth, this cyclone produced the strongest wind gust speed (267 kph) recorded on the Australian mainland shortly before midday on 22 March 1999. The impact of this cyclone on Coral Bay was reduced as the speed of the cyclonic wind experienced at Coral Bay was reduced as through passage over land. At Coral Bay, the impact of a cyclone passing to the west (offshore) of the Coral Bay settlement would be considerably greater.

The sea breeze is a local-scale phenomenon that is generated by the temperature differential between the land and the ocean. Sea breezes typically occur during late morning to early afternoon in summer when the air overlying the land becomes hotter than that overlying the ocean. The hot air over the land rises causing a lowering of the air pressure above the land which induces a stream of cool air to flow landward from the ocean. A weak reverse breeze (land breeze) may occur during the early morning when the sea temperature may be higher than the land temperature. The land breeze may be more pronounced in winter when the land temperature drops substantially below the sea surface temperature.

During summer, the wind at Learmonth is predominantly from the south and south-west with southerly winds prevailing in the mornings and south-westerly sea breezes prevailing in the afternoon (Figure 3a). During winter, the winds at Learmonth are typically lighter and more variable with south and south-easterly winds prevailing during the morning and northerly through to easterly winds in the afternoon

(Figure 3b). The wind speeds are typically between 11 and 30 km/hr during summer and 11 to 20 km/hr in winter.

2.2 OCEANOGRAPHY

2.2.1 Wave climate

The wave climate offshore of the Ningaloo Reef is dominated by low swell waves generated by the roaring 40s and the south-east trade wind belt of the Indian Ocean. Detailed wave observations have not been obtained in the Coral Bay region; however, visual estimates of wave height, period and direction obtained from shipboard observations are summarised by US Navy (1976). These observations indicate that the offshore waves in summer generally arrive from the south and typically have a wave height of 1–2 m. During winter the offshore waves typically have a height of 2–3 m and the wave direction shifts towards a more south-westerly direction.

During summer the sea-breeze causes the superposition of a local sea wave climate onto this background swell regime. Extreme waves may be generated during tropical cyclones. Numerical modelling of tropical cyclone Hazel (February/March 1979), which was considered to be representative of a 1 in 100 year return period event, indicated that maximum significant wave heights could reach 6.2 m outside the reef line and 3.7 m in a water depth of 7 m near Mauds Landing (Port and Harbours Consultants, 1989).

It should be noted that the Ningaloo Reef acts to considerably attenuate the offshore wave energy via shoaling, refraction, diffraction and breaking processes across the reef crest and bottom friction across the reef lagoon. The degree of wave attenuation is dependent on the wave period (short period wind waves are less attenuated than longer period swell waves) and the water level over the reef (as determined by the tide and surge levels—shallower water depths result in greater wave energy attenuations).

Typical and extreme wave conditions along the shoreline of Bills Bay have been hindcast from the wind conditions by Egis Consulting (1997). The results of this modelling indicated that during non-cyclonic conditions the median wave height is 0.1–0.2 m and 90th percentile wave height (which would be expected to occur regularly) is 0.2–0.4 m (Egis Consulting, 1997). The most extreme wave conditions in the Coral Bay region are generated by tropical cyclones. The modelling conducted by Egis Consulting (1997) indicated that the extreme wave heights are strongly dependent on water levels across the offshore reef. The five year recurrence interval wave height for offshore and inshore (Bills Bay) were determined to be 6.0 m and 1.7 m, respectively and the 50 year recurrence interval wave heights for offshore and inshore were calculated to be 10.1 m and 2.0 m, respectively (Table 1). These results indicate the strong attenuation of wave energy due to the offshore reef.

Table 1 Wave height recurrence intervals for Bills Bay

RECURRENCE INTERVAL (years)	OFFSHORE WAVE HEIGHT (m)	INSHORE WAVE HEIGHT (m)
2	3.1	1.5
3	4.7	1.6
5	6.0	1.7
10	7.6	1.8
20	8.8	1.9
50	10.1	2.0

Source: Egis Consulting (1997)

2.2.2 *Storm surges*

Storm events are typically associated with onshore winds and low atmospheric pressure and these factors together may result in elevated water levels at the shoreline, termed storm surge. Tropical cyclones are likely to have the greatest potential for causing storm surge events in the Coral Bay region. The storm surge at Carnarvon from the 1 in 100 year storm has been estimated at 1.76 m above Australian Height Datum (AHD) (Wallace and Boreham, 1990). Steedman Science & Engineering (1989) examined tidal residuals for Carnarvon for the period 1966–1986 to determine the storm surge recurrence intervals (Table 2). On the basis of wind, wave and atmospheric pressure components Steedman Science and Engineering (1989) estimated that the surge levels at Mauds Landing would be approximately 15% greater than at Carnarvon. When wave run-up is added to the surge level it is considered that water levels in Carnarvon may reach from 3.0–4.2 m above AHD (MFP, 1996b), and possibly slightly higher in the vicinity of Coral Bay.

Table 2 Recurrence interval of surge events at Carnarvon

RECURRENCE INTERVAL (years)	SURGE LEVEL ABOVE AHD (m)
2	0.8
10	1.3
25	1.5
50	1.7
100	1.9

Source: Steedman Science and Engineering (1989)

2.2.3 *Seiching*

Long-period standing waves, seiches, may occur inside the reef lagoon and cause a periodic rise and fall of the water level at the shoreline. Seiche motions are typically triggered by an impulse that may be related to: a storm surge; a change in wind direction/speed; or by periodic fluctuations in the wave heights breaking across the reef crest. Seiching in the Coral Bay region may occur between the shoreline and the reef edge or alongshore within coastal embayment such as Bills Bay. Observations along the shoreline at Southern Bills Bay suggest several periods of seiche motion with small pulses with a period of approximately 30 s superimposed upon a larger seiche motion of approximately 5 minutes (Muntz, pers. comm., 1998).

2.2.4 *Tsunamis*

Tsunamis are large amplitude ocean waves that are caused by a sudden large displacement of the ocean floor or shores. Tsunamis may be initiated by a severe earth quake or volcanic eruption. On 3 June 1994 an undersea earthquake south of Indonesia produced a tsunami wave that was observed on the north-west coast of Australia some two to three hours later (MFP, 1996b). This tsunami caused a temporary inundation of some nearshore facilities in Exmouth. A similar event occurred approximately 17 years ago (MFP, 1996b) and provides an indication of the vulnerability of this coast to tsunami events.

2.2.5 *Currents*

The offshore water circulation in the Coral Bay region is dominated by the Leeuwin Current which is a southward flow of warm, relatively low-salinity water of tropical origin. The current moves rapidly along the continental shelf with maximum surface speeds of greater than 1 ms^{-1} (Godfrey and Ridgway, 1985; Pearce and Griffiths, 1991). The flow of the Leeuwin Current is generally greatest between autumn and winter and is greatly attenuated by wind stress from the southerly winds in summer.

Inside Ningaloo Reef the current structure is complex and is driven by wind, waves and tides. The currents are considerably modified by the coastal morphology, in particular the location of size of passages and channels through the reef system. Typically, the persistent southerly swell waves break on the reef and result in the pumping of water over the reef crest and into the lagoon. This generally results in the generation of northward flowing circulation cells inside the lagoon which exit via breaks in the reef (including Yalobia and Cardabia Passages) (Hearn and Parker, 1988).

Observations by Hearn and Parker (1988) at Osprey Bay (120 km north of the Coral Bay settlement) indicate that the lagoon in this region has a flushing time of less than 24 hours. The lagoon flushing in the vicinity of Coral Bay is expected to be less influenced by tidal currents than at Osprey Bay due to the reduced tidal range at Coral Bay. Drogue tracking observations in Bateman Bay indicated that the currents in the region are largely driven by wind and wave forcing and have typical velocities in the order of 0.1–0.2 ms^{-1} (Rogers & Associates, 1994). A localised increase in the current velocity (up to 0.5 ms^{-1}) may be experienced in the narrow channel immediately offshore of Point Maud (Rogers & Associates, 1994).

2.2.6 Tides

The tide at Point Maud is microtidal, mixed predominantly diurnal, with a mean spring tide range of 1 m and a mean neap tide range of 0.3 m (Department of Defence, 1990). The ranges from lowest astronomic tide (LAT) to highest astronomic tide (HAT) at Carnarvon and Learmonth are 1.4 m and 2.9 m, respectively (Department of Defence, 1990). DPI monitored tidal levels at Monck Head between 1991 and 1993 and determine the tidal parameters presented in Table 3.

Table 3 Tidal parameters for Monck Head determined by DPI

TIDAL LEVEL	ELEVATION RELATIVE TO DATUM (m)
Highest Astronomical Tide	1.92
Mean High Water Spring	1.44
Mean High Water Neap	1.21
Mean Sea Level	0.99
Mean Low Water Neap	0.80
Mean Low Water Spring	0.54
Lowest Astronomical Tide	0.11

Source: Egis Consulting (1997)

2.2.7 Sea level rise

The Inter-governmental Panel on Climate Change (IPCC, 1995) presents several scenarios for future sea level rise and the figures for the 'most likely' scenario suggest a sea-level rise between 0.20 to 0.86 m by 2100 with the mid level of 0.49 m (Table 4).

Table 4 Sea level rise scenarios 'most likely' presented by IPCC (1995)

SCENARIO	YEAR		
	2030	2050	2100
LOW	0.04	0.07	0.20
MID	0.11	0.19	0.49
HIGH	0.23	0.37	0.86

Note: sea level rise presented in units of metres

2.3 LANDFORMS

2.3.1 Coastal geology

The coast in the region of Coral Bay is largely composed of Pleistocene (1.5 million to 10,000 years old) limestones and Holocene (less than 10,000 years old) sands which are superimposed on a Miocene (26 to 7 million years old) limestone anticline (Hocking et al., 1985). The major marine geomorphologic feature in this region is the Ningaloo Reef, which is the largest fringing reef in Australia and extends from Bundegi Reef, north of Exmouth, around the North West Cape and continues south for some 260 km to Gnarloo Bay. The reef is discontinuous and encloses a lagoon which varies in width from 0.2 km to 6 km. In the vicinity of the Coral Bay settlement the lagoon is approximately 2.0–2.5 km wide and has an average depth of 3 m. Two navigable channels through the Ningaloo Reef occur in this region: Cardabia Passage (the northern passage) is located approximately 6 km north of Point Maud; and Yalobia Passage (the southern passage) is located approximately 8 km south of Point Maud.

The shoreline immediately north of Point Maud is sandy, whereas to the south of Point Maud, occasional limestone outcrops occur along the shoreline. The coastal belt is characterised by a series of carbonate rich dune features including (Department of Planning and Urban Development [DPUD], 1992): Pleistocene parabolic dunes that have been stabilised by vegetation, isolated active parabolic dunes (blowouts) that occur where the dune sands have become unstable and, active and relict foredune deposits (Figure 4). A large area of saline flats occurs to the east of Point Maud which appears to be a palaeolagoon feature which was open to the sea in the vicinity of Mauds Landing during a period of higher sea level. These saline flats become flooded during peak rainfall events.

Two lines of limestone beach rock (calcarenite rock) parallel the shoreline of Bills Bay and represent relict shorelines. The more seaward of these beach rock lines underlays the present shoreline in the south-eastern section of Bills Bay, whereas along the mid-section of Bill Bay these beach rock lines are located offshore of the present shoreline. Towards the North Bills Bay site these relict shorelines intersect with the present shoreline and are expected to underlie the foredune sequence at the tip of Point Maud. Field surveys indicated extensive areas of limestone pavement, and occasional coral outcrops in the North Bills Bay region.

2.3.2 Soils

The predominant soils found throughout the study area are calcareous, coarse, sands with no, or minimal texture profile development (Bettenay *et al*., 1967). These sands overlie a core of Pleistocene limestone, which forms low cliff faces, platforms or shallow offshore bars along the coast in places. Dispersed throughout the region are small patches of weakly or strongly coherent calcareous loams. Inland from Mauds Landing is a saline flat with clayey soils (Figure 4).

2.3.3 Geohydrology

There are essentially two aquifers in the Coral Bay region: a shallow unconfined aquifer and a deep confined aquifer (the Birdrong Sandstone) (Rockwater, 1994). Most of the shallow groundwater in the vicinity of Coral Bay is saline (10–14 ppt) with salinities generally increasing towards the coast where seawater intrusion occurs. The salinity of the shallow groundwater beneath the saline flats is likely to be even higher than the coastal saline intrusion (Rockwater, 1994). In some dune locations there is a thin layer of fresh groundwater overlying the more saline waters;

wells at Mauds Landing and Cardabia Station homestead contain salinities of 1–5 ppt. The Birdrong Sandstone is the deeper groundwater aquifer and extends over a wide area of the Carnarvon Basin. This aquifer is the main source of water for the Coral Bay settlement where it occurs at a depth of approximately 800 m. The water from this aquifer is hot (58°C) and saline (5.1–5.8 ppt).

2.3.4 Beach morphodynamics

The offshore wave energy in the Coral Bay region is considerably modified and attenuated by the Ningaloo Reef so that the beaches in this region typically experience very low wave energies. Of the three sites, Mauds Landing experiences the most energetic wave conditions as this shoreline lies in the lee of a large break in the Ningaloo Reef chain, the Cardabia Passage.

Mauds Landing

The beachface at Mauds Landing is relatively steep and marked by active swash cusps with a wavelength of approximately 30 m. Sediment analysis by Simpson and Field (1995) indicates that the nearshore sediments at Mauds Landing are composed of coarse sands and the sediment across the back of the beach (berm) at Mauds Landing is relatively soft and uncompacted. During the field survey (March 1998) the beach width was approximately 30 m and was backed by a 60 m wide low foredune plain which itself was backed by high parabolic dunes (approximately 9 m) to the west and primary dunes (approximately 5 m height) to the east (Figure 5a). Limestone outcropping was observed in the primary dunes along the road to Mauds Landing.

East of Mauds Landing the foredune plain narrows to approximately 20 m and this plain is backed by a series of parabolic dunes. Towards Point Maud, the offshore region is underlain by a limestone pavement; to the east of this pavement the shoreline orientation changes and the beach cusps are no longer present. The shoreline at Point Maud is composed of loosely compacted medium sands with a broad berm with a maximum width of approximately 80 m. A tongue of sands is located offshore of Point Maud and suggests a northerly sediment drift from Point Maud.

Aerial photograph interpretation, combined with dive surveys, revealed the presence of large sand waves offshore of Mauds Landing which indicates that a relatively dynamic sediment transport regime prevails in this area. Modelling of sediment transport along the shores of Bateman Bay during Cyclone Hazel (1 in 100 year return period) indicates that the sediment transport direction during this event was southerly and the potential volume of sediment transported decreased from approximately 28,000 m^3 at the northern end of Bateman Bay to approximately 9,000 m^3 at Mauds Landing and a negligible amount at Point Maud. Analysis of shoreline change from 1971–1994 indicates that the shoreline at Mauds Landing is accreting at an average rate of 0.9 m year (Egis Consulting, 1997).

North Bills Bay

The sediment along the North Bills Bay shoreline is well compacted. Two ridges of submerged beachrock provide additional protection to the shoreline along this section of coast. The outermost beachrock ridge intersects the shoreline in the vicinity of the active dune blowout in Bills Bay (Figure 5b) and forms the shoreline south towards the Coral Bay townsite. Along North Bills Bay the wave energy is relatively low although the prevailing southerly winds may generate moderate wave energy at this location. The beach is broad and flat with an intertidal width of approximately 15 m and a narrow supertidal beach width of approximately 3 m (Figure 6a). Analysis of shoreline change indicated that the shoreline in this region has accreted an average width of 10 m between 1971 and 1994 which represents an average of 0.4 m per annum accretion (Egis Consulting, 1997).

The Southern Bills Bay area typically experiences very low wave energies. The beachface and berm are very flat. However, just below low tide the beach slope steepens considerably into water depths of approximately 2 m. Immediately south of Southern Bills Bay there is an aeolianite limestone headland which is fronted by a narrow sandy beach (Figure 6b). South of this headland, the beach narrows to approximately 1–5 m and is backed by a steep dune. At high tide the water level reaches the base of the primary dunes.

Monck Head

The Monck Head site is located in the lee of the Ningaloo Reef and is thereby sheltered from the direct impact of the offshore swell waves. Immediately north of Monck Head the shoreline has a north-westerly aspect and is therefore protected from the prevailing southerly winds and local wind waves.

Within approximately 300 m of Monck Head, a unit of limestone is exposed along the shoreline. Visual examination of this limestone suggests that it represents a unit of beachrock which has been overlain by aeolianitic limestone. Along the shoreline to the north of Monck Head, a limestone pavement underlies the nearshore. Towards Monck Head this limestone unit forms a low 1–2 m limestone cliff. The limestone headland of Monck Head has a height of 7 m and is backed by parabolic dunes.

From Monck Head to Point Maud the prevailing sediment transport direction is northwards and this is evidenced by the orientation of sand shoals at Monck Head, Skeleton Bay and Point Maud.

Immediately offshore of Monck Head there appears to be zone of active longshore sediment transport from south to north. However, north of Monck Head the shoreline is underlain by limestone pavement and there is little longshore sediment transport trapping in this region.

3. COASTAL GEOMORPHOLOGY AND PROCESS—IMPLICATIONS AND IMPACTS OF PROPOSED BOATING FACILITY

The coastal geomorphology and processes in the Coral Bay region will have important implications on the development of the proposed boating facility at each of the three sites. In addition, the development of the boating facility at these sites may impact on features of the prevailing coastal geomorphology and processes. These issues are described below for each site.

3.1 MAUDS LANDING

The marine and terrestrial elements of the boating facility if it were constructed at Mauds Landing are detailed below.

3.1.1 Marine Facilities

Dredging will not be required during construction but will be required periodically at the entrance to this facility. The following features will be included:

- An **offshore breakwater** will be constructed to provide shelter for a boat ramp, service jetty and mooring pens. The breakwater will be constructed through the placement of armour units and backloading of core material starting from the beach and moving offshore. A navigable water depth of at least 1.5 m Chart Datum will be provided within the harbour. The breakwater will also assist to minimise sedimentation within the harbour. It is expected that the material for the breakwater will be obtained from areas inland where rock has been obtained previously or is known to exist. However, if the rock is not suitable, or is not economically viable to extract, then rock will be obtained from the existing quarry in Exmouth and will be trucked to the site of the boating facility;
- A two lane **boat launching ramp** for use by trailered craft. A small finger jetty will be located between the ramps to facilitate loading of these craft;
- **Two service jetties** will be located within the boat harbour; and
- A limited number of **mooring pens**; and
- **Channel markers** to assist navigation on the approach to the boating facility. Channel markers will also be installed to mark navigation channels through the lagoon area, in particular the navigation passage which parallels the back reef from Monck Head to Point Maud.

3.1.2 Terrestrial Facilities

- The **existing access road** from the settlement to Mauds Landing is approximately 3.2 km long and will be upgraded to accommodate heavy vehicles for the transport of construction materials. The width of this carriageway will be widened to approximately 14.4 m;
- **Car parking** for approximately 100 vehicles which will include parking bays for vehicles with trailers, as well as parking for coaches if required to service charter boats (the total area of the carpark will be approximately 1 ha);
- Two on-site **water tanks** will be provided, one to provide fresh water for drinking and filling water tanks on non-trailered boats, and the second to provide groundwater for hand washing and fish cleaning. The two water tanks will be regularly filled by hauling water from Coral Bay;

- A **public toilet facility** which will use a sealed system. This system will not require water for flushing, will require minimal maintenance and does not result in leaching to the groundwater;
- **Fish cleaning facility** for cleaning, scaling and gutting of fish. Solid waste reception facilities shall be provided on site and these facilities will be disposed of at the present Coral Bay waste disposal site and the limited liquid waste will be discharged to a small groundwater soak;
- Diesel **fuel storage tanks.** It is anticipated that approximately 10,000 to 20,000 L of fuel will be stored at the facility. The diesel will be stored in two low profile steel storage tanks which will be located in a lined and bunded storage area. Refuelling for non-trailered vessels is intended as an interim measure until this function can be provided elsewhere, possibly at the proposed private Coral Coast Marina Development at Mauds Landing;
- A small **on-site generator** will be used to operate dieseline fuel pumps; and
- Limited **public lighting**.

3.1.3 Breakwater

The beach at Mauds Landing is relatively steep and beach cusps are typically present. Wave refraction analysis indicated that the prevailing offshore south-westerly swell is considerably refracted through Cardabia Passage and approaches parallel to the shoreline at Mauds Landing (Rogers & Associates, 1994). Hence, Rogers & Associates (1994) concluded that during typical conditions, the longshore sediment transport at Mauds Landing would be small. Modelling of the longshore sediment transport along this coastline during Tropical Cyclone Hazel indicated that in the vicinity of Mauds Landing there was a potential for approximately 9,000 m^3 of sediment to be transported southward along Bateman Bay (Port & Harbours Consultants, 1989). The construction of a breakwater at Mauds Landing would interrupt longshore sediment transport in this region and sediment bypassing may be required.

Analysis of shoreline change from 1971–1994 indicates that the shoreline at Mauds Landing is accreting at an average rate of 0.9 m year (Egis Consulting, 1997). Continued shoreline accretion at Mauds Landing may in time cause the swamping of the facility and a requirement for dredging.

3.1.4 Launching ramp, service jetties and mooring pens

The launching ramp, service jetties and mooring pens will be located within the breakwater complex and it is not expected that they will have a significant impact on the coastal geomorphology or processes of this region. Due to the exposure of this site to high-energy storm events it will be necessary to locate all moorings inside the breakwater.

3.1.5 Navigation considerations

The Mauds Landing site has a north-westerly aspect and is located in the lee of the Cardabia Passage, which represents a relatively large break in the Ningaloo Reef (Figure 1). Consequently, this site is subjected to relatively high-energy waves that approach from the north-west during storm or tropical cyclone events. The north-westerly aspect of the Mauds Landing site will also cause this site to be more exposed to storm induced surges. However, this location would be sheltered by Point Maud from the predominantly southerly winds and waves. It is considered that the wave energy that prevails in Bateman Bay would often preclude the safe passage of small trailered boats to and from the Mauds Landing site. Hence, the use of the

Mauds Landing boating facility by trailered craft would be restricted to periods of relatively low wave energy.

The seabed in the vicinity of Mauds Landing is sandy and reaches a water depth of 2.0 m within 100 m from the high water mark. Hence, it is expected that the requirement for dredging would be either small or unnecessary. If dredging were required, then it would be relatively easy due to the unconsolidated bottom material.

3.1.6 Access road

An access road to Mauds Landing exists but would require upgrading. However, it is not considered that upgrading this road would significantly impact on the coastal geomorphology or processes.

3.1.7 Carpark

It is recommended that the carpark at Mauds Landing be located in the foredune plain towards the primary dunes to obtain some shelter from the prevailing southerly winds and also to minimise overwash during cyclone events. It is recommended that drainage from the carpark be diverted to soaks and not discharged to sea. It is not expected that run-off to these drainage soaks would have a significant impact on the groundwater in this region.

3.1.8 Ablutions

A small dry-compost toilet facility could be located adjacent to the carpark. As this system would be completely sealed it will therefore not affect the groundwater and is not expected to have a significant environmental affect.

Small volumes of water will be required for drinking, hand washing and fish cleaning at the boating facility. These water requirements could be drawn from the existing deep wells in Coral Bay and would represent a very minor additional extraction from the existing groundwater resource. Hence, the impacts of the proposed boating facility on the groundwater resources in the Coral Bay region are expected to be extremely minor.

3.2 NORTH BILLS BAY

The marine and terrestrial components of the boating facility, if it were constructed at North Bills Bay, would be effectively the same as described above for Mauds Landing. However, at North Bills Bay, a smaller breakwater than that required at Mauds Landing would be constructed. One service jetty would be constructed at North Bills Bay and a 1.8 km two lane access road would be required to provide land access to the North Bills Bay site.

3.2.1 Breakwater

The North Bills Bay site is located in the lee of the Ningaloo Reef and is well protected from the offshore swell wave energy by the reef. However, this site has a south-westerly aspect and is therefore exposed to the prevailing southerly winds and local wind waves. Sediment transport at North Bills Bay is northward and the construction of a breakwater would result in sediment accretion on the south-eastern side of the boating facility and erosion on the north-western side of the facility. Careful design of the breakwaters may enable some natural bypassing of sediment; however, it is considered that regular mechanical sediment bypassing would still be required.

Analysis of shoreline change indicated that the shoreline in this region has accreted an average width of 10 m between 1971 and 1994 which represents an average accretion of 0.4 m per annum (Egis Consulting, 1997).

3.2.2 Launching ramp and service jetty

A launching ramp and service jetty will be located inside the breakwater and it is not expected that they will have a significant impact on the coastal geomorphology or processes of this region.

3.2.3 Navigation considerations

A boating facility at the North Bills Bay site would be closer to the Cardabia Passage and hence could encourage boats travelling outside the reef to use this Passage rather than the more dangerous Yalobia Passage to the south.

The hydrographic chart for Coral Bay is presently being revised and will carry caution notes similar to the Coral Bay Boating Guide (Department for Planning and Infrastructure, 2001) which states *"Yalobia Passage breaks and becomes dangerous for navigation during times of heavy swell and/or low tides. The lead markers into Yalobia Passage are sometimes difficult to see at various times of the day and in hazy conditions. Yalobia Passage should only be attempted by experienced mariners"*. Copies of the Boating Guide are available free of charge and will be made available in Coral Bay. Caution signs regarding the Yalobia Passage will also be installed at the Boating Facility if constructed at North Bills Bay.

Boats (particularly smaller boats) that seek the sheltered waters to south of Coral Bay would be required to leave the North Bills Bay facility and travel past Point Maud into Bateman Bay before proceeding south along the recommended boating track inside the reef.

Boating access along the inside of the fringing reef, along the recommended boating track, would require marked navigation channels to ensure safe boat passage. The location of a boating facility at North Bills Bay is likely to increase the number of boats in southern Bateman Bay, hence it may be necessary to install some isolated danger navigation markers to mark the submerged pile of the jetty at Mauds Landing (note that these "jetty ruins" are already marked on the hydrographic chart of the area). The majority of the navigation markers would most likely be installed as spar buoys. If necessary, larger markers will be installed using drilling methods to avoid pile-driving operations wherever possible.

3.2.4 Access road

Access to the North Bills Bay site will be partly facilitated by the existing access road to Mauds Landing; however, it will be necessary to construct an access road through the dunes of Point Maud from Mauds Landing to North Bills Bay. Care should be taken during the construction of this access road to avoid the development of regions of dune instability resulting from the removal of the vegetation as these dunes are composed of unconsolidated aeolian deposits with very little soil development.

To reduce the potential for dune instability due to the construction of the access road the majority of the route should be located within the dune swales and crossing of the dune crests should be routed to cross at the low points. Where possible, the orientation of these dune crest crossings should be perpendicular to the prevailing south to south-westerly wind direction to avoid wind funnelling and erosion along the access route. Revegetation and placement of brush or matting on the exposed dune sands adjacent to the access road should be conducted to avoid wind erosion alongside the access road.

3.2.5 Carpark

It is recommended that the carpark at North Bills Bay be located in the swale behind the primary foredune to minimise the exposure of the carpark to the prevailing southerly winds. This location will help to reduce erosion at the edges of the carpark and sand transport across the carpark. It is recommended that drainage from the carpark be diverted to drainage soaks and not discharged to sea. However, it is not expected that run-off to these drainage soaks would have a significant impact on the groundwater in this region.

3.2.6 Ablutions

A small dry-compost toilet facility could be located adjacent to the carpark. As this system would be completely sealed it will therefore not affect the groundwater and is not expected to have a significant environmental affect.

Small volumes of water will be required for drinking, hand washing and fish cleaning at the boating facility. These water requirements could be drawn from the existing deep wells in Coral Bay and would represent a very minor additional extraction from the existing groundwater resource. Hence, the impact of the proposed boating facility on the groundwater resources in the Coral Bay region are expected to be extremely minor.

3.3 MONCK HEAD

At Monck Head, dredging will not be required during construction and only minor excavation work near the toe of the boat ramp would be required infrequently. The marine and terrestrial elements of a proposed boating facility at Monck Head are described below.

3.3.1 Marine facilities

- An **offshore boat launching ramp**. This will be built as a rubble mound structure with two ramps facing north east. A navigable water depth of at least –1.0 m Chart Datum will be provided at the base of the boat ramp. The breakwater will be constructed through the placement of armour units and backloading of core material via the piled bridge and culvert causeway. It is expected that the rock material for the boating facility will be obtained from a pre-exiting quarry;
- A **piled bridge and culvert causeway** will connect the offshore boat launching ramp to the shoreline. This structure will not interrupt longshore sediment movement;
- **Two jetties** will be placed on either side of the two ramps. The western jetty will provide a degree of wave screening to the ramp and will also assist boat loading and the unloading and refuelling of larger non-trailered vessels. It is likely that current shear protection will be required at the toe of the rubble mound structure to minimise the effects of sediment scour; and
- **Channel markers** to assist navigation on the approach to the boating facility. Channel markers will also be installed to mark navigation channels through the lagoon area, in particular the navigation passage which parallels the back reef from Monck Head to Point Maud.

3.3.2 *Terrestrial facilities*

- The **existing access road** from the settlement to Monck Head is approximately 1.5 km long and will be upgraded to accommodate heavy vehicles for the transport of construction materials. The width of this carriageway will be widened to approximately 14.4 m;
- **Car parking** for approximately 100 vehicles which will include parking bays for vehicles with trailers, as well as parking for coaches, if required, to service charter boats (the total area of the carpark will be approximately 1 ha);
- Two on-site **water tanks** will be provided, one to provide fresh water for drinking and filling water tanks on non-trailered boats, and the second to provide groundwater for hand washing and fish cleaning. The two water tanks will be regularly filled by hauling water from Coral Bay;
- A **public toilet facility** which will use a sealed system. This system will not require water for flushing, will require minimal maintenance and does not result in leaching to the groundwater;
- **Fish cleaning facility** for cleaning, scaling and gutting of fish. Solid waste reception facilities shall be provided on site and these facilities will be disposed of at the present Coral Bay waste disposal site and the limited liquid waste will be discharged to a small groundwater soak;
- Diesel **fuel storage tanks.** It is anticipated that approximately 10,000 to 20,000 L of fuel will be stored at the facility. The diesel will be stored in two low profile steel storage tanks which will be located in a lined and bunded storage area. Refuelling for non-trailered vessels is intended as an interim measure until this function can be provided elsewhere, possibly at a private development at Mauds Landing;
- A small **on-site generator** may be required to operate dieseline fuel pumps; and
- Limited **public lighting**.

3.3.3 *Piled bridge and culvert causeway and offshore launching ramp*

This structure will connect the offshore boat launching ramp with the shoreline. This will be an open structure and therefore is not expected to interrupt longshore sediment transport or have a significant impact on the coastal processes in this area. The offshore launching ramp will cause some sheltering of wave energy on the shoreward side and therefore minor localised sedimentation in this area is likely.

3.3.4 *Navigation considerations*

The Monck Head facility would be located along the existing recommended boating track to and from Southern Bills Bay. As such, boats travelling from the Monck Head site will have reduced travel time from the existing Southern Bills Bay site. Vessels travelling from Coral Bay to the outer side of the fringing reef have two routes available: the Yalobia (south) Passage or the Cardabia (north) Passage.

The hydrographic chart for Coral Bay is presently being revised and will carry caution notes similar to the Coral Bay Boating Guide (Department for Planning and Infrastructure, 2001) which states *"Yalobia Passage breaks and becomes dangerous for navigation during times of heavy swell and/or low tides. The lead markers into Yalobia Passage are sometimes difficult to see at various times of the day and in hazy conditions. Yalobia Passage should only be attempted by experienced mariners"*. Copies of the Boating Guide are available free of charge and will be made available in Coral Bay. Caution signs regarding the Yalobia Passage will also be installed at the Boating Facility if constructed at Monck Head.

Boating access along the inside of the fringing reef, along the recommended boating track, would require marked navigation channels to ensure safe boat passage. The markers would most likely be spar buoys. Driven pile markers would be avoided if possible.

3.3.5 Access road

Two tracks extend south from the Coral Bay settlement and converge prior to reaching Monck Head. These roads are well located in the dune swales and have not initiated dune instabilities. The soil structure in this region should enable easy upgrade of these roads which would be required to accommodate traffic to the boating facility. Several other tracks occur in the vicinity of Monck Head and it is recommended that the need for these other tracks be reviewed and the unnecessary roads could be rehabilitated.

3.3.6 Carpark

It is recommended that the carpark be located approximately 300 m north of Monck Head in the flat dune swale area. This area has relatively stable soils and the carpark would be designed to blend with the existing contours. It is recommended that drainage from the carpark be diverted to soaks and not discharged to sea. It is not expected that run-off to these drainage soaks would have a significant impact on the groundwater in this region.

3.3.7 Ablutions

A small dry-compost toilet facility could be located adjacent to the carpark. As this system would be completely sealed it is not expected to have a significant environmental affect.

Small volumes of water will be required for drinking, hand washing and fish cleaning at the boating facility. These water requirements could be drawn from the existing deep wells in Coral Bay and would represent a very minor additional extraction from the existing groundwater resource. Hence, the impact of the proposed boating facility on the groundwater resources in the Coral Bay region are expected to be extremely minor.

4. RECOMMENDATIONS AND MITIGATION MEASURES

To minimise wind erosion during the development of the access road and carpark it is recommended that construction of these facilities be conducted during the winter months (May to August) if possible. During this period, the wind strength is typically lighter and combined with rainfall events will help to minimise wind erosion.

To minimise wind erosion adjacent to the access road it is recommended that the orientation of dune crossings and the final approach to the beach be oriented perpendicular to the prevailing southerly wind direction (i.e. orient in a north-westerly direction). In addition, any exposed cuttings through the dunes should be rehabilitated and replanted as soon as possible to minimise the effects of wind erosion.

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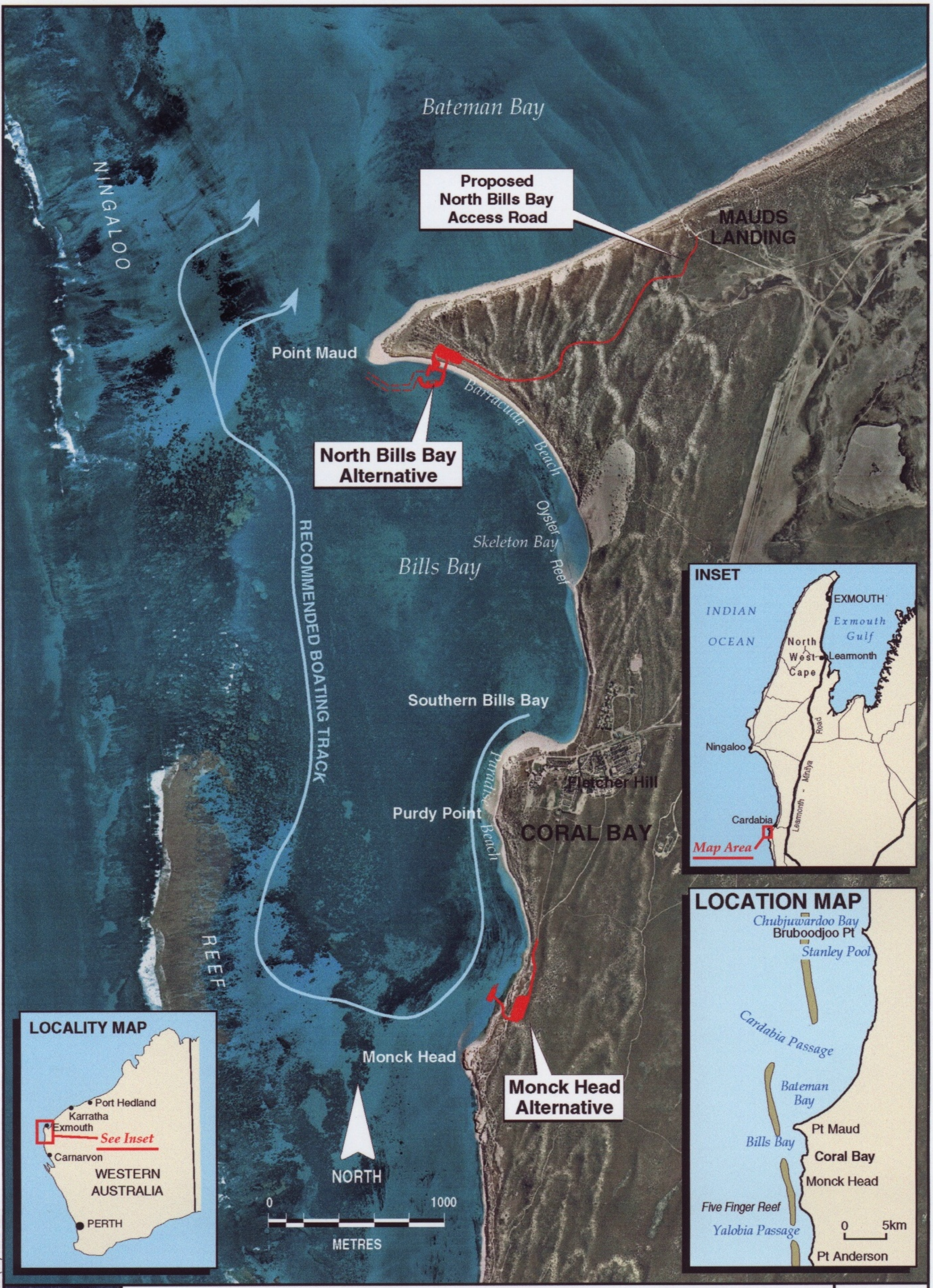
FIGURES



Fri 17 May

ENVIRONMENTAL DRAFTING (08) 9278 8211

Department for Planning and Infrastructure

CORAL BAY BOATING FACILITY PUBLIC ENVIRONMENTAL REVIEW

LOCATION DIAGRAM

Figure

1

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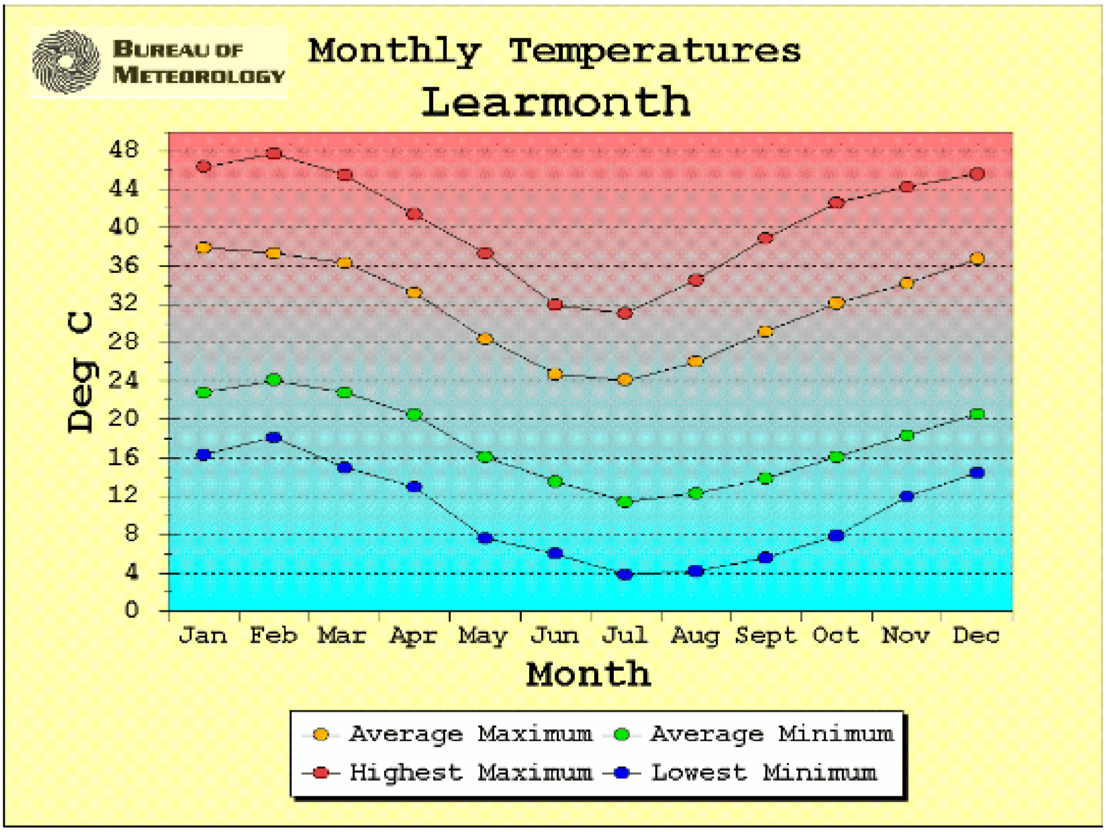
A



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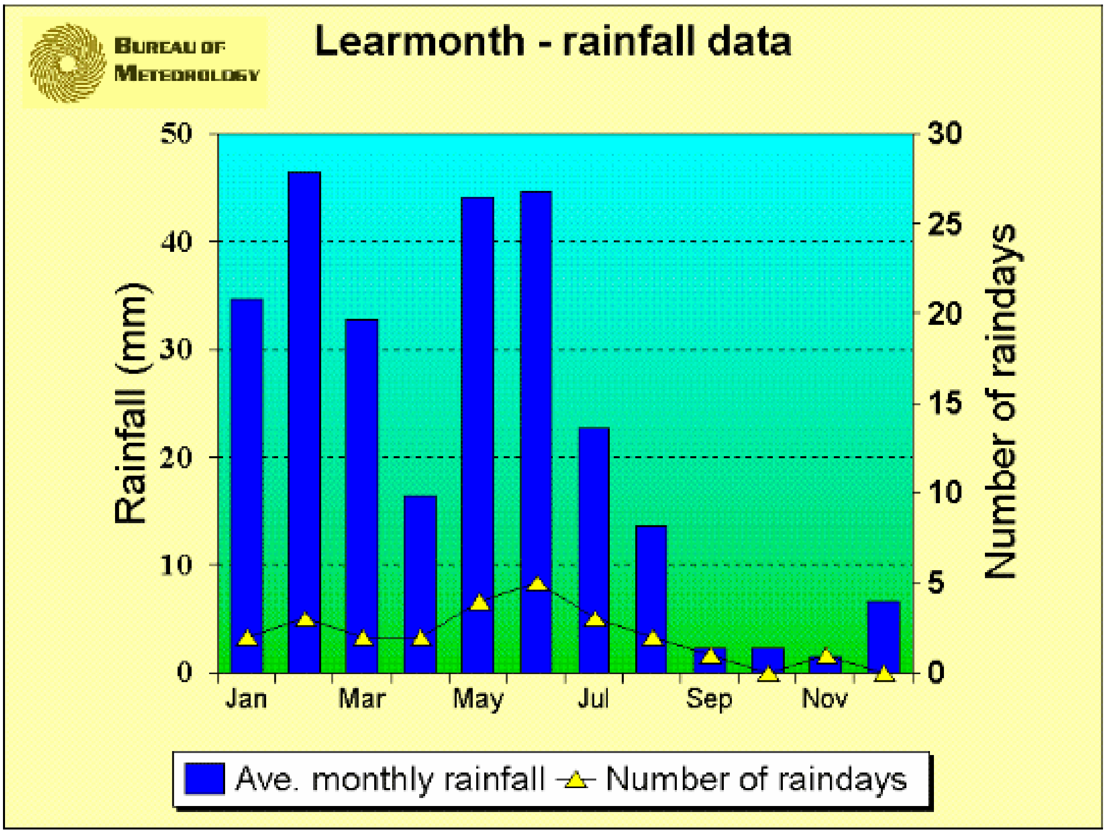

Figure 2 Monthly (A) temperature and (B) rainfall data for Learmonth

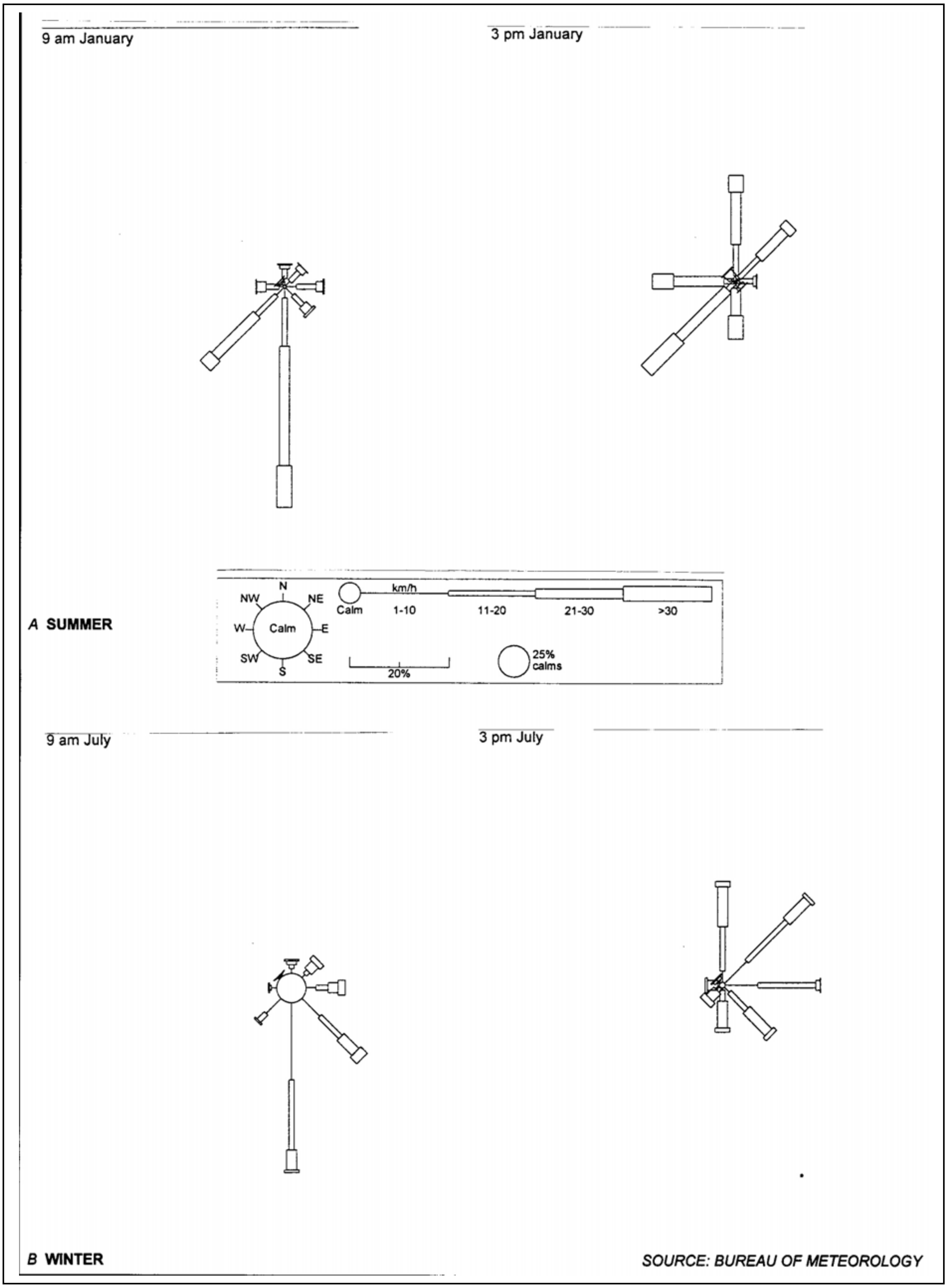

Figure 3 Wind roses for Learmonth for (A) summer and (B) winter

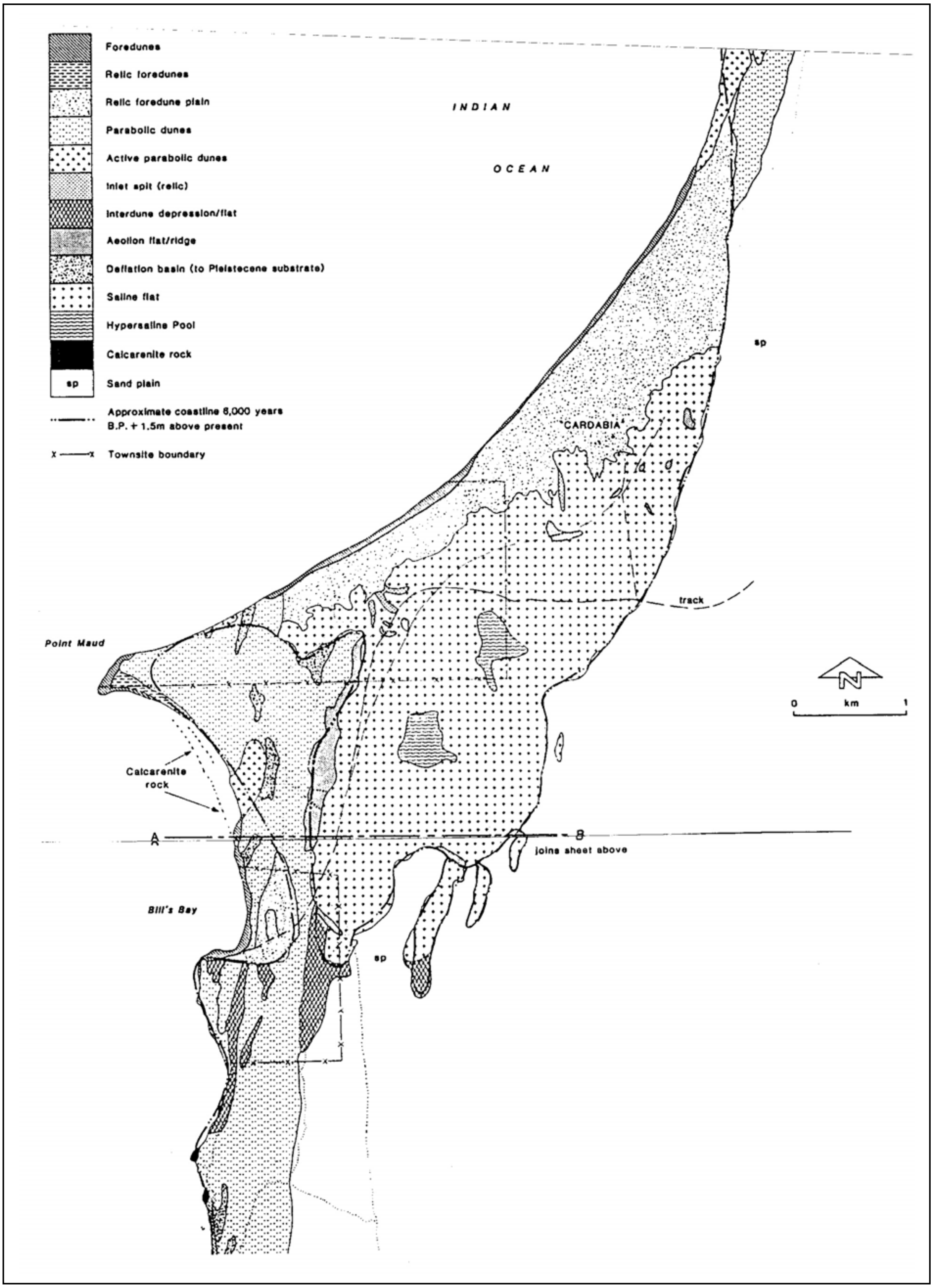

Figure 4 Coastal geomorphology of the Coral Bay region

Figure 5 (top) View west from Mauds Landing across foredune plain backed by parabolic dunes; (bottom) intersection of outermost beachrock ridge with shoreline in Bills Bay

Figure 6 (top) Shoreline at North Bills Bay; (bottom) low limestone cliff north of Monck Head

TECHNICAL APPENDIX 2
CORAL BAY BOATING FACILITY
MARINE WATER AND SEDIMENT QUALITY

Prepared for:

DEPARTMENT FOR PLANNING AND INFRASTRUCTURE

Prepared by:

DAL SCIENCE & ENGINEERING PTY LTD

AUGUST 2002

REPORT NO. 97/050/23

CONTENTS

TABLES

FIGURE

EXECUTIVE SUMMARY

Coral Bay is a small coastal tourist settlement adjacent to the Ningaloo Reef and situated on the southern shore of Bills Bay, North West Cape (Western Australia). Due to the increase in boating activity in the Coral Bay region, there is a need for a boating facility. The Department for Planning and Infrastructure (DPI) is presently investigating the development of a boating facility that aims to remove all boating activity (except glass bottomed tour boats) from the southern end of Bills Bay. It is anticipated that this relocation of boating activity will help to minimise the physical damage to the coral formations, reduce the risk of fuel spills and increase the safety of swimmers in the southern end of Bills Bay. The proposed boating facility includes a boat launching ramp, jetty, refuelling facilities, carpark, toilet block, and fish cleaning area.

The following document presents the results of investigations into marine water quality and marine sediment quality. This Appendix examines three alternative sites: Mauds Landing, North Bills Bay and Monck Head. Note that it is proposed that a boating facility only be developed at one of these sites.

At all three sites, the construction of the proposed boating facility may result in a slight increase in turbidity, but this will be small scale, localised and of very short duration. Once operational, the boating facility is not expected to have a significant deleteriously affect water or sediment quality due to its design features (e.g. the use of a sealed dry-compost system the public toilet) and small size.

Surface run-off from the carpark and launching ramp may result in slight contamination of nearshore waters and sediments, due to fuel spillage from boat fuel tanks, oil leakage from cars, tyre rubber, paint, and rust flakes. However, the boats that will use the proposed facilities already currently launch off the beach at Southern Bills Bay, and studies carried out by the Department of Environmental Protection (DEP) in 1994 did not detect any contamination of waters in this area, whilst sediments showed no evidence of metal contamination, and only slight traces of polycyclic aromatic hydrocarbons (PAHs). The level of contamination of coastal waters and sediments at properly designed facilities will probably be less than current contamination at Southern Bills Bay, that is, beyond analytical detection limits in many cases, apart from Tributyltin (TBT) levels in sediments.

TBT is an ingredient in anti-fouling paints used on boat hulls of larger boats, and is highly toxic to many marine organisms. Hence, mooring of larger vessels may result in negative impacts on the TBT concentrations in the underlying sediments. DEP studies have shown that that TBT contamination of sediments is already occurring with informal mooring arrangements at Southern Bills Bay and Monck Head (which is apparently used occasionally as a temporary mooring area for large vessels unable to get into Bills Bay). Unlike the present informal mooring arrangements, the chance of TBT contaminated sediments affecting marine communities outside a properly designed boating facility is considered to be negligible.

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1. BACKGROUND

Coral Bay is a small coastal tourist settlement adjacent to the Ningaloo Reef and situated on the southern shore of Bills Bay, North West Cape (Western Australia) (Figure 1). It is presently the only settlement along the Ningaloo Reef Marine Park which offers formal accommodation, fuel and shopping facilities. Hence, the settlement represents one of the few focus points for recreational and commercial marine-based activities in this region. The marine-based activities occurring in Coral Bay include swimming, snorkelling and fishing; in addition commercial diving and coral viewing operations operate from Coral Bay.

Due to the increase in boating activity in the Coral Bay region, there is a need for a boating facility. The DPI is presently investigating the development of a boating facility which aims to remove all boating activity (except glass bottomed tour boats) from the southern end of Bills Bay. It is anticipated that this relocation of boating activity will help to minimise the physical damage to the coral formations, reduce the risk of fuel spills and increase the safety of swimmers in the southern end of Bills Bay. The proposed boating facility includes a boat launching ramp, two small breakwaters, jetty, refuelling facilities, carpark, toilet block and fish cleaning area.

All development proposals in Western Australia are subject to an environmental impacts assessment process under the Environmental Protection Act 1986. Accordingly, DPI appointed a team of consultants headed by DAL Science & Engineering Pty Ltd (DALSE—formerly D.A. Lord & Associates [DAL]) to examine the environmental aspects of this development and, towards this end, a Notice of Intent (NOI) for the Coral Bay boating facility was submitted to the Environmental Protection Authority (EPA) in December 1997 (DAL, 1997). The level of assessment was determined by the EPA to be a Public Environmental Review (PER) and was advertised by the EPA in mid-January 1998.

The following document presents the results on investigations into marine water quality and marine sediment quality. Three alternative sites were examined in this document for the siting of the boating facility were: Mauds Landing, North Bills Bay and Monck Head (Figure 1). Note that it is proposed that a boating facility only be developed at one of these three sites.

2. EXISTING ENVIRONMENT

2.1 MARINE WATER QUALITY

A water quality survey of the Coral Bay region was undertaken by the Department of Environmental Protection (DEP) in September/October 1994, and included the three sites that are the subject of this PER (Simpson and Field, 1995). The survey found that waters at all three sites were generally clear, nutrient-poor, low in phytoplankton biomass (as expressed by chlorophyll a concentrations), and had no evidence of faecal contamination (as determined by levels of thermo-tolerant coliforms and faecal streptococci). However, the survey recorded elevated levels of inorganic nitrogen and faecal bacteria at the south-eastern corner of Bills Bay, adjacent to the settlement (Simpson and Field, 1995). An area within 200 m of the shore at the south-eastern corner of Bills Bay also had relatively higher levels of macroalgal biomass, phytoplankton biomass and light attenuation (a measure of water clarity) compared to sites further from the settlement.

A further survey of marine water quality was carried out on 26 March 1998 as part of the present study, with two filtered and two unfiltered samples taken at Mauds Landing (water depth 2.5 m), North Bills Bay (water depth 0.9 m), Southern Bills Bay (water depth 0.6 m) and Monck Head (water depth 1.2 m) (Figure 1). The samples were analysed for inorganic phosphorus (HPO_4), organic phosphorus, total phosphorus, ammonium (NH_4), nitrate-+ -nitrite (NO_x), Kjeldahl nitrogen, total nitrogen and chlorophyll a concentrations by the Marine and Freshwater Research Laboratory at Murdoch University, and the results are shown in Table 1.

Table 1 Water quality data obtained on 26 March 1998

SITE*	PARAMETER								
	NH_4 (µg N/L)	**NO_x (µg N/L)**	**Organic (µg N/L)**	**Kjeldahl (µg N/L)**	**Total (µg N/L)**	**HPO_4 (µg P/L)**	**Organic (µg P/L)**	**Total (µg P/L)**	**Chl. A (µg/L)**
Detection limit	**<3**	**<2**	**<60**	**<60**	**<60**	**<2**	**<10**	**<10**	**<0.1**
North Bills Bay	11–12	8–11	154–155	166	174–177	5	13–15	18–20	1.4–1.7
Southern Bills Bay	13	16–17	113–143	126–156	143–172	8	11	19	0.9–1.0

** AMG84 coordinates (zone 49)— North Bills Bay: 783190 (easting); 7439900 (northing). Southern Bills Bay: 783544 (easting); 7438024 (northing).*

2.1.1 All three sites

There was little difference between the sites. The data on inorganic and organic phosphorus concentrations obtained in this study were similar to the data reported by Simpson and Field (1995), whilst the levels of ammonium and nitrate + nitrite were slightly higher. Data obtained in the present study were also similar to concentrations of Kjeldahl nitrogen (120–210 µg N/L) and total phosphorus (10–40 µg P/L) measured in Southern Bills Bay and Monck Head by the DEP in March 1998 (DEP unpublished data[1]). However, Simpson and Field (1995) report much lower concentrations of organic nitrogen (13–32 µg N/L), Kjeldahl nitrogen (23–39 µg N/L) and chlorophyll a (0.07–0.16 µg/L). As there was little difference between the sites in each survey, the difference in water quality between the surveys is considered to be a natural seasonal variation (Simpson and Field's data were obtained in September and October, whilst the present survey and the recent DEP

[1] Courtesy of Mr Peter Skitmore, DEP.

survey were conducted in March). The magnitude of seasonal differences reported here are similar to those encountered in nearshore coastal waters off Perth, although they occur at different times of the year (Thompson, 1997).

The faecal bacterial data of Simpson and Field (1995) also contrast with data collected by the Shire of Carnarvon; the latter showing little or no bacterial contamination of waters in the south-eastern corner of Bills Bay. Simpson and Field (1995) suggest the differences are due to their samples being analysed on the same day as collection, whereas samples collected by the Shire of Carnarvon were not submitted until the day after collection, during which time bacterial die-off may have occurred. Nonetheless, data on monthly measurements of faecal bacteria in water samples taken by the Shire in the inner south-eastern corner of Bills Bay in 1996 indicate that national water quality guidelines for bathing (ANZECC, 1992) would be met even if bacterial populations in the water samples had declined by 90% in the time taken for delivery to the PathCentre in Perth (the laboratory where bacterial analysis is carried out): it is unlikely that this level of bacterial die-off would have occurred in samples stored on ice in the dark (Caldwell Connell Engineers, 1980).

Simpson and Field (1995) suggested that the elevated faecal bacteria observed in the south-eastern corner of Bills Bay were related to groundwater contamination. However, examination of the data shows that faecal streptococci were only found in one out of ten groundwater sites sampled near the settlement, and thermo-tolerant coliforms were not measured in any of these groundwater samples. Due to the relatively sheltered nature of the inner south-eastern corner of Bills Bay, the elevated faecal coliforms are more likely to be due to intense levels of recreational use (swimming and boating), as part of the sampling period coincided with the term three school holiday break. It is well established that contamination of waters can occur from recreational users, with the level of recreational use of particular importance in waters with restricted exchange (WHO/UNEP, 1991; Papadakis *et al*, 1997).

2.2 MARINE SEDIMENT QUALITY

The DEP survey of water quality in 1994 also included a detailed analysis of sediment quality at the same sites. The sediments at the three sites considered in the present study are generally coarse calcareous sand, with the majority (58–71%) of particles in the size range 150–600 μm (Simpson and Field, 1995). Particle size analysis data from Simpson and Field (1995) are shown in Table 2.

Table 2 Particle size analysis of sediments at North Bills Bay (Simpson and Field, 1995)

SITE	% OF SEDIMENT IN EACH PARTICLE SIZE RANGE (μm)				
	>1,000	1,000–600	600–150	150–38	<38
North Bills Bay	10.4	6.8	58.4	23.5	0.9

Levels of heavy metals, pesticides, polychlorinated biphenyls (PCB) and polycyclic aromatic hydrocarbons (PAHs) in the sediments were generally low and indicative of pristine sediments at all sites (excepting some analytes at Mauds Landing as described below). Extremely high tributyltin (TBT) levels (3,412–10,237 μg/kg) were found at other sites adjacent to the mooring locations of large boats in Southern Bills Bay. TBT is highly toxic to many marine organisms, and regulations prohibiting the use of TBT on boats under 25 m (and restricting its use to low leaching forms on boats over 25 m) became effective in Western Australia on 1 November 1991 (Simpson and Field, 1995). Simpson and Field (1995) expressed concern about the high levels of TBT found at some sites, because the absence of

TBT breakdown products indicated that the contamination was relatively recent (1991 or afterwards).

2.2.1 Mauds Landing

Sediment particle size at Mauds Landing is coarser than that at the other two sites. This site had slightly higher levels of arsenic, chromium, iron, manganese and zinc (Simpson and Field, 1995). Low concentrations of TBT were found.

2.2.2 North Bills Bay

Sediments at the North Bills Bay site were similar to that at Monck Head site, but finer than that at Mauds Landing. (TBT), the active ingredient in anti-fouling paints applied to the hull of boats, was found in low concentrations at the North Bills Bay site (Simpson and Field, 1995).

2.2.3 Monck Head

Sediments at the Monck Head site were very similar to that at North Bills Bay, but finer than that at Mauds Landing. High concentrations (200–463 µg/kg) of TBT were found at Monck Head, which is apparently used occasionally as a temporary mooring area for large vessels unable to get into Bills Bay (R. Karniewicz *pers. comm.*, referenced in Simpson and Field, 1995).

3. PREDICTED ENVIRONMENTAL IMPACTS

3.1 MARINE WATER QUALITY

3.1.1 Physical and chemical characteristics

All three sites

The construction of breakwaters and/or boat ramps at any of the sites will result in turbidity due to fine particulates in the adjacent water column. The length of time taken for suspended particles to settle out depends on their size, and this can be roughly approximated using Stokes fall velocity. Sand particles greater than 100 μm settle out in 2 m of water in less than five minutes, and fine particles (less than 38 μm) take half an hour to two hours or more.

The proposed boating facility will not be large (approximately two hectares), and neither will the associated breakwaters. Therefore, as the sediments at all three areas are relatively coarse sand (75–98% of particles are 150 μm or more in diameter), it is expected that any turbidity would be small scale, localised and of very short duration. Road construction and the associated increase in wind blown sediments could also increase turbidity in adjacent waters, but this is expected to be minimal due to the routine dust control measures required in road construction.

It is anticipated that the fuel storage tank(s) and on-site generator will be sited and constructed to ensure that fuel and lubricants do not contaminate surface run-off or groundwater. Fuel spill risks are addressed in detail in Technical Appendix 3 of the PER.

Nutrient enrichment of marine waters due to the boating facility is not expected, as the public toilet will use a sealed dry-compost system. The availability of these facilities should also minimise faecal contamination of nearshore waters. It is assumed that the fish cleaning facilities will be suitably sited and designed to ensure that nutrients do not contaminate surface run-off or groundwater and hence this component of the facility is not expected to impact negatively on the marine water quality. Provision of adequate rubbish bins is also assumed.

It is recommended that 'baseline' (pre-construction) water quality data be collected at the selected site(s) prior to construction of boating facilities, and post-construction monitoring be carried out annually: the temporal and spatial coverage of the monitoring programme should be discussed with CALM personnel. During construction, water quality monitoring should focus on changes in the turbidity of adjacent waters. Parameters measured during pre- and post construction phases should include inorganic and organic nutrient concentrations, turbidity, chlorophyll a, thermo-tolerant coliforms and faecal streptococci. It may also be appropriate to analyse some samples for PAHs.

North Bills Bay

There is a small potential for a very dilute plume (comprising fine particles) to drift over coral communities if construction takes place at the North Bills Bay site.

Monck Head

As with North Bills Bay, there is a slight potential for a very dilute plume of fine particles to drift over coral communities if construction takes place at this site.

3.1.2 Flushing within the boating facility

Mauds Landing

If the boating facility is located at Mauds Landing, the facility will probably be about 2 ha in area, 3.5 m deep, with a opening 40–50 m wide on the north-west side. The interior of the breakwater will have rounded sides and no barriers to prevent circulation. These features, in combination with semi-diurnal tides ranging from 0.4 m (neap tide) to 0.9 m (spring tide), should ensure that waters within the breakwater are well flushed by tidal action. Wind induced wave action from south-westerly seabreezes will also enhance water exchange.

North Bills Bay

The boat harbour at North Bills Bay will probably be 0.8 ha in area and at least 1.4 m in depth with a 30–40 m wide entrance to the west. The interior of the breakwater will have rounded sides and no barriers to prevent circulation. There may be a slight change in water quality within the enclosed waters of the boating facility (compared to water quality outside the breakwaters), simply due to the calmer conditions and increased residence time of the water. Based on tidal prism calculations, complete flushing due to tide alone will be achieved in two to six days, depending on whether a spring or neap tide occurs. This estimate is extremely conservative, as it does not allow for exchange due to wind (or boating activity). Due to the increase in residence time, slightly elevated chlorophyll levels and turbidity may occur within the boating facility, but the degree of this effect should be minimal as wind-stirring in the shallow waters of the boating facility is likely to prevent any significant degree of organic matter build-up in sediments (a key factor causing increased chlorophyll levels in enclosed waters). Furthermore, based on empirical data from larger, deeper and less well flushed structures in waters with similar tidal ranges (eg Hillary's boat harbour, Success Harbour; BBG, 2001), effects on water quality immediately outside the boating facility are expected to be negligible.

Monck Head

The boating facility option for Monck Head would be an open dual lane boat ramp and would enable free flushing. It is not anticipated that this option will substantially reduce the circulation and flushing characteristics of this area

3.2 MARINE SEDIMENT QUALITY

3.2.1 All three sites

Environmental impacts on marine sediment quality can be expected to be similar at all three sites. Simpson and Field (1995) have observed elevated levels of some contaminates within the sediments at several sites within Bills Bay that are likely to be due to boating activities. With the exception of TBT in Southern Bills Bay, the contaminants are well below levels likely to cause adverse effects on marine biota.
Boating activities, and possibly surface run-off from the carpark and launching ramp, of the proposed boating facility may likewise cause elevated levels of heavy metals in the sediments. However, as most boats would be trailered (and therefore not coated with anti-foulant) and the density of moored boats would be very low, the potential for contaminant accumulation should be extremely low and very localised.

As a result, the chances of sediment contaminants affecting nearby benthic communities are low. Mooring of larger vessels may result in negative impacts on the TBT concentrations in the underlying sediments: this is already occurring with informal mooring arrangements at Monck Head and Southern Bills Bay. However, (unlike the present informal mooring arrangements) the chance of sediment contaminants affecting benthic communities outside a properly designed boating facility is considered to be negligible.

Although there is no evidence of metal contamination, and only slight traces of PAHs, in sediments at the beach at Southern Bills Bay currently used for launching small boats (Simpson and Field, 1995), it is recommended that surface run-off from the carpark be directed to groundwater soaks, not to the ocean.

Regardless of which of the three sites are chosen for the boating facilities, sediment quality data from Simpson and Field's (1995) 1994 survey should support the 'baseline' (pre-construction) data. It is recommended that a baseline survey of sediment quality be conducted prior to construction and subsequent surveys two years and five years after construction. Further monitoring frequency will depend on the results of the first two surveys. Contaminants analysed should include heavy metals (especially arsenic, chromium, copper, iron, manganese, zinc and TBT), PCBs and PAHs.

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FIGURE

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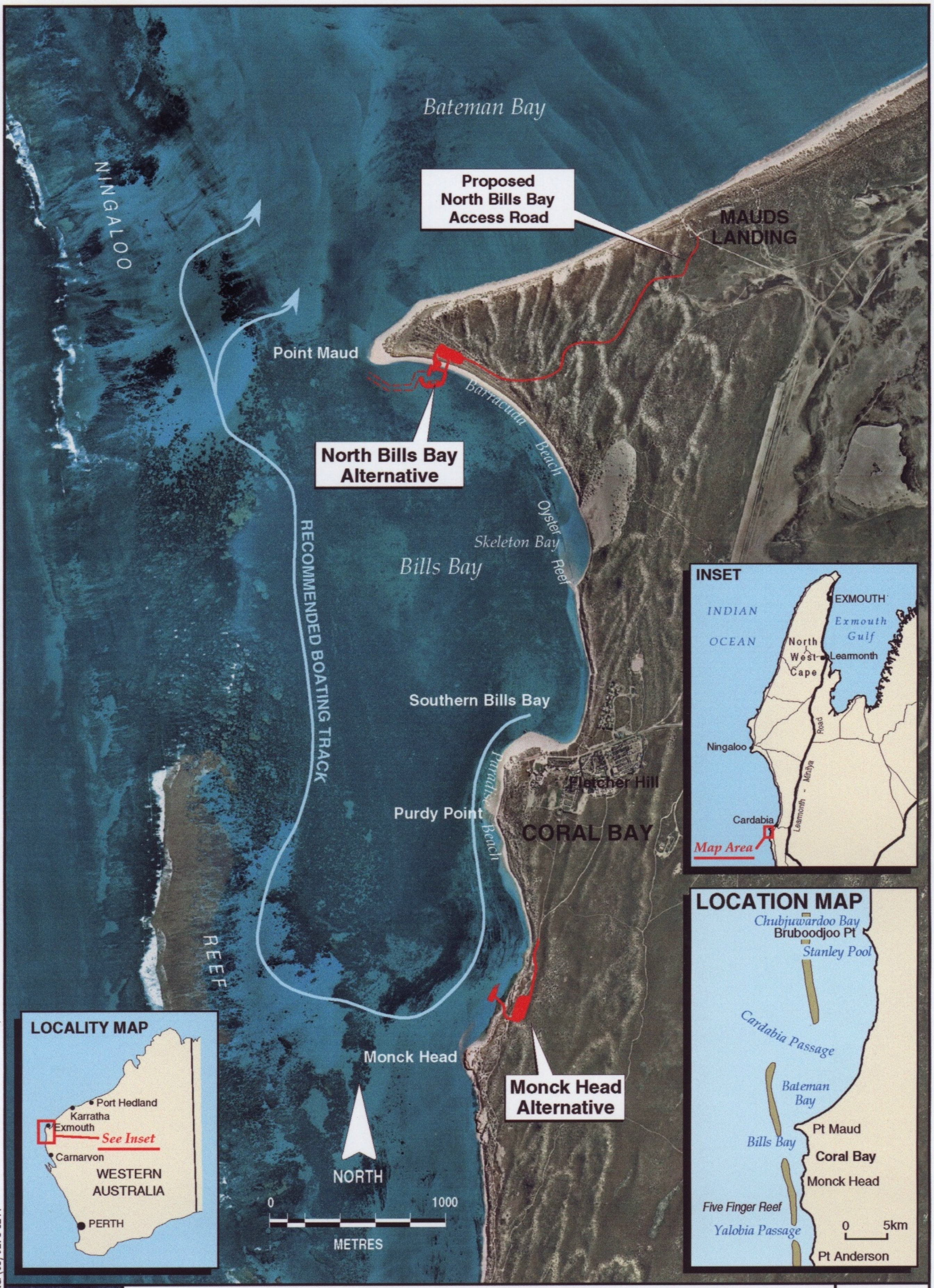

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Department for Planning and Infrastructure

CORAL BAY BOATING FACILITY PUBLIC ENVIRONMENTAL REVIEW

LOCATION DIAGRAM

Figure

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TECHNICAL APPENDIX 3
CORAL BAY BOATING FACILITY
FUEL SPILL ENVIRONMENTAL RISK ASSESSMENT

Prepared for:

DEPARTMENT FOR PLANNING AND INFRASTRUCTURE

Prepared by:

DAL SCIENCE & ENGINEERING PTY LTD

AUGUST 2002

REPORT NO. 97/050/24

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EXECUTIVE SUMMARY

Coral Bay is a small coastal tourist settlement adjacent to the Ningaloo Reef and situated on the southern shore of Bills Bay, North West Cape, Western Australia. The protected waters of Southern Bills Bay are a popular swimming area, and also the main site at which boat launching is conducted. Trailerable boats refuel at the facilities within the Coral Bay settlement. Refuelling of large boats is achieved by mooring the boats as close as possible to the shore at Southern Bills Bay, and then transferring fuel via a hose from a tank in a trailer parked at the waters edge.

The close proximity of boating and swimming activities in the Southern Bills Bay area is becoming increasingly undesirable as the growing number of tourists to the region cause an increasing risk of injury to swimmers. In addition, the amount of anchor damage and risk of fuel spills due to the increased boating activity within the Southern Bills Bay area is becoming unacceptable.

The Department for Planning and Infrastructure (DPI) proposes to develop a formal boating facility in the vicinity of Coral Bay. Three alternative sites for this facility were identified: Mauds Landing, North Bills Bay and Monck Head. Note, that it is proposed that a boating facility only be developed at one of these sites. A detailed assessment determined that none of the three sites could be precluded on engineering, management or environmental grounds. The proposed boating facility will provide services for both trailered craft and non-trailered vessels. The provision of refuelling facilities for the non-trailered boats at North Bills Bay or Monck Head is an interim solution pending any private development at Mauds Landing. If refuelling facilities become available at Mauds Landing as part of a private development, the temporary refuelling facilities that would be provided at either Monck Head or North Bills Bay may be de-commissioned.

There has been some concern amongst Coral Bay community members that if a fuel spill occurred in the vicinity of the interim refuelling facilities, the potential for environmental damage would be greater at Monck Head than at North Bills Bay. A risk assessment was therefore carried out to determine the relative environmental risks due to a spill at these two sites. The risk assessment also addressed the effect of fuel spills released in Southern Bills Bay as the ‘reference’ (i.e. present) condition.

RESULTS OF RISK ASSESSMENT

A standard SOURCE-PATHWAY-RECEPTOR analysis was used for risk assessment. Source assessment identified the potential sources, frequency and nature of fuel spills. Pathway analysis identified the ‘pathways’ by which spills could reach the ‘receptors’. Receptor analysis identified those receptors (e.g. corals, turtle, birds, recreational swimmers) likely to be affected by fuel spills.

The types of boat fuel that could potentially be spilled in the Coral Bay region (gasoline and diesel) are light refined products that would disperse and evaporate very quickly, particularly under the warm, windy conditions that are typical of the region. Gasoline leaves no residue after evaporation, and diesel leaves little residue (2%) that is readily biodegradable.

The ‘most probable’ fuel spill scenario from a refuelling facility at Coral Bay is a spill of 30 litres or less, and the ‘worst case’ scenario is a spill of 1,000 litres or more. However, the risk of the most probable scenario is extremely low, and the risk of the worst-case scenario is even lower.

Wind and currents largely determine the movement of fuel spills. Spill dispersion from the three sites was predicted using a simple numerical model that incorporated typical winds and

currents for the region, and evaporation rates for the types of fuel concerned. Although only diesel would be dispensed at the facility, both gasoline and diesel were modelled as this provided useful information on the likely effects of gasoline spills from boating accidents in the region.

North Bills Bay and Monck Head

Due to rapid dispersion and evaporation, a small-scale fuel spill (30 litres or less) would have negligible effects on the marine biota and recreational uses of the Coral Bay region. Gasoline and diesel were considered in this risk assessment and are both classified as light refined petroleum products with low densities, low viscosities and high proportion of volatile compounds. Gasoline is more volatile than diesel and more toxic to biota but also evaporates more rapidly than diesel hence reducing its exposure to organisms. A large-scale fuel spill (1,000 litres or more) would, at worst, be seen as an iridescent slick (about 0.0003 mm thick) over several square kilometres of water: gasoline slicks would be undetectable within two hours, and diesel spills would be hard to detect after six hours.

The coral communities at Coral Bay are all subtidal, and classified as receptors of *high* environmental sensitivity. However, even the most conservative calculations indicate that fuel concentrations in waters overlying corals would be far lower than levels at which toxicity effects occur.

North Bills Bay

The worst impacts of a large fuel spill would be felt by biota in intertidal limestone reef and sand habitats, as they would have direct contact with the spill. Under all the wind and current scenarios considered, a large spill of either type of fuel at North Bills Bay has the potential to affect the bird sanctuary at Point Maud, although a gasoline spill would rapidly evaporate. The area at Point Maud is classified as a receptor of *extreme* environmental sensitivity: oil contact can affect the health and development of the eggs and contact with birds' feathers can reduce the buoyancy of the birds. A large spill of diesel at Southern Bills Bay also has the potential to affect the Point Maud area under typical wind conditions in winter.

The impact of a fuel spill on human uses and public amenity (receptors of *moderate* environmental sensitivity) would be least severe at North Bills Bay, whereas the potential environmental impacts would be highest at this site.

Monck Head

A large spill at Monck Head would result in acute toxicity of some biota in areas of intertidal limestone reef and sand (receptors of *moderate* environmental sensitivity) under all the wind and current scenarios considered.

The worst impacts on human uses and public amenity (receptors of *moderate* environmental sensitivity) would be caused by fuel spills in Southern Bills Bay, followed by Monck Head. Monck Head offers the least risk of effects on receptors of *extreme* environmental sensitivity in the event of a large fuel spill.

Regardless of which site is chosen, the siting of facilities in a marine park requires that an appropriate pollution contingency management plan (PCMP) for fuel spills be prepared, and the necessary spill response equipment be maintained on site. The basic elements of an PCMP are provided in this document.

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1. INTRODUCTION

1.1 BACKGROUND

Coral Bay is a small coastal tourist settlement adjacent to the Ningaloo Reef and situated on the southern shore of Bills Bay, North West Cape, Western Australia (Figure 1). Coral Bay is presently the only settlement along the Ningaloo Reef Marine Park which offers formal accommodation, fuel and shopping facilities, and thus is one of the few focus points for recreational and commercial marine-based activities in this region. The settlement currently has a permanent population of approximately 50. However, during holiday periods (particularly in winter), the population increases by approximately 3,000–4,000 (Simpson and Field, 1995). The marine-based activities occurring in Coral Bay include swimming, snorkelling and fishing; in addition commercial diving and coral viewing operations operate from Coral Bay.

Formal boat launching facilities along the Ningaloo Reef coast are only provided at the Exmouth Marina and Bundegi and Tantabiddi boat ramps; all approximately 160 km north of Coral Bay. Boat launching at Coral Bay is, at present, conducted off the beach in the protected Southern Bills Bay area. Trailered boats refuel at the facilities within the Coral Bay settlement. Refuelling of large boats is achieved by mooring the boats as close as possible to the shore at Southern Bills Bay, and then transferring fuel via a hose from a tank in a trailer parked at the waters edge.

The protected waters of Southern Bills Bay contain coral gardens and are a popular swimming area. The close proximity of boating and swimming activities in the Southern Bills Bay area is becoming increasingly undesirable as the growing number of tourists to the region causes an increasing risk of injury to swimmers (MfP, 1996b). In addition, the amount of anchor damage and higher risk of fuel spills due to the increased boating activity within the Southern Bills Bay area is becoming unacceptable.

The Department for Planning and Infrastructure (DPI) proposes to develop a formal boating facility in the vicinity of Coral Bay. Three alternative sites for this facility were identified: Mauds Landing, North Bills Bay and Monck Head. Note that it is proposed that a boating facility only be developed at one of these three sites. A detailed assessment determined that none of the three sites could be precluded on engineering, management or environmental grounds. The proposed boating facility will provide services for both trailered craft and non-trailered vessels. The provision of refuelling facilities for the non-trailered boats at North Bills Bay or Monck Head is an interim solution pending any private development at Mauds Landing. If refuelling facilities become available at Mauds Landing, the refuelling facilities at either Monck Head or North Bills Bay will be de-commissioned.

There has been some concern amongst the Coral Bay community that if a fuel spill occurred in the vicinity of the interim refuelling facilities built at Monck Head, the potential for environmental damage would be greater than from similar facilities at North Bills Bay. The rationale behind this concern is that if a fuel spill occurred, the prevailing northerly currents would be more likely to transport fuel over corals at Monck Head than at North Bills Bay. To address these community concerns, DPI commissioned DAL Science & Engineering Pty Ltd (DALSE—formerly D.A. Lord & Associates Pty Ltd [DAL]) to conduct an environmental risk assessment of fuel spills at the North Bills Bay and Monck Head sites. For comparison, the impacts of a fuel spill at the existing fuelling location, Southern Bills Bay has also been considered. The findings of this assessment are documented in this report.

1.2 PROPOSED BOATING FACILITY OPTIONS

The proposed boating facilities at either the North Bills Bay or Monck Head sites would include fuel storage tanks and possibly a small on-site generator to operate dieseline fuel pumps. The use of refuelling facilities at either site will only be allowed by registered operators. Trailerable boats will have to refuel in the car park or at the facilities in the Coral Bay settlement. The provision of fuelling facilities at either of these two sites is proposed as an interim measure pending any development of a private facility at Mauds Landing.

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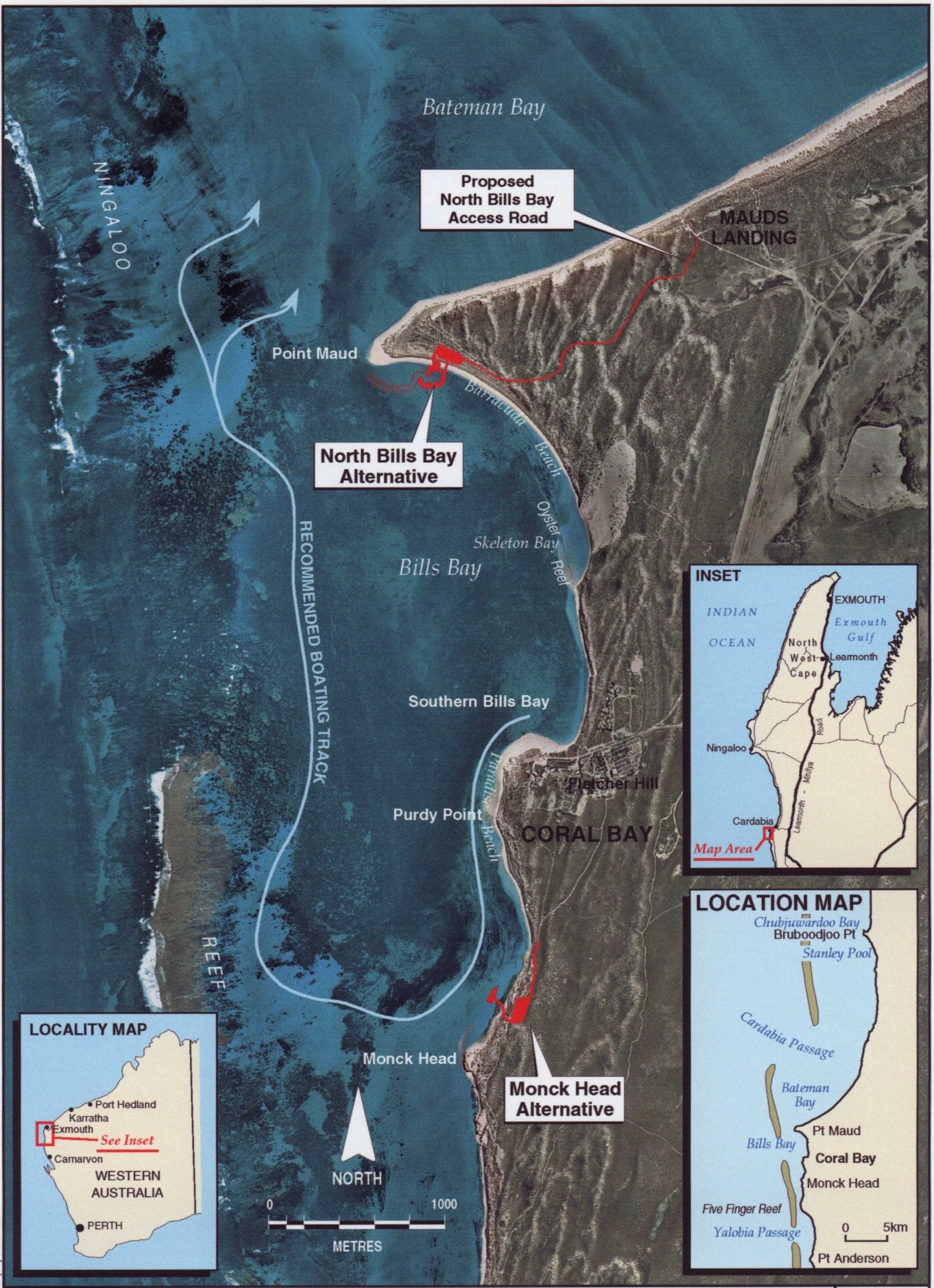

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CORAL BAY BOATING FACILITY PUBLIC ENVIRONMENTAL REVIEW

LOCATION DIAGRAM

Figure 1

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2. KEY CHARACTERISTICS OF FUEL SPILLS

The fuels that could be spilled from boats and/or refuelling facilities in the Coral Bay region are gasoline (petrol) and diesel, which are only two of the hundreds of different types of petroleum hydrocarbon products (e.g. condensate, crude oil, bunker fuel oil, stove oil, kerosene etc.) that are usually grouped under the generic term ‘oil’. Before assessing the risks associated with fuel spills in the Coral Bay region it is appropriate to consider some key aspects of ‘oil’ spill behaviour.

Oil is more buoyant than water, and when spilled it rapidly spreads out over the water surface as a slick of variable thickness. Transport of the slick occurs via two processes: spreading (controlled in turn by surface tension, fuel viscosity, friction, gravity and inertia), and advective processes (due to wind and currents). Wind is an important factor in the movement of a slick, which generally moves in the same direction as the prevailing winds at 3–4% of the wind speed (National Research Council, 1985; Swan *et al*., 1994). Spreading and advection cause a rapid increase in the exposure area of the fuel to ‘weathering’ processes, which include evaporation, dissolution, vertical dispersion, emulsification, sedimentation, oxidation and biodegradation (Figure 2). Evaporation is by far the dominant process for the types of fuel being considered in this document: emulsification and sedimentation are only important for heavier fuels.

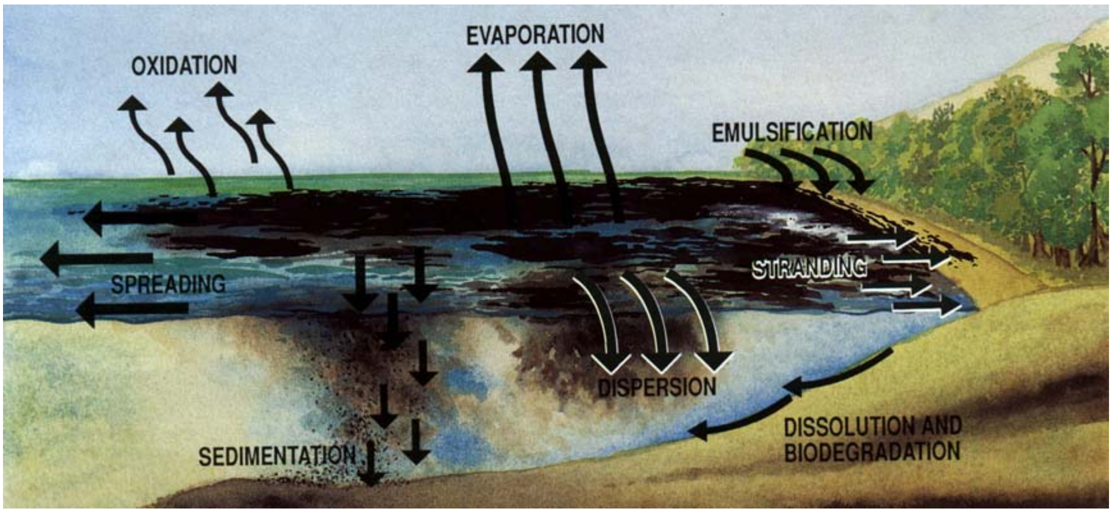

Figure 2 Fate of spilled oil, including the main weathering processes

Oil slicks as thin as 0.00001 mm are visually detectable as a colourless film: no actual fuel can be seen, but the water appears less ‘rough’ and more ‘glassy’. As the thickness increases light interference effects become apparent: at a thickness of about 0.0001 mm the slick is seen as a silvery sheen; and at about 0.0003–0.0005 mm iridescent colours can be seen (the ‘rainbow’ effect). At thicknesses above 0.001 mm the slick begins to turn dull and then brown or black. As an example, a spill of 30 litres would give a silvery sheen to an area about 100 m by 300 m, and a spill of 1,000 litres would give an iridescent effect over an area of about two to three square kilometres.

The relative importance of the various weathering processes depends on the amount and type of oil spilled as well as environmental conditions such as wind and temperature. A major proportion of a spill is usually lost by evaporation, and all things being equal, the smaller the spill the more lost by evaporation, as the ratio of surface area:volume is greater. Evaporative losses are particularly high from spills of the lighter, refined fuels, as they contain high proportions of volatile compounds.

The most volatile compounds are also the most soluble in water, and the most toxic to biota, particularly the soluble aromatic hydrocarbons such as benzenes and naphthalenes. However, the amount removed by evaporation is usually 100 (for aromatics) to 10,000 (for alkanes) times higher than the amount that dissolves (Chapman, 1985). Generally, a maximum of 1% of a slick ends up in the dissolved phase (Chapman, 1985).

The gasoline and diesel considered in risk assessment for the Coral Bay region are both classified as light refined petroleum products, with low densities (ca. 0.7 g/ml for gasoline and ca. 0.8 g/ml for diesel), low viscosities (and therefore rapid spreading) and a high proportion of volatile compounds. Gasoline is more toxic to biota, but evaporates more quickly than diesel, which limits it exposure to organisms. For the size of spills being considered in this document, in the warm and relatively windy conditions of Coral Bay over 50% of gasoline would evaporate within seven minutes (90% within one hour), 50% or more of the diesel would evaporate within three hours, and there would be no mousse formation with either fuel type. Gasoline evaporates completely and leaves no residue. Diesel leaves a slight residue (about 2%) that is readily biodegradable (i.e. within several days) (I.T.O.P.F., 1987).

3. RISK ANALYSIS

A standard SOURCE-PATHWAY-RECEPTOR analysis was used for risk assessment. Source assessment identifies the potential sources, frequency and nature of fuel spills. Pathway analysis identifies the 'pathways' by which spills reach the 'receptors'. Receptor analysis identifies those receptors (e.g. corals, turtle, birds, recreational swimmers) likely to be affected by fuel spills.

The existing conditions at Coral Bay were used as the 'reference' condition for the risk assessment. Assessment of risk under the reference condition and with development of the boating facility at Monck Head and North Bills Bay included the 'most probable' and 'worst case' scenarios.

Although only diesel would be dispensed at the proposed refuelling facility, both gasoline and diesel were modelled as this provided useful information on the likely effects of gasoline spills from boating accidents in the region.

3.1 SOURCE

Potential sources of fuel spills include:

- Boat grounding;
- Collisions between boats;
- Collisions of boats with fixed objects such as a jetties or channel markers;
- Accidental spills from boats; and
- Accidental spills during refuelling operations.

The first three can be caused by human error or technical failure of steering, propulsion, mooring or anchor systems. The fourth is usually caused human error including poor maintenance of boat engine or structural components. The fifth can be due to human error or technical failure of refuelling equipment. Estimated risks for the Coral Bay region of a fuel spill from each source are discussed below.

3.1.1 Fuel spills due to boat grounding or collisions

Recreational craft

Based on state-wide data from DPI, the rate of boating accidents is approximately 1.80% per registered boat per annum (1,070 boating accidents in 1996/97 for over 58,000 registered recreational boats and 1,700 commercial boats; DPI unpublished data). If the conservative assumption is made that all the accidents involved recreational craft (which the large majority did), the rate becomes 1.84%/boat/annum, or 0.005%/boat/day. Of the 1,070 accidents reported in 1996/97, only two involved boating collisions and 47 involved navigation errors: by far the majority of boating accidents (over 77%) involved boat engine or structural problems.

The above rates were used for boating in Coral Bay even though they apply to a far greater range of boating conditions than experienced at Coral Bay. If accidents occur in the Coral Bay region, based on DPI data and conservatively assuming the accidents occur near coral reefs and that boats collide with coral reef rather than grounding onshore, there is a 77% chance of a boat drifting into coral reefs due to boat engine or structural failure; a 4% chance of a boat drifting into coral reefs due to anchor failure or being left unattended; a 4% chance of hitting coral reefs due to navigation errors; and less than a 0.2% chance of a boating collision.

Wave conditions within the reef line at Coral Bay are relatively calm, and the chances of a hull breach are slight if a boat hits coral: the chance of a fuel spill under these conditions is deemed to be negligible as fuel is stored within a separate metal container(s). The highest risk of a fuel spill would be due to a boating collision if one or more of the boats sank and/or had a fuel tank ruptured. Thus, the risk of a boating accident leading to a fuel spill is calculated as 0.2% of 1.84%, that is, less than 0.0037%/boat/annum or less than 0.00001%/boat/day (one in 10 million). The magnitude and nature of this fuel spill is likely to range from 20 litres of gasoline to 200 litres of diesel, given the size of fuel tanks and type of fuel used in most trailered boats.

It should be noted that the above risk of boat collisions leading to fuel tank rupture or a boat sinking applies to boating traffic throughout the entire Coral Bay region. The risk of a boat collision of sufficient magnitude to sink a boat or rupture a fuel tank is practically negligible near a launching ramp (due to the low speeds of the boats), although minor bumps and scrapes between boats are more frequent.

Future increases in boat traffic are likely to occur due to increased recreational use of Coral Bay rather than the existence of a boating facility *per se*, and changes in risk will be directly proportional to the numbers of boats.

Commercial craft

Between 12–15 large commercial boats (fuel capacity 1,000–3,000 litres) are currently moored in Bills Bay.

On most occasions, the commercial boats travel to locations outside the reef line. Although more fuel could potentially be spilled if a commercial boat collides with a reef, the risk of a commercial vessel becoming grounded through navigation error or boat engine failure is considered to be negligible. Commercial boats are well maintained (lack of maintenance is a frequent cause of engine failure in recreational craft), and commercial crews can be expected to be more familiar with the Coral Bay area.

The conservative assumption has been made that the percentage rate of collisions between commercial vessels is the same as for recreational vessels, i.e. less than 0.00001%/boat/day (one in 10 million). Again, as the vessels are manned by experienced captains and crew, the actual risk is likely to be even lower than this.

There is also the possibility of a fuel spill due to commercial boats breaking their moorings or foundering during a tropical cyclone. Tropical cyclones with wind speeds in excess of 40–50 knots occur in the region every three to five years (Lourensz, 1981). The current risk of such an incident is unknown (as there are no data), and the erratic nature of cyclones makes it virtually impossible to predict where a boat would be grounded.

3.1.2 *Accidental fuel spills from boats*

State-wide marine pollution incident data from DPI for the period from April 1997 to March 1998[1] report 41 incidents (including boat and roadway washdowns, stormwater run-off, sullage overflow, bilge water discharge, litter, and fuel spills),

[1] courtesy of Mr Con Sappelli, Department for Planning and Infrastructure

the majority of which were due to human negligence rather than equipment malfunction. Twelve of these incidents involved fuel spills from commercial vessels, and 12 involved fuel spills from private vessels. The majority of the spills reported by DPI are very small—less than 30 litres.

Again, the conservative assumption has been made that the rates of fuel spills per recreational and commercial boats in Coral Bay are the same as the state-wide rates. Thus, the daily risk of such small fuel spills is:

- Approximately 0.0207%/boat/year or 0.000057%/boat/day (one in 1,764,167) for fuel spills from recreational boats; and
- Approximately 0.71%/boat/year or 0.0019%/boat/day (one in 51,708) for fuel spills from commercial boats.

3.1.3 *Accidental fuel spills during refuelling operations*

Of the 41 marine pollution incidents reported by DPI for the period from April 1997 to March 1998, only one involved a fuel spill during use of a refuelling facility by a commercial boat, and this resulted in the loss of less than 30 litres of diesel. In Western Australia in the last 10 years there has only been one relatively large (approx. 1,000 litres of diesel) fuel spill during use of refuelling facilities by a commercial boat, due in this case to human error and not equipment failure.

Again, if the conservative assumption is made that the rate of fuel spills per commercial boat in Coral Bay is the same as the state-wide rates, the daily risk of fuel spills during use of refuelling facilities are:

- 0.00016%/boat/day (one in 620,500) for small fuel spills (30 litres or less); and
- 0.000016%/boat/day (one in 6,205,000) for large fuel spills (1,000 litres or more).

Summary of risk of fuel spills

Daily risks of fuel spills per boat based on DPI data are provided in Table 1, and are adjusted for peak boat numbers in Coral Bay to provide estimates of maximum daily risks for the region. These values represent a summary of all the *relative* risks associated with various potential sources of fuel spills. The fuel spills from sources one to four in Table 1 already apply in Coral Bay, and would be unchanged by the provision of the boating facilities under consideration.

To calculate the maximum risk, based on the number of recreational boats using the Coral Bay region, the peak number of boats was assumed to be 150: at peak period during school holidays there can be about this number of small recreational boats, about two thirds of which are less than 5 m in length (Muntz, *pers. comm.*). For calculation of the maximum risk from commercial boats, the peak number was assumed to be 15 boats.

The risk of fuel spills due to technical failure of refuelling equipment is considered negligible, as all fuel storage, handling and maintenance would be conducted in accordance with the Australian Standard for the storage and handling of flammable and combustible liquids (AS 1940–1993). It is noted that in the last 15 years there have only been three reported instances of fuel spills due to failure of refuelling equipment throughout <u>all</u> refuelling facilities in Western Australia—including one incident at Christmas Island (Sappelli, *pers. comm.*). By way of illustration, refuelling facilities at the small coastal town of Cervantes (240 km north of Perth) supply approximately 45–70 commercial fishing boats with a total of about two million litres of diesel fuel each year. No large fuel spill due to failure of refuelling equipment at Cervantes has ever been reported. The intensity and volume of refuelling events at Cervantes is far greater than would occur at the interim facilities proposed for Coral Bay.

Table 1 Daily risk of accidental fuel spills in Coral Bay

SOURCE OF FUEL SPILL	LIKELY SIZE OF FUEL SPILL	LOCATION	RISK FACTOR* (per boat/day)	MAXIMUM DAILY RISK FOR CORAL BAY
1. Fuel spill due to *recreational* boat collision	20–200 L	Throughout Coral Bay region	Less than 1 in 10,000,000	1 in 66,667 (once every 183 years)
2. Fuel spill due to *commercial* boat collision	Up to 3,000 L	Throughout Coral Bay region	Less than 1 in 10,000,000	1 in 666,667 (once every 1,826 years)
3. Accidental fuel spills from *recreational* boats	Less than 30 L*	Throughout Coral Bay region	1 in 1,764,167	1 in 11,761 (once every 32 years)
4. Accidental fuel spills from *commercial* boats	Less than 30 L*	Throughout Coral Bay region	1 in 51,708	1 in 3,447 (once every 9.4 years)
5. Small fuel spill during use of refuelling facilities by *commercial* boat owner	Less than 30 L*	At refuelling site	1 in 620,500	1 in 4,137 (once every 113 years)
6. Large fuel spill during use of refuelling facilities by *commercial* boat owner	1,000 L or more*	At refuelling site	1 in 6,205,000	1 in 413,667 (once every 1,133 years)
7. Technical failure of refuelling facility (e.g. burst pipe, tank corrosion)	Up to 20,000 L	At refuelling site	Negligible, as facility will be constructed and maintained according to Australian Standards	-

** Based on available data from DPI*

Refuelling of the large commercial boats presents the greatest risk of large spills, although this is still extremely low, and it is also anticipated that the commercial boat operators within Ningaloo Marine Park would be particularly careful during refuelling operations. It is noted that even with the present informal refuelling arrangements of commercial operators in Southern Bills Bay, no fuel spill has been recorded in Coral Bay to date. Barring serious human error or serious equipment malfunction, fuel spills during refuelling operations are expected to be small (less than 30 L). It is also worth noting that even the ‘large’ spills being considered in this document are ranked as ‘small’ according to most definitions of oil spills. Small spills are generally classified as less than seven tonnes (about 9,000 L or 55 barrels), medium spills are 7–700 tonnes, and large spills greater than 700 tonnes (I.T.O.P.F., 1987).

3.2 PATHWAY

Pathway analysis concentrated on the release of fuel spills at the proposed refuelling facility sites at North Bills Bay and Monck Head. The reference (existing) condition was addressed by assuming a fuel spill at the informal refuelling site in Southern Bills Bay. Although only diesel would be dispensed at the facility, both gasoline and diesel were modelled as this provided useful information on the likely effects of gasoline spills from boating accidents in the region.

A simple model was used to simulate the dispersion of fuel spills at the three sites. The modelling approach, the scenarios modelled and the results obtained are discussed below.

3.2.1 Modelling approach

Advective processes (due to currents and winds) are the main controls for the fate of spills, and therefore are the most frequently modelled. The common approach is based on a vector that combines surface current data with the '3% of the wind speed' rule (Swan *et al*., 1994). The latter percentage is based on a wealth of information on drift speeds of both oil and surface drifters from all over the world over the past 40 years, which indicate that the drift of oil is in the region of 2–4% of the wind speed relative to the underlying water.

The development of trajectory and fate models for oil spills is particularly active worldwide, and there are probably between 30 and 50 models available at the moment. Three-dimensional hydrodynamic models are often used to simulate current velocities in an area, but they cannot be relied upon to accurately predict currents in coastal areas of complicated bathymetry, particularly in an area such as Coral Bay where there are no local wind data or fine-scale bathymetric data. If a hydrodynamic model is to be used to simulate currents in a nearshore area, it is essential to field-validate the simulations.

Lack of agreement between predicted and actual trajectories of slicks is usually due to lack of reliable data on wind speed and direction (due to distance from weather stations) and lack of detailed surface current data (National Research Council, 1985). For the Coral Bay region it was necessary to use approximations for both of these factors. Learmonth was the nearest site for which there were wind data from the Bureau of Meteorology, whilst Rogers and Associates (1994) and Swan *et al*. (1994) have estimated currents in the region as 0.1–0.2 m/sec to the north. This concurs with observations by local residents.

Under the circumstances, it was decided that the most appropriate approach was a simple model that incorporated the '3% of the wind speed' rule and a range of likely currents (0–2 m/sec to the north) for the region.

Model characteristics

The model used for the Coral Bay region has the following characteristics:

1. Simple and quite robust.
2. Uses advection in a downwind direction, incorporating a spatially and temporally constant current.
3. Uses the '3% of the wind speed', for fuel drift relative to the underlying water.
4. Allows for time-dependent wind.
5. The fuel spill is released instantaneously.
6. Fuel spill release occurs at the shoreline and is not confined by a harbour or breakwaters (it should be noted that the impact and extent of a fuel spill will be considerably reduced from that modelled here if the spill occurs within a boat harbour such as that proposed for North Bills Bay).
7. It simulates the fuel by an assemblage of (typically 1,000) particles.

8. Spreading is simulated by randomly diffusing the particles horizontally, using a diffusion coefficient of 5 m^2/s, which is typical of small spills (the observed range for small spills is roughly 1–10 m^2/s).
9. Evaporation/degradation is according to an exponential decay law.
10. There is permanent beaching whenever a particle encounters the coast, and no further degradation of the fuel occurs once beached. These two points are important limitations of the model to be borne in mind when the results are discussed below.

Evaporation rates were calculated from the ADIOS (Automated Data Inquiry for Oil Spills) model developed by the USA National Oceanographic and Atmospheric Agency (NOAA). ADIOS allows evaporation rates to be calculated based on fuel type, size of spill, water temperature, wind speed and wave conditions. For fuel spilled in the Coral Bay region (spills of 2,000 L or less, water temperature around 25°C, wind speed around 5 m/sec), ADIOS gave the following evaporation rates:

- 0.00089/sec for gasoline (exponential decay time = 19 min); and
- 0.000042/sec for diesel (exponential decay time = 6.6 hours).

This decay rate (φ) is equal to:

$$C_t = C_{t0} e^{-t\varphi}$$

where t is time (seconds), C_t is concentration at time *t*, and C_{t0} is the initial concentration (i.e. at time = 0).

Modelled scenarios

Wind data for Learmonth in 1998 were obtained from the Bureau of Meteorology. These data consisted of wind speed and direction recorded every half hour. Analysis of the wind data showed that in winter (the period of highest boating use), the wind is from the south quadrant approximately 60% of the time, and from the north or east quadrants about 30% of the time. In summer, the dominance of southerly winds is even stronger.

Based on available information, it was decided to simulate fuel spill dispersion under the following five combinations of current and wind:

- No current, wind 3 m/s from south;
- Current 0.15 m/sec to the north, wind 7.5 m/s from south;
- Current 0.15 m/sec to the north, wind pattern for a typical summer day (13 January 1998);
- Current 0.15 m/sec to the north, wind pattern for a typical winter day (8 July 1998); and
- Current 0.15 m/sec to the north, wind pattern for a winter day with predominantly north-easterly winds (1 July 1998).

For all the fuel spill runs, a spill release time of 6:00 am was chosen, as this was considered the most likely time for refuelling. The above conditions were simulated at all three sites, and runs were done for spills of both diesel and gasoline, resulting in a total of 30 runs. Run characteristics are summarised in Table 2.

Table 2 Characteristics of the current, wind and fuel type simulated in modelling runs at North Bills Bay, Southern Bills Bay and Monck Head

RUN NO.	SITE	CURRENT	WIND	FUEL TYPE
1	North Bills Bay	Zero	3 m/sec southerly	Diesel
2	North Bills Bay	Zero	3 m/sec southerly	Gasoline
3	North Bills Bay	0.15 m/sec to the north	7.5 m/sec southerly	Diesel
4	North Bills Bay	0.15 m/sec to the north	7.5 m/sec southerly	Gasoline
5	North Bills Bay	0.15 m/sec to the north	Typical summer day	Diesel
6	North Bills Bay	0.15 m/sec to the north	Typical summer day	Gasoline
7	North Bills Bay	0.15 m/sec to the north	Typical winter day	Diesel
8	North Bills Bay	0.15 m/sec to the north	Typical winter day	Gasoline
9	North Bills Bay	0.15 m/sec to the north	Winter day with north-easterlies	Diesel
10	North Bills Bay	0.15 m/sec to the north	Winter day with north-easterlies	Gasoline
11	Southern Bills Bay	Zero	3 m/sec southerly	Diesel
12	Southern Bills Bay	Zero	3 m/sec southerly	Gasoline
13	Southern Bills Bay	0.15 m/sec to the north	7.5 m/sec southerly	Diesel
14	Southern Bills Bay	0.15 m/sec to the north	7.5 m/sec southerly	Gasoline
15	Southern Bills Bay	0.15 m/sec to the north	Typical summer day	Diesel
16	Southern Bills Bay	0.15 m/sec to the north	Typical summer day	Gasoline
17	Southern Bills Bay	0.15 m/sec to the north	Typical winter day	Diesel
18	Southern Bills Bay	0.15 m/sec to the north	Typical winter day	Gasoline
19	Southern Bills Bay	0.15 m/sec to the north	Winter day with north-easterlies	Diesel
20	Southern Bills Bay	0.15 m/sec to the north	Winter day with north-easterlies	Gasoline
21	Monck Head	Zero	3 m/sec southerly	Diesel
22	Monck Head	Zero	3 m/sec southerly	Gasoline
23	Monck Head	0.15 m/sec to the north	7.5 m/sec southerly	Diesel
24	Monck Head	0.15 m/sec to the north	7.5 m/sec southerly	Gasoline
25	Monck Head	0.15 m/sec to the north	Typical summer day	Diesel
26	Monck Head	0.15 m/sec to the north	Typical summer day	Gasoline
27	Monck Head	0.15 m/sec to the north	Typical winter day	Diesel
28	Monck Head	0.15 m/sec to the north	Typical winter day	Gasoline
29	Monck Head	0.15 m/sec to the north	Winter day with north-easterlies	Diesel
30	Monck Head	0.15 m/sec to the north	Winter day with north-easterlies	Gasoline

Simulated dispersion patterns were plotted every three hours for diesel, and every half hour for gasoline (as it evaporates rapidly).

3.2.2 Modelling results

Over 160 dispersion patterns were produced, and a representative selection is shown in Appendix A. The runs are numbered as indicated in Table 2, and are shown in the header for each plot. The header for each plot also has:

- The time elapsed since release of the fuel;
- The percentage of the original spill left in sea after evaporation and beaching; and
- The percentage of the original spill that has beached, remembering that the model does not incorporate further evaporation after beaching.

The grey dots show the release sites, fuel on the sea surface is shown by black dots, and narrow grey bands on the shoreline signify beached fuel. The plots show the *relative* extent of a fuel spill of *unspecified size*. The actual amount of fuel present for any scenario can be calculated from the size of the spill being considered, the areal extent of the spill and the percentage of the spill present.

Present conditions at Southern Bills Bay

Under conditions of little current and a gentle southerly breeze, 35.1% of a diesel spill has the potential to spread over most of Bills Bay within three hours (Run 11), but due to rapid evaporation, only 2.9% of a gasoline spill would be spread over Southern Bills Bay waters after one hour (Run 12).

Under typical summer conditions most diesel and gasoline spills would rapidly (within one hour) end up on the beaches from southern to northern Bills Bay (Runs 15 and 16). However, it is important to remember the model's limitation of permanent beaching whenever a particle encounters the coast: longshore currents close to the shore would continue to move 'beached' spill northwards even though the model shows no movement.

Under typical winter conditions, a diesel spill would mostly end up on the beaches in Bills Bay, but 11.8% of a diesel spill would reach Point Maud within three hours (Run 17). A gasoline spill would largely evaporate before reaching North Bills Bay (Run 18).

Under north-easterly winds, 40.4% of a diesel spill would disperse over a five square kilometre area of corals to the west of Coral Bay within six hours (Run 19), and 3.1% of a gasoline spill would disperse over a quarter of a square kilometre of corals closer to the shore within one hour (Run 20).

Fuel spills at North Bills Bay

At North Bills Bay, under most conditions, an unconfined fuel spill would rapidly beach in the area between the facility and Point Maud (Runs 1, 2, 7 and 8). As mentioned earlier, when looking at Runs 7 and 8 (typical winter conditions) it is important to remember the model's limitation of permanent beaching whenever a particle encounters the coast: longshore currents would continue to move a 'beached' spill to Point Maud even though the model shows no movement.

Under north-easterly winds, 33.5% of a diesel spill would disperse over a five square kilometre area of corals to the west of Coral Bay within six hours, and 20.6% would beach near Point Maud (Run 9). A fair proportion (19.2%) of a gasoline spill would also beach near Point Maud, and 2.8% would disperse off Point Maud over an area of about half a square kilometre within an hour of (Run 10).

Fuel spills at Monck Head

Under conditions of little current and a gentle southerly breeze, 27.5% of a diesel spill would move over 1.5 square kilometres of coral to the north within three hours (Run 21), and shoreline limestone platform communities and beaches would also receive a large proportion of the spill (49.7%). After one hour 2.8% of a gasoline spill would spread over half a square kilometre of corals to the north of Monck Head, and shoreline limestone platform communities and beaches would also be affected (Run 22). A small proportion of a diesel spill would reach the Coral Bay settlement, but gasoline would not.

Under typical summer conditions, most of both the diesel and gasoline spills would affect intertidal limestone platform and sandy beaches to the north (Runs 25 and 26). Again, a small proportion of a diesel spill would reach the Coral Bay settlement, but gasoline would not.

Under typical winter conditions, most of a diesel spill would affect intertidal limestone platform and sandy beaches to the north, and 30.3% would disperse over about two square kilometres of coral from Monck Head to Bills Bay within six hours (Run 27). Gasoline would also affect shoreline communities, and 2.1% of the spill would disperse over about half a square kilometre of corals between Monck Head and Southern Bills Bay within an hour (Run 28).

Under north-easterly winds, diesel would disperse over a water body five square kilometres in size to the west of Monck Head within six hours (Run 29), and gasoline would disperse over about half a square kilometre of coral closer to the shore within an hour (Run 30).

3.3 RECEPTORS

3.3.1 Receptors

Marine biota

The main habitats and/or important biota to be affected by fuel spills in the Coral Bay region are:

- Corals and their associated invertebrate and fish communities. The coral communities in the Coral Bay region are subtidal, which are less susceptible to fuel spills than intertidal corals. Fertilisation and larval settlement of corals is vital to the viability of coral reefs, and are potentially vulnerable phases in the life history of these organisms. Mass spawning of corals occurs on one or two nights each year, 8–9 nights after the full moon in March (and sometimes April as well), with the planular larvae developing from fertilised eggs over the next 36 hours, and the larvae drifting with currents over the next 4–5 days before settling. If conditions are calm, coral eggs and larvae can form surface slicks, and so would be particularly vulnerable to fuel spills. Fuel spills during, or up to a week after, a mass spawning event could result in surface concentrations of fuel sufficient to kill eggs, sperm or larvae, and so affect subsequent recruitment of corals in localised areas (via effects on fertilisation and larval settlement). The potential impact of reduced recruitment would be greatest at North Bills Bay, which has already suffered mass mortality of corals due to anoxic conditions that developed during unusually calm weather following a mass spawning event in 1989;
- Waders and seabirds. Point Maud is a gazetted Bird Roosting Sanctuary under the Offroad Areas Act. Many of the species present are protected by the Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act 1999 and/or are migratory species protected by international treaties;
- Turtles. Egg laying and hatching of loggerhead and green turtles occurs at Point Maud, and on the wider beaches south of Monck Head. Loggerhead and leathery turtles are listed as Schedule 1 species under the Wildlife Conservation Act 1950–1975. Loggerhead turtles are also protected under the Commonwealth EPBC Act 1999 and are listed as endangered. Leathery, green, flatback and hawksbill turtles are listed as vulnerable under the Commonwealth EPBC Act 1999. Green turtles breed from November and February, with nesting occurring until late March and the last of the hatchlings appearing by the end of May. Loggerhead turtles breed all year round;

- Schooling sharks. Large schools of black- and grey-tip reef sharks have been observed inshore of the submerged beach rock ridges along Skeleton Beach during late-August to December;
- Manta rays. Aggregations of manta rays occur on the northern side of Point Maud. Manta rays are protected under the Fish Resources Management Act 1994;
- Intertidal limestone platform and their biota (mainly at Monck Head);
- Subtidal limestone platform and their biota (mainly at Monck Head);
- Intertidal sand habitat and their biota (all sites); and
- Subtidal sandy habitat and their biota (all sites).

In general terms, intertidal organisms are more susceptible than subtidal organisms to adverse effects from fuel spills because they have direct contact with the spill. The surface slicks of coral eggs and larvae that form during mass spawning events are also vulnerable to fuel spills, but the vulnerable phase only lasts about one week a year at a time when the likelihood of fuel spill is particularly low (as recreational use is also low). Effects on subtidal organisms depend on dissolution and vertical dispersion of fuel in the water, and fish and marine mammals can also swim away from the spill. Non-resident biota that utilise the intertidal zone or sea surface, such as seabirds and turtles, are also highly susceptible to fuel spills.

Actual toxicity effects due to ingestion of fuel are not believed to be the main cause of the death of seabirds (Swan et al., 1994). The direct effect of fuel spills on birds is to clog the fine structure of their feathers, which are responsible for maintaining water repellence and heat insulation. It follows that birds in colder climates are more susceptible to adverse effects from fuel spills than those in warmer climates such as at Coral Bay.

Ingestion of small amounts of fuel can cause temporary depressions of egg laying and reduce the hatching success of the eggs that are laid (National Research Council, 1985; Swan *et al*., 1994). The window of time during which ingestion of fuel could occur would, however, be small.

Fuel that adheres to the legs and feathers of a bird can also be passed onto its eggs, and small quantities of fuel on eggs are known to kill the embryo at certain stages of development: this also applies to turtles that come ashore to lay their eggs (National Research Council, 1985; Swan *et al*., 1994). The less volatile components of diesel could remain for long enough for this to be a problem, depending on the time of year (with respect bird and turtle breeding cycles) that a fuel spill occurs.

Human uses

In terms of human uses, Southern Bills Bay is a popular swimming and snorkelling area. The corals in the vicinity of the Monck Head area are also popular for snorkelling.

Fishing is also extremely popular, but the majority of fishing takes place offshore (outside the reefline) or just south of the Maud Sanctuary Zone (south of Monck Head).

3.3.2 Toxicity effects

Tsvetnenko (1998) has collated acute toxicity ranges for different fuels to a range of Australian tropical marine organisms, including fish, crustaceans, molluscs, annelids and algae. The LC_{50} values (the concentration of fuel is lethal to 50% of the test organism after 24–96 hours of exposure) for the water-soluble fraction of the fuels examined (which included diesel) ranged from 0.07–11.5 mg/L, with values for diesel of 0.3–4.5 mg/L. Gilbert (1996) also reports 48–96 hour LC_{50} values for 14 crude and refined fuels of 1–100 mg/L for a range of fish and invertebrates.

As mentioned in Section 3, the soluble aromatic hydrocarbons are the most toxic component of fuels, and most adult marine organisms experience lethal effects when exposed for up to several hours to concentrations of 1–100 mg/L, whereas sensitive larval and juvenile stages experience lethality at 0.1–1 mg/L (Swan *et al*., 1994). Sublethal effects (e.g. changes in growth, reproduction or behavioural patterns) can become apparent at relatively persistent (i.e. long-term) concentrations as low as 0.01 mg/L (Swan *et al*., 1994).

Due to the fact that fuel spills would beach under most conditions considered in this document, intertidal organisms at beaching areas at all three sites would experience direct contact with the buoyant fuel layer if a large spill occurred. Acute lethal concentrations may also be experienced by subtidal organisms' at all three sites in the shallow waters between the spill and beaching area. Effects on subtidal organisms (including corals) in waters offshore from the spill are unlikely due to fuel dispersion and evaporation (see also Section 3.4.2). Sublethal effects on any organisms are also unlikely due to the high evaporation rates of the fuels concerned.

In terms of human health, the greatest danger associated with spills of diesel or gasoline is due to inhalation of the evaporated volatile compounds, rather than direct skin contact (which can cause slight irritations) or ingestion (which can affect the lungs, gastrointestinal tract, liver, kidney and central nervous system). Exposure to gasoline vapours at concentrations of 500–1,000 ppm can produce eye nose and throat irritation and dizziness, and at 1,000–10,000 ppm varying degrees of nausea, headache, vomiting, abdominal pains, numbness and anaesthesia (National Research Council, 1985). The lower level symptoms are often reported by cleanup workers and scientists working in fuel spill areas (National Research Council, 1985). The rapid evaporation characteristic of gasoline can also create a very high fire hazard as the ignition potential in the surrounding atmosphere becomes extremely high.

3.3.3 Environmental sensitivity of various receptors

The environmental sensitivity of receptors is usually based on their 'biological value', the likely severity of impact due to fuel spills, the likely persistence of the spill, and the ease with which clean-up can be effected. The environmental sensitivity grading adopted for the North-West Shelf area by the Dampier Port Authority (1995) has been used in this document, and is shown in Table 3.

Southern Bills Bay and North Bills Bay

Based on the modelling results, fuel spills at Southern Bills Bay and North Bills Bay have the potential to adversely affect receptors of extreme, high and moderate sensitivity, with the greatest potential for effects on receptors of extreme sensitivity (the bird sanctuary) due to fuel spills at North Bills Bay.

Monck Head

Based on the modelling results, fuel spills at Monck Head would affect receptors of high and moderate sensitivity.

Table 3 Relative environmental sensitivity of receptors

ENVIRONMENTAL SENSITIVITY GRADING	CRITERIA FOR GRADING	RECEPTORS
1: Extreme	Areas of very high biological value Areas of national significance Areas likely to suffer severe impacts if oiled Areas unable to be effectively cleaned or restored Areas where oil may persist for some considerable time	Mangroves Intertidal coral reefs Turtle/seabird breeding grounds Intertidal seagrasses Intertidal mudflats
2: High	Areas of high biological value Areas of regional significance Areas likely to suffer impact if oiled Areas where clean up is likely to be difficult, protracted and partially successful	Subtidal seagrasses Subtidal corals
3: Moderate	Areas of moderate biological value Areas unlikely to suffer sever impact if oiled Areas that should recover if oiled and can be effectively cleaned, restored or replaced	Sheltered beaches Sheltered rocky shores and reefs Recreational/amenity areas
4: Low	Areas of moderate biological value Areas exposed to high energy conditions Areas easily cleaned or likely to recover naturally	Other beaches Exposed rocky shores and reefs

3.4 ESTIMATED RISK

In terms of accidental fuel spills during refuelling operations, the most probable scenario is a fuel spill of less than 30 L of fuel, and the worst case scenario is a fuel spill of 1,000 L or more. Each scenario is discussed below.

3.4.1 Most probable scenario

North Bills Bay, Southern Bills Bay and Monck Head

For the 'most probable' scenario (fuel spills of less than 30 L), none of the above fuel dispersion patterns are likely to produce deleterious effects on biota. Even for the release of fuel in Southern Bills Bay under the calmest conditions considered (Modelling Runs 11 and 12), the spill would be invisible in an hour or less, and concentrations of fuel in waters over corals would be several orders of magnitude lower than those that cause sublethal effects on marine biota. In point of fact, small-scale fuel spills are already occurring in Southern Bills Bay (probably mostly from boat exhausts rather than direct spills), as evidenced by slightly elevated levels of petroleum hydrocarbons in the sediments (Simpson and Field, 1995).

3.4.2 Worst case scenario under calm conditions

Southern Bills Bay

Under calm conditions a large diesel spill in Southern Bills Bay would be seen as an iridescent slick (i.e. 0.0003–0.0005 mm thick) over most of Bills Bay within three hours. A gasoline spill would be seen as a silvery sheen (i.e. about 0.0001 mm thick) over Southern Bills Bay in the first hour, but would disappear within two hours. Assuming a water depth of 0.5–1.0 m over the coral and 1% of the slick being fully dissolved throughout the water, fuel concentrations over corals due to spills would be approximately 0.002–0.005 mg/L, which are less than levels at which sublethal effects on biota are seen (0.01 mg/L) let alone acute toxicity effects (0.3–4.5 mg/L for diesel). A safety factor can be estimated by a toxicity quotient, as follows:

$$\text{Toxicity quotient (TQ)} = \frac{\text{Expected environmental concentration (EEC)}}{\text{Estimated toxicity threshold (ETT)}}$$

The TQ for diesel is about 0.01, i.e. a safety factor of 100.

It should also be remembered that the ranges quoted for acute toxicity effects are based on continuous exposure for 24–96 hours and the sublethal effects to long-term exposure, whereas corals and their biota are unlikely to be exposed for more than several hours with the spills considered in this document.

North Bills Bay

At North Bills Bay a large unconfined spill under calm conditions would be concentrated in the nearshore and intertidal zone between the facility and Point Maud, potentially affecting the bird sanctuary at Point Maud. It should however be noted that the environmental effect would be greatly reduced if the spill is confined to within the boat harbour.

Monck Head

At Monck Head a large diesel spill would be seen as a faintly iridescent slick over the corals between Monck Head and Bills Bay within three hours, and a gasoline spill would be barely visible over a much smaller area for the first hour: fuel concentrations in waters over coral communities would be similar to those experienced with a large spill in Southern Bills Bay. However, intertidal communities (beach and rocky shore) at Monck Head would suffer acute toxicity effects with either type of fuel spill.

3.4.3 Worst case scenario under typical summer conditions

North Bills Bay, Southern Bills Bay and Monck Head

Under typical summer conditions, spills at all sites would move along the intertidal and nearshore zones to the north, and would be more concentrated and therefore more visible as iridescent or dull slicks, although gasoline spills would evaporate within a few hours. At all sites, intertidal biota and to a lesser extent subtidal biota close to the shore would suffer acute toxicity affects.

North Bills Bay

The bird sanctuary at Point Maud would potentially be affected by a large spill at North Bills Bay.

3.4.4 Worst case scenario under typical winter conditions

Southern Bills Bay

Under typical winter conditions, a large diesel spill at Southern Bills Bay would undergo slightly less beaching than in summer but would extend to Point Maud. A gasoline spill would beach little, and the slick on the water would be barely visible for the first hour and disappear within two hours.

North Bills Bay

The scenario at North Bills Bay would be similar to that of typical summer conditions.

Monck Head

A large diesel spill released from Monck Head would be seen as a iridescent slick west of Southern Bills Bay within three hours, whereas a gasoline spill would be barely visible in waters north of Monck Head for the first hour and would disappear within two hours. Corals north of Monck Head would experience fuel concentrations similar to, or less than, those under the ‘calm’ scenario. However, with a spill of either type of fuel at Monck Head, the intertidal biota and to a lesser extent subtidal biota close to the shore would experience acute toxicity effects.

3.4.5 Worst case scenario under conditions of north-easterly winds

North Bills Bay, Southern Bills Bay and Monck Head

Under conditions of north-easterly winds, there is little difference between the three sites in terms of approximate size of coral area potentially affected. Diesel spills would be visible as a silvery sheen within three hours but barely visible within six hours, whilst the gasoline spills would be visible as a silvery sheen for the first hour and invisible within two hours. Concentrations of fuel in water over the corals would be about 0.001 mg/L, so the toxicity quotient would be even lower than calculated for Southern Bills Bay under calm conditions.

North Bills Bay

About 20% of a large spill at North Bills Bay would beach in the vicinity of Point Maud, potentially affecting the bird sanctuary.

For all the above scenarios, the fuel spill was modelled as an instantaneous release. In reality, a large spill would be discharged over a period of fifteen minutes or more, which would further enhance dispersion and evaporation. Conversely, work carried out by the Department of Conservation and Land Management indicates that the residence times of waters in south-eastern and north-eastern parts of Bills Bay are sometimes slightly higher than the rest of the Bay, which would act to retain spills in these areas and exacerbate any environmental effects (Nick D’Adamo, *pers. com*.).

4. MANAGEMENT

4.1 MANAGEMENT APPROACH

The most effective way to deal with fuel spills is to prevent them in the first place. Preventing spills requires education of potential users of the refuelling facilities, compliance with existing standards and regulations, and regular monitoring of refuelling equipment. Simple features such as safety release mechanisms on fuel dispensers (similar to those on petrol bowsers in typical petrol stations) and controlling fuel discharge rates can also reduce the likelihood and size of fuel spills.

The refuelling facilities will be constructed according to Australian Standard AS 1940–1993, and therefore will automatically include a schedule for regular inspection, cleaning and maintenance to minimise the risk of equipment malfunction. This schedule should be strictly adhered to. The management plan for the refuelling facilities should also include a refuelling safety plan, and a pollution contingency management plan (PCMP) to deal with fuel spills, including those not related to the refuelling facilities (i.e. from boating accidents, which may occur anywhere throughout the Coral Bay region).

There are a variety of options for responding to fuel spills, as follows:

- The ‘do nothing’ option, i.e. simply allowing natural dispersion and weathering to occur;
- Containment and recovery (which involves the use of booms, skimmers and absorbent material);
- Protection of areas of high sensitivity (using booms);
- Application of fuel dispersants;
- Physical break-up of spill using surface craft;
- *In situ* burning;
- Beach clean-up; and
- Bioremediation (application of nutrients and/or bacteria to acceleration decomposition of beached or recovered spills.

Many of the above options either require highly trained personnel, or are inappropriate for the Coral Bay region. For example, recent research has shown that mixtures of fuel and dispersant are often more toxic to corals than the fuel alone (Negri and Heyward, 1999).

Under REEFPLAN, the marine pollution contingency plan for the Great Barrier Reef, the philosophy is to leave the fuel on the sea to degrade naturally unless it is likely to cause unacceptable environmental or amenity impacts (Swan *et al*., 1994). It is recommended that this philosophy be adopted for the Coral Bay region, and that booms be used when necessary to protect sensitive areas. The basic elements suggested for inclusion in a PCMP are outlined below.

4.2 POLLUTION CONTINGENCY MANAGEMENT PLAN

The PCMP must clearly delineate roles and responsibilities of personnel that make up the pollution response team. The pollution response team should include the following personnel:

1. Manager. Main duty to advise the appropriate authorities (and the media if necessary) of fuel spills, and provide them with updates on spill response progress.
2. Works Superintendent. Main duties to maintain response equipment and an 'On-call' roster schedule, and train field team personnel.
3. On-scene Coordinator. Main duties to assess potential impact of spill, initiate appropriate response (including notifying the Manager about the spill); mobilise, deploy and coordinate field team; and maintain a log of all factors relevant to the fuel spill response exercise.
4. Investigator. Main duties to determine the source and reason for the spill, take any necessary samples and submit them for analysis, and, if necessary, give evidence in court.
5. Field staff, which provide the manpower for fuel spill response activities, including spill monitoring and deployment of booms.

The PCMP should also delineate procedures to be followed in the event of a fuel spill. These should include initiation procedures for normal office hours and after hours. Flow charts showing assessment and response procedures during normal office hours and after hours should be prepared.

The roster maintained by the Works Superintendent should stipulate an 'On-call' officer, who will be required to make an initial site assessment to determine the potential environmental impact of the spill. Assessment should be based upon the type and size of spill, its location, its likely trajectory of movement, and the potential for sensitive habitats to be affected. A possible classification for spills that could be used is the one adopted by the Swan River Trust, as follows:

- Priority 3—No threat;
- Priority 2—Medium threat, where the spill poses an environmental threat that is not considered serious; and
- Priority 1—High threat, where life, property or the environment is threatened.

Priority 3 spills should require little more than a site assessment by the 'On-call' officer, rectification of the cause, and preparation of a brief written report to the Manager. If Priority 1 or Priority 2 spills occur, the 'On-call' officer becomes the On-scene Coordinator for response procedures, the Manager is notified and the Field Crew and Investigator are alerted (Priority 1 and 2) and/or activated (Priority 1). After Priority 1 or 2 spills have been dealt with, the On-scene Coordinator and Investigator should submit a comprehensive joint report to the Manager.

The equipment for fuel spill response will need to be maintained on site to enable rapid deployment during Priority 1 or 2 spills. In addition to the necessary vehicles, boats and trailers, possible equipment could include booms capable of protecting sensitive areas, absorbent booms capable of confining fuel spills, absorbent mats to mop-up spillages, and high pressure hoses for beach clean-up. Storage measures will be needed to protect the absorbent material from rodent attack. Regular servicing and inspection of fuel response equipment will be required to ensure it is operational at all times.

After any spill clean up exercise, an audit of all spill response equipment should be carried out, and any equipment disposed of or damaged should be replaced immediately. All personnel involved in the spill response should also attend a debriefing meeting to discuss the following issues:

- Response performance;
- Clean up performance;
- Health and safety issues;
- Equipment effectiveness; and
- Alterations required to improve the PCMP.

5. CONCLUSIONS

The types of boat fuel that could be spilled in the Coral Bay region (gasoline and diesel) are light refined products that would disperse and evaporate very quickly, particularly under the warm, windy conditions that are typical of the region. Gasoline leaves no residue after evaporation, and diesel leaves little residue (2%) that is readily biodegradable. Although only diesel would be dispensed at a refuelling facility, the effects of both gasoline and diesel spills were examined as this provided useful information on the likely effects of gasoline spills from boating accidents in the region.

The 'most probable' fuel spill scenario from a refuelling facility at Coral Bay is a spill of 30 L or less, and the 'worst case' scenario is a spill of 1,000 L or more. However, the risk of the most probable scenario is extremely low, and the risk of a large-scale fuel spill (1,000 litres or more) is even lower.

Due to rapid dispersion and evaporation, a small-scale fuel spill would have negligible effects on the marine biota and recreational uses of the Coral Bay region. A large-scale fuel spill would, at worst, be seen as an iridescent slick (about 0.0003 mm thick) over several square kilometres of water: gasoline slicks would be undetectable within two hours, and diesel spills would be hard to detect after six hours.

The coral communities at Coral Bay are all subtidal, and classified as receptors of high environmental sensitivity. However, even the most conservative calculations indicate that fuel concentrations in waters overlying corals would be far lower than levels at which toxicity effects occur.

The worst impacts of a large fuel spill would be felt by biota in intertidal limestone reef and sand habitats, as they would have direct contact with the spill.

5.1 NORTH BILLS BAY

Under all the wind and current scenarios considered, a large unconfined spill of either type of fuel at North Bills Bay has the potential to affect the bird sanctuary at Point Maud, although a gasoline spill would rapidly evaporate. The area at Point Maud is classified as a receptor of extreme environmental sensitivity. The worst impacts on human uses and public amenity (classified as of moderate environmental sensitivity) would be least at North Bills Bay. In terms of the potential environmental impacts of fuel spills, it is highest at North Bills Bay. However, it should be noted that if the fuel spill occurred within a boat harbour the impacts would be substantially reduced.

5.2 SOUTHERN BILLS BAY

A large spill of diesel at Southern Bills Bay also has the potential to affect the Point Maud area under typical wind conditions in winter. The worst impacts on human uses and public amenity would clearly be caused by fuel spills in Southern Bills Bay.

5.3 MONCK HEAD

A large spill at Monck Head would result in acute toxicity of biota in areas of intertidal limestone reef and sand (receptors of moderate environmental sensitivity) under all the wind and current scenarios considered. The worst impacts of a fuel spill on human uses and public amenity would be between those at Southern Bills

Bay and North Bills Bay. In terms of the potential environmental impacts of fuel spills, it is the lowest at Monck Head. This site offers the least risk of effects on receptors of extreme environmental sensitivity in the event of a large fuel spill.

Regardless of which site is chosen, the siting of the facility in a marine park requires that an appropriate pollution contingency management plan for fuel spills be prepared, and the necessary spill response equipment be maintained on site.

6. ACKNOWLEDGMENTS

This report was prepared by **Dr Karen Hillman** and **Dr Bruce Hegge** (DAL), and fuel spill modelling was carried out by **Dr John Hunter** (CSIRO). **Dr Des Lord** (DAL) reviewed the document, and **Ms Emma Newark** and **Katy Rawlings** (DAL) was responsible for formatting and production.

The cooperation and advice of **Mr Con Sappelli** (DPI) and **Mr Michael Mulligan** (Swan River Trust) is gratefully acknowledged.

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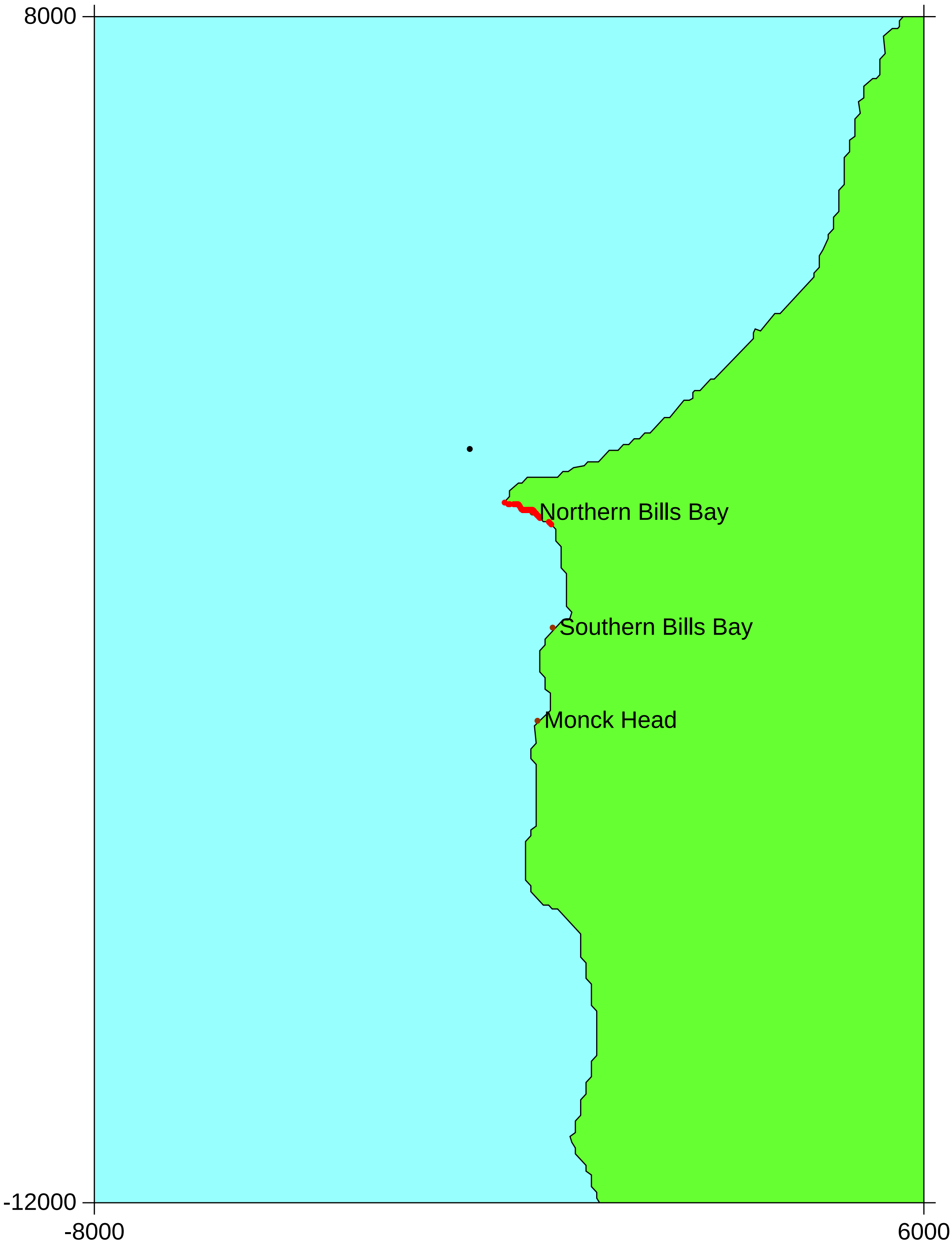
APPENDIX A
RESULTS OF FUEL SPILL MODELLING

Run 01; Time: 3 hours; 0.1% in sea; 98.8% beached.



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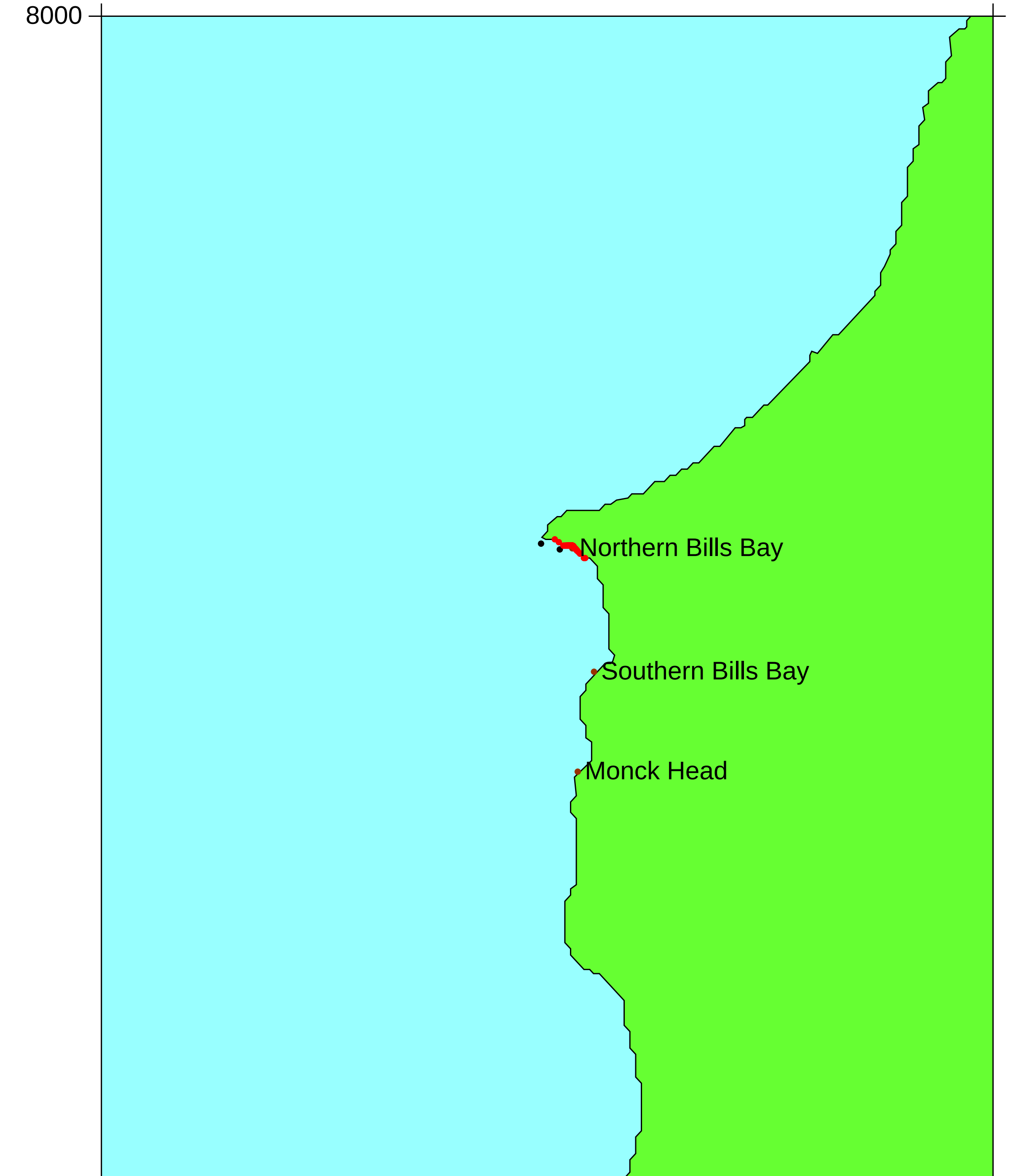
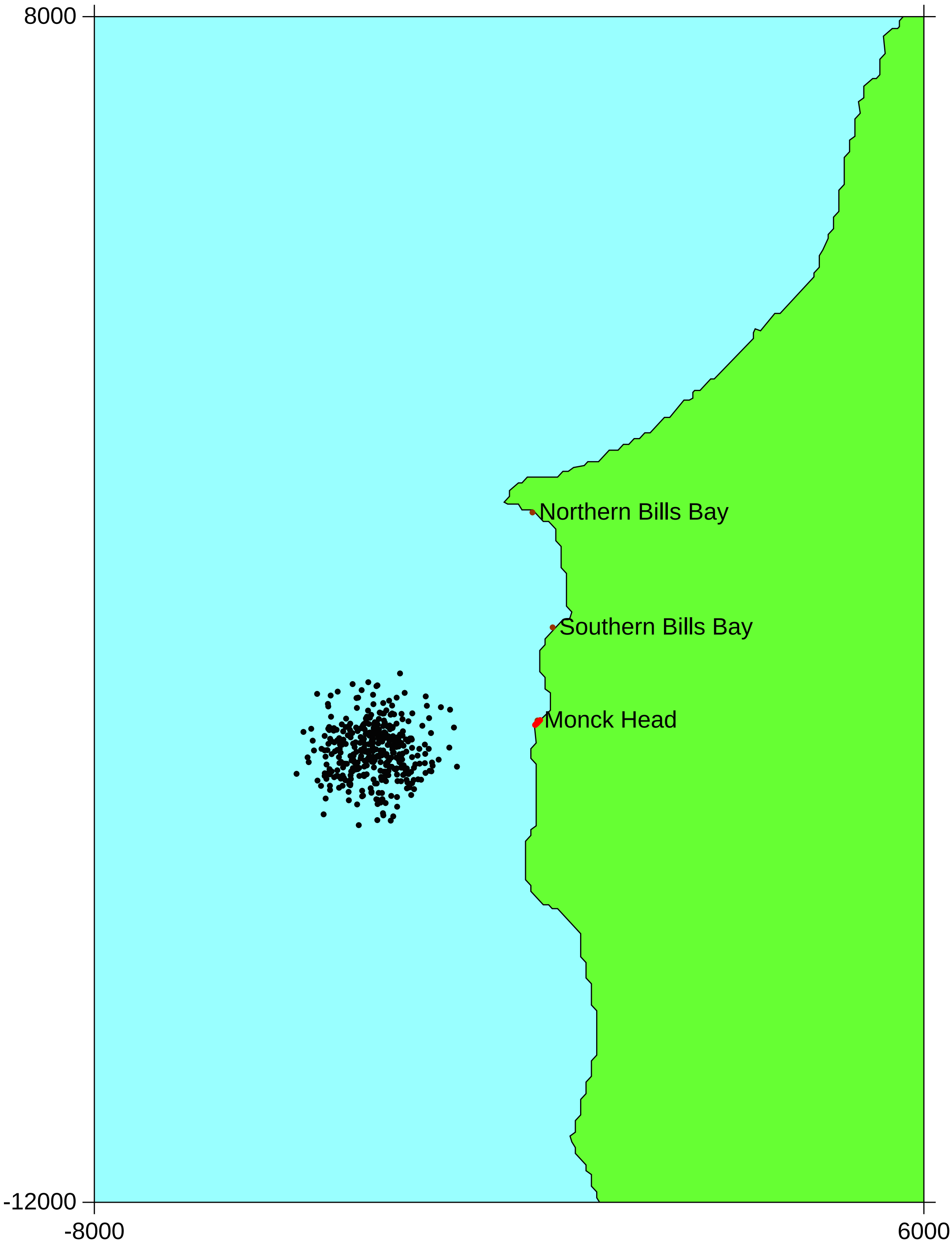
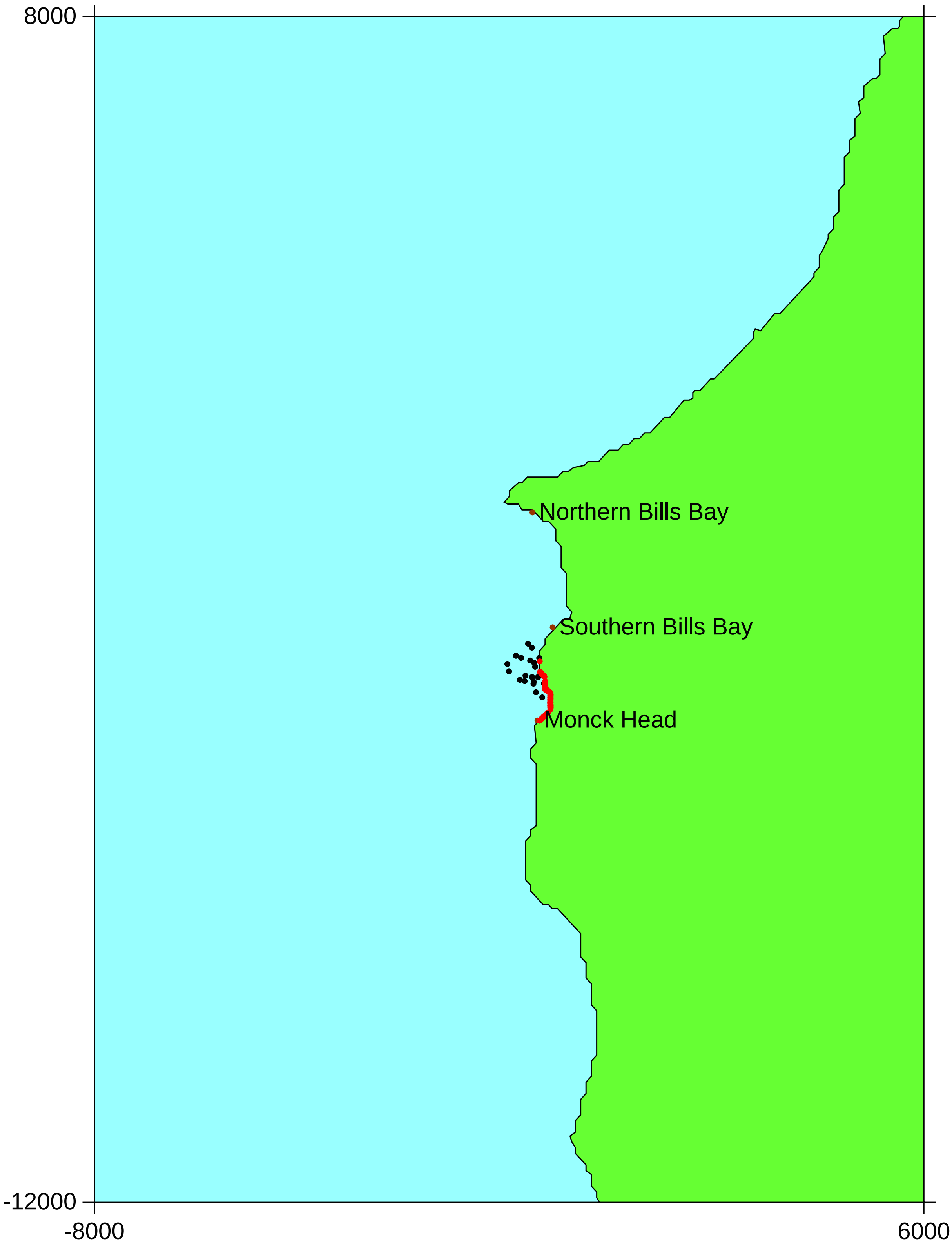


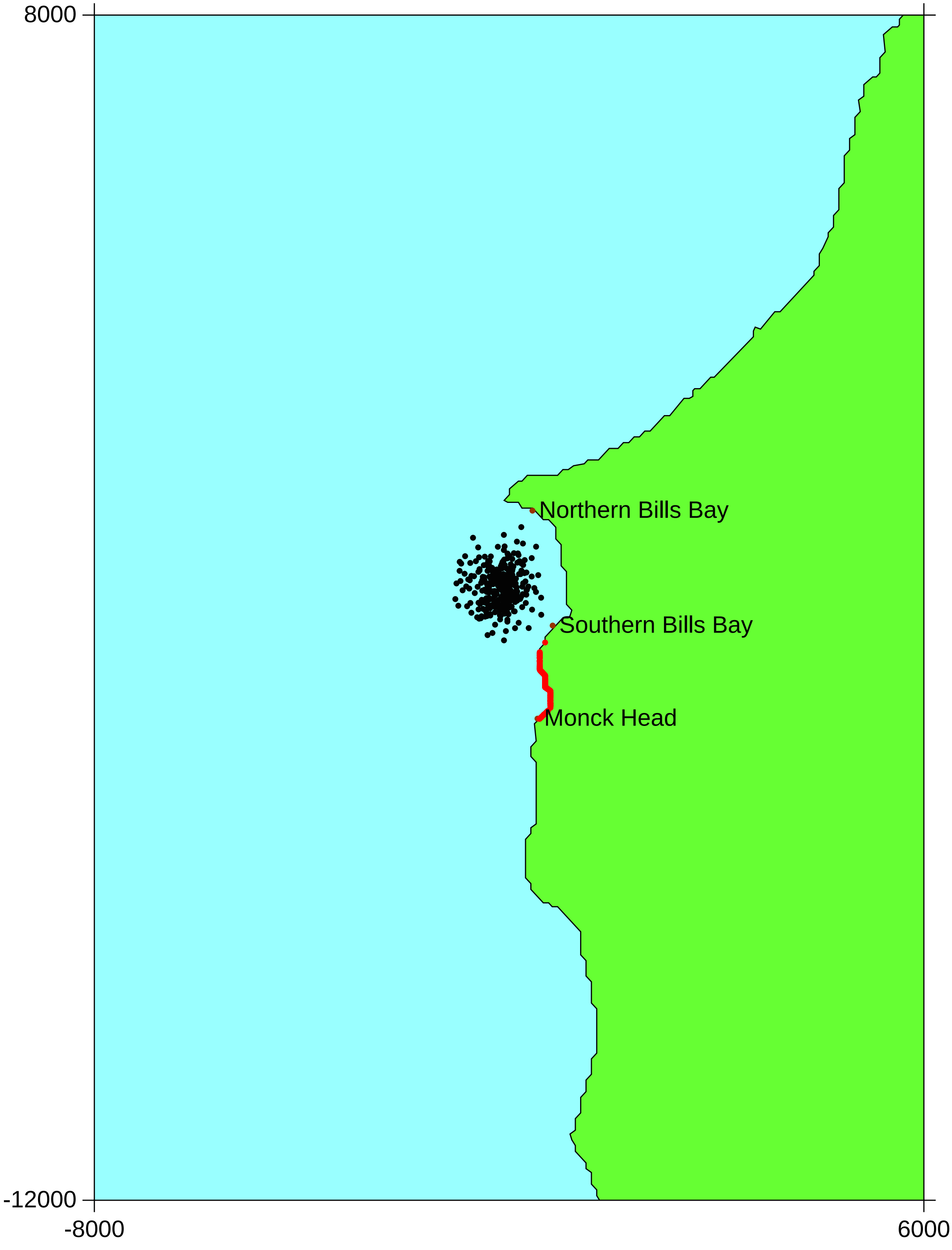
Run 29; Time: 6 hours; 40.4% in sea; 2.3% beached.



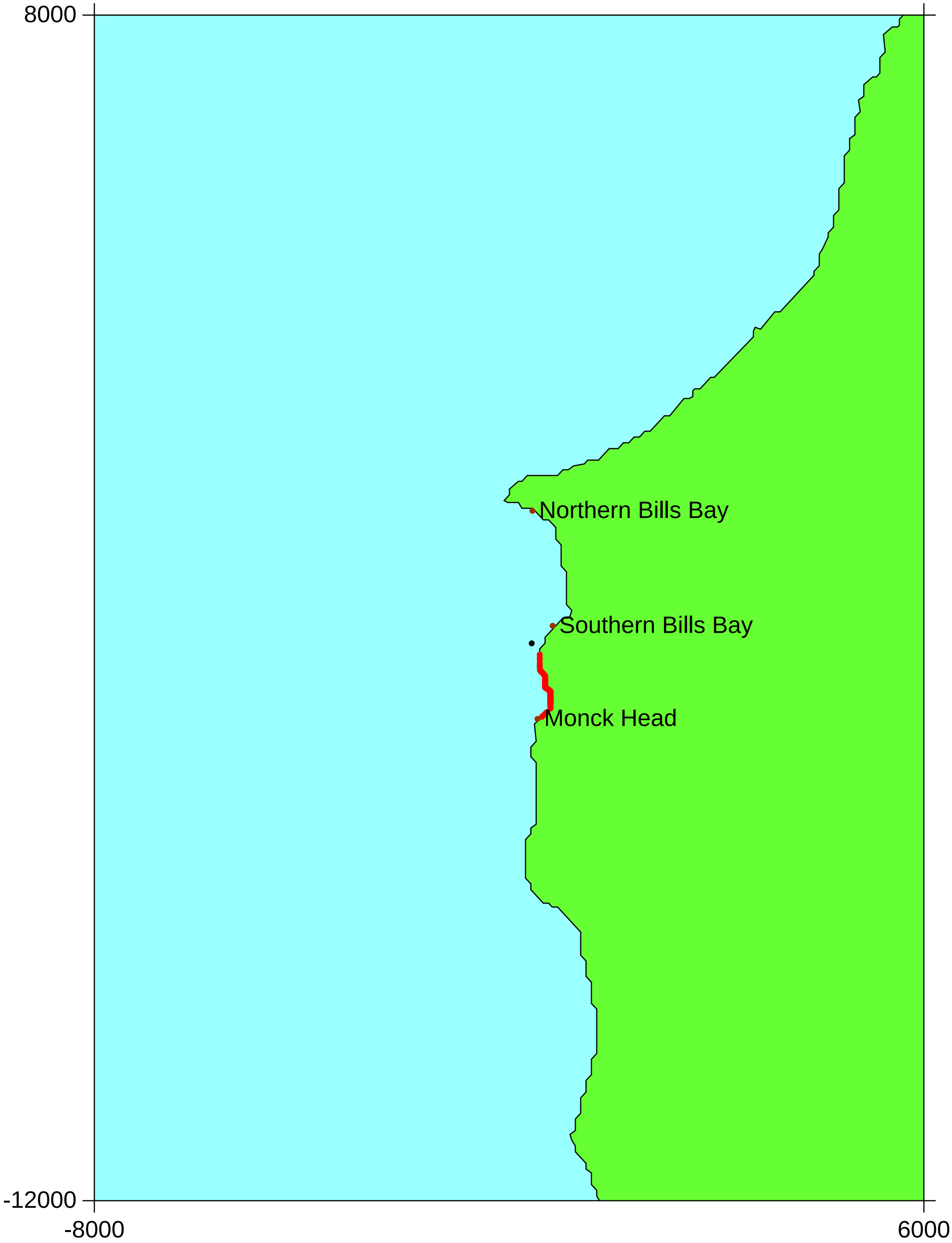
Run 28; Time: 1 hours; 2.1% in sea; 19.3% beached.



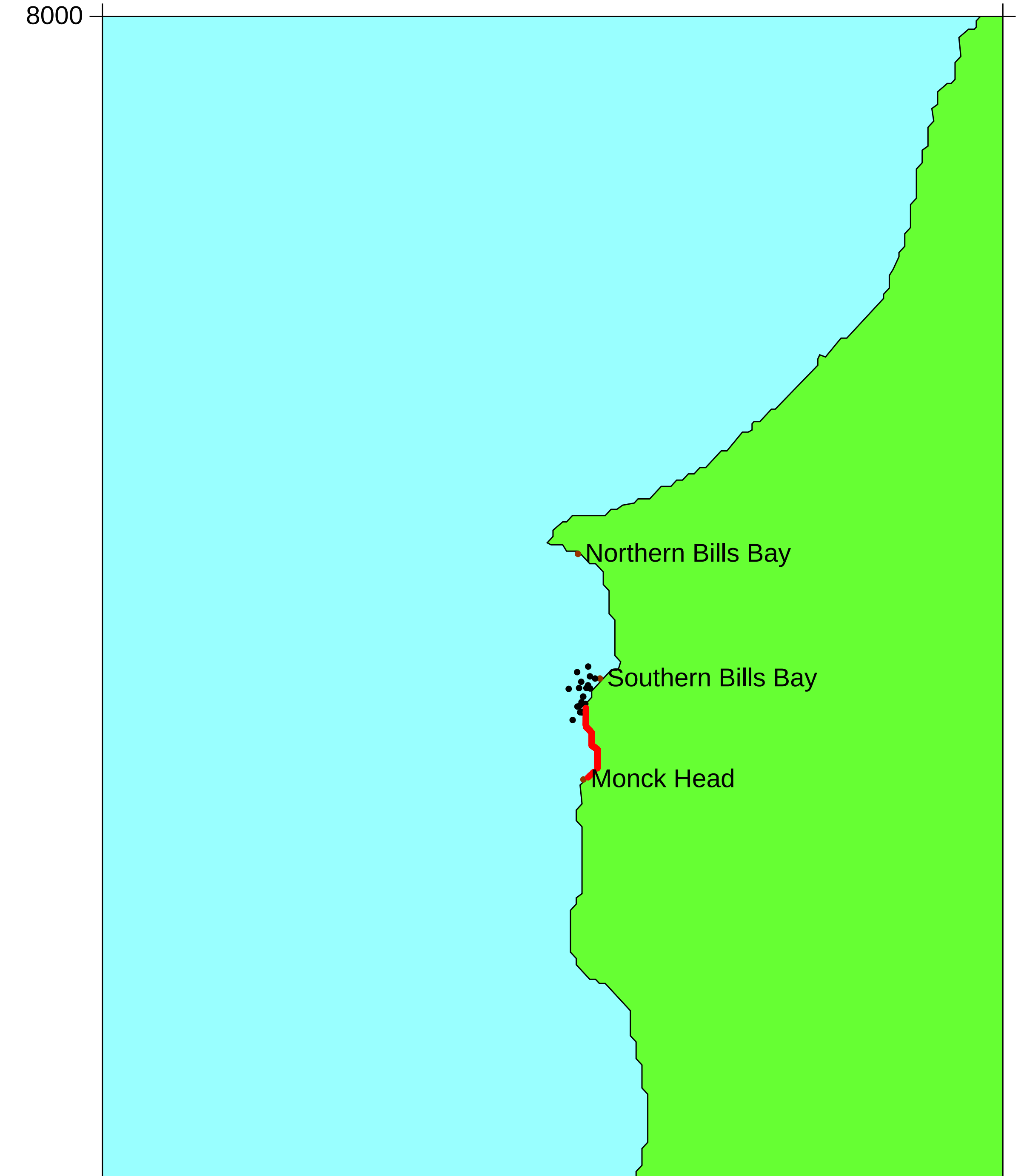
Run 27; Time: 3 hours; 30.3% in sea; 48.2% beached.



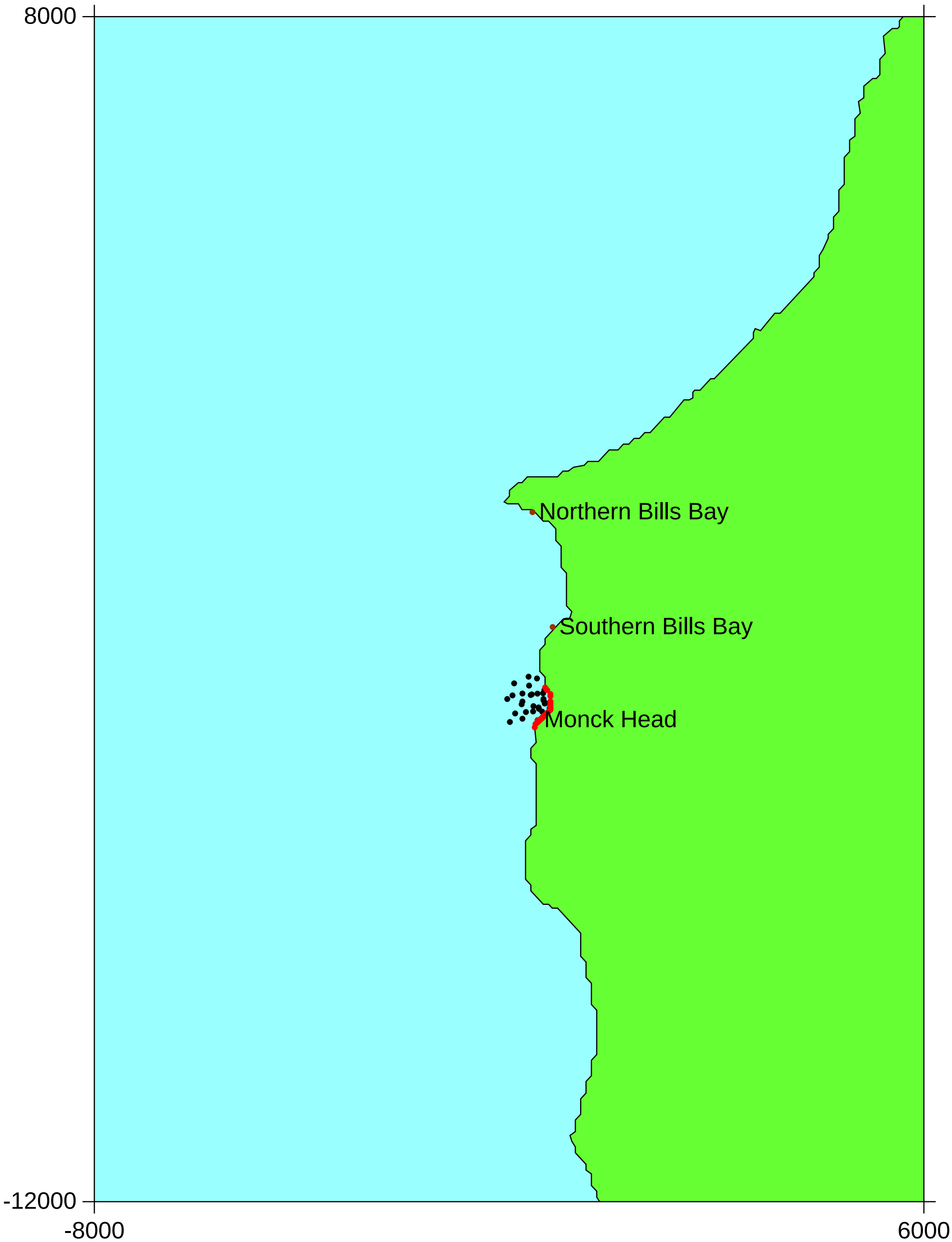
Run 26; Time: 1 hours; 0.1% in sea; 69.8% beached.



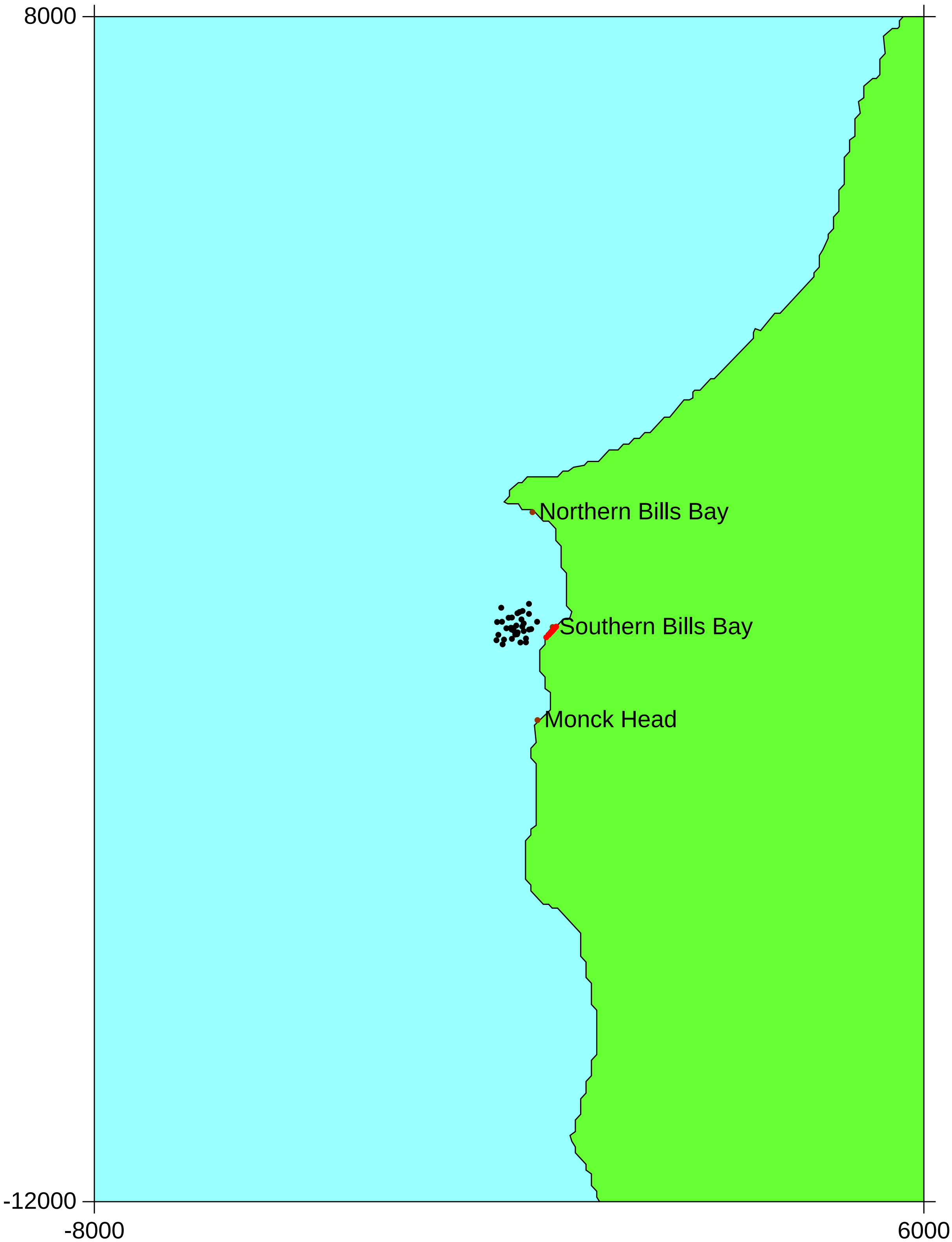
Run 25; Time: 1 hours; 2.1% in sea; 95.4% beached.



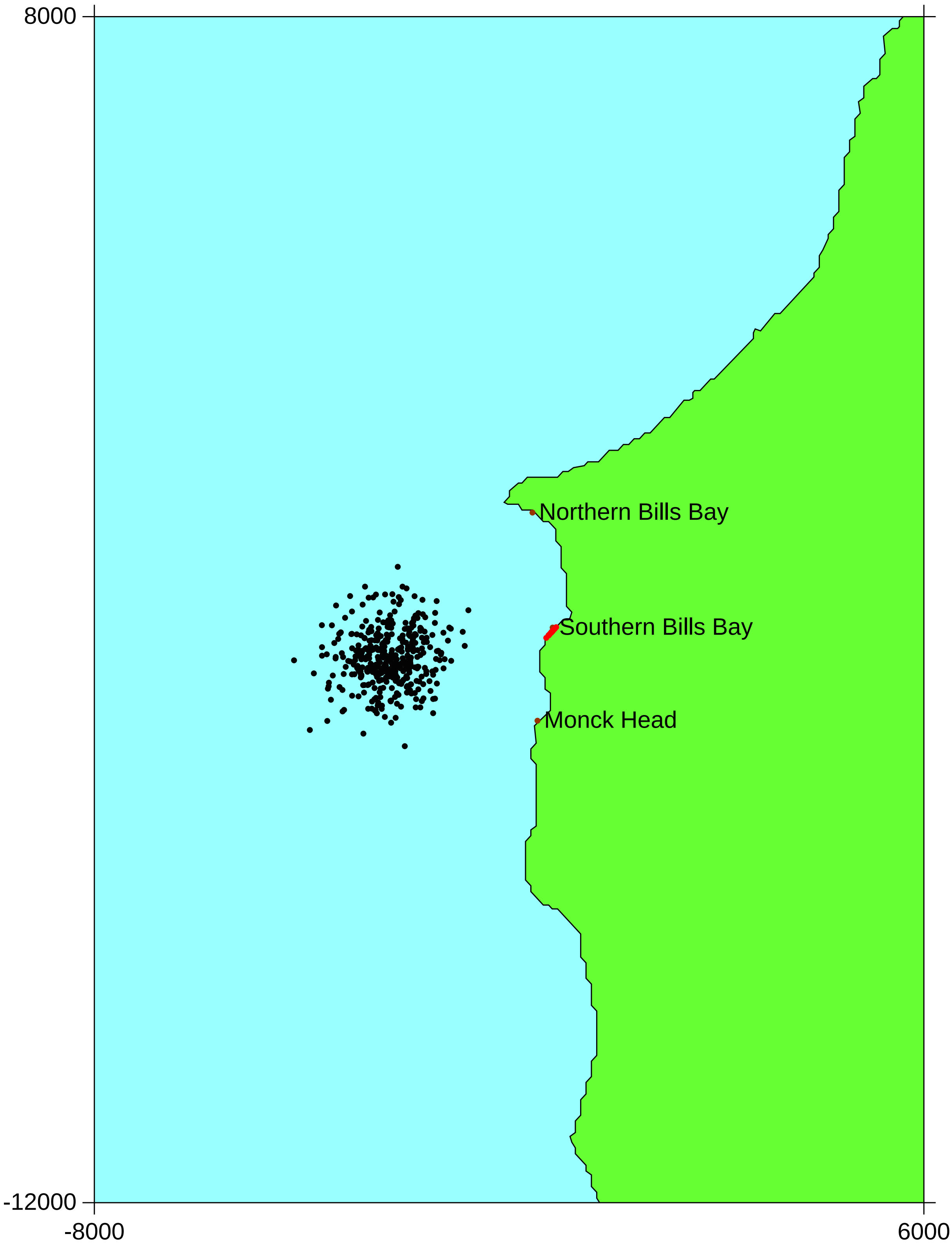
Run 22; Time: 1 hours; 2.8% in sea; 17.3% beached.



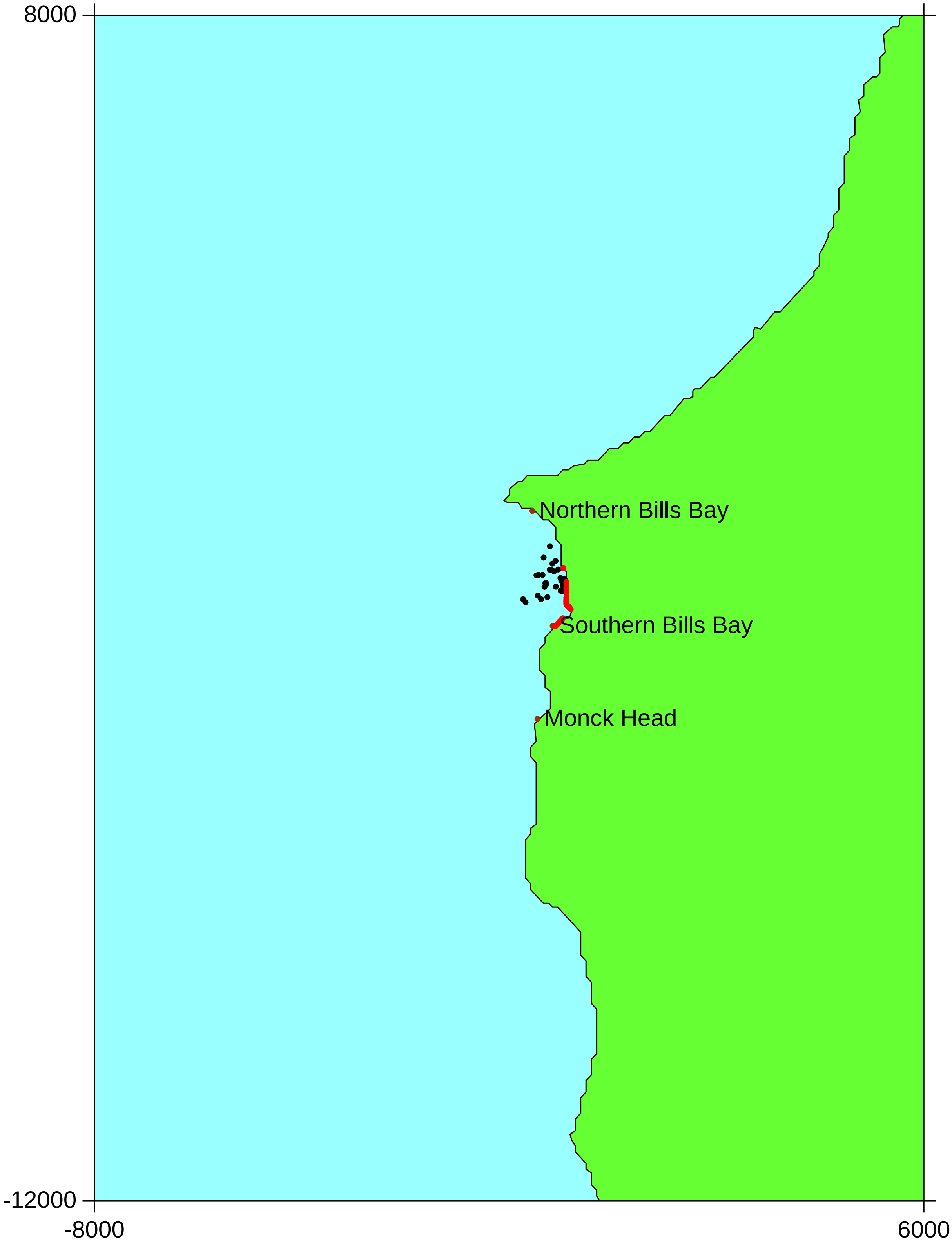
Run 20; Time: 1 hours; 3.4% in sea; 2.6% beached.



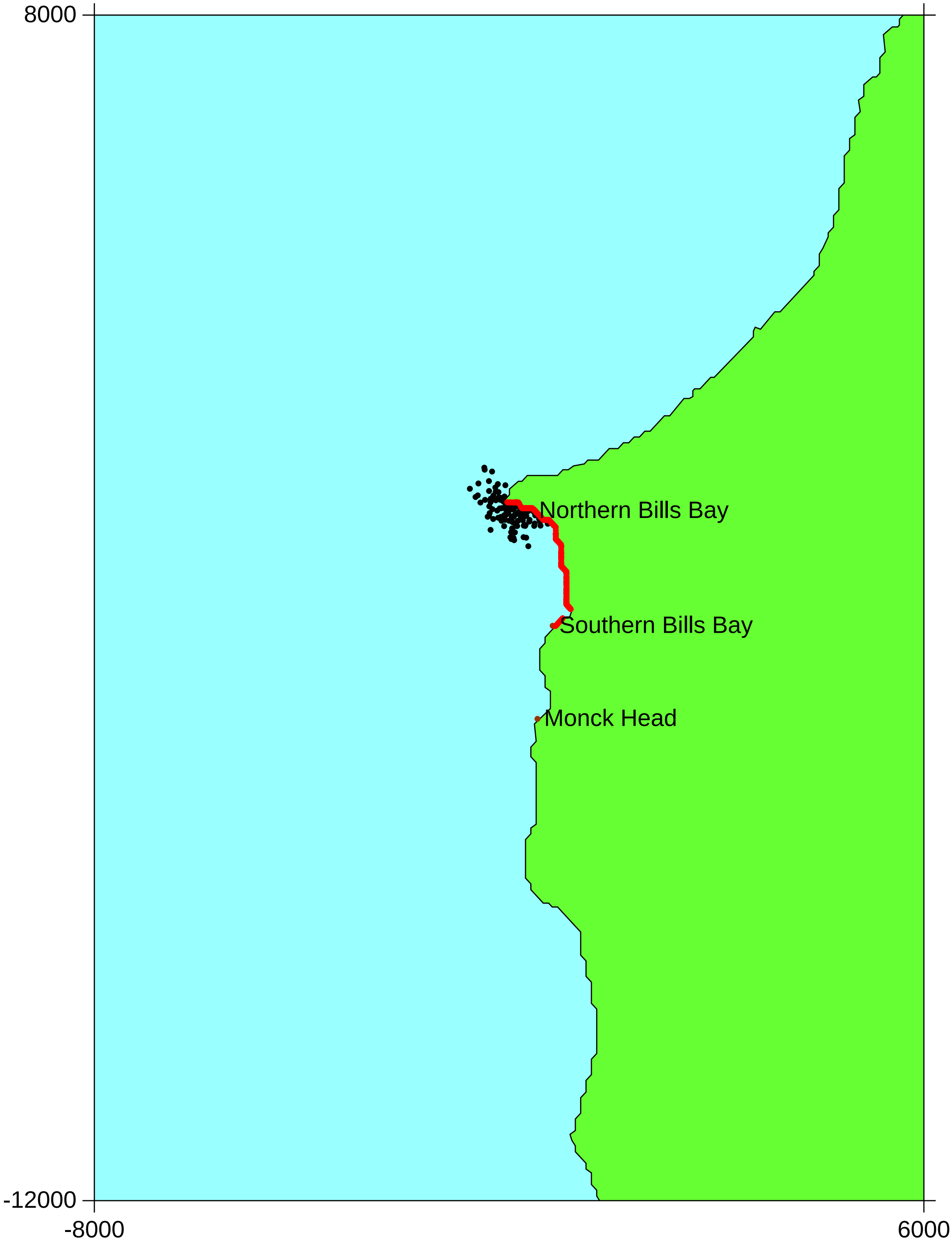
Run 19; Time: 6 hours; 40.4% in sea; 2.7% beached.



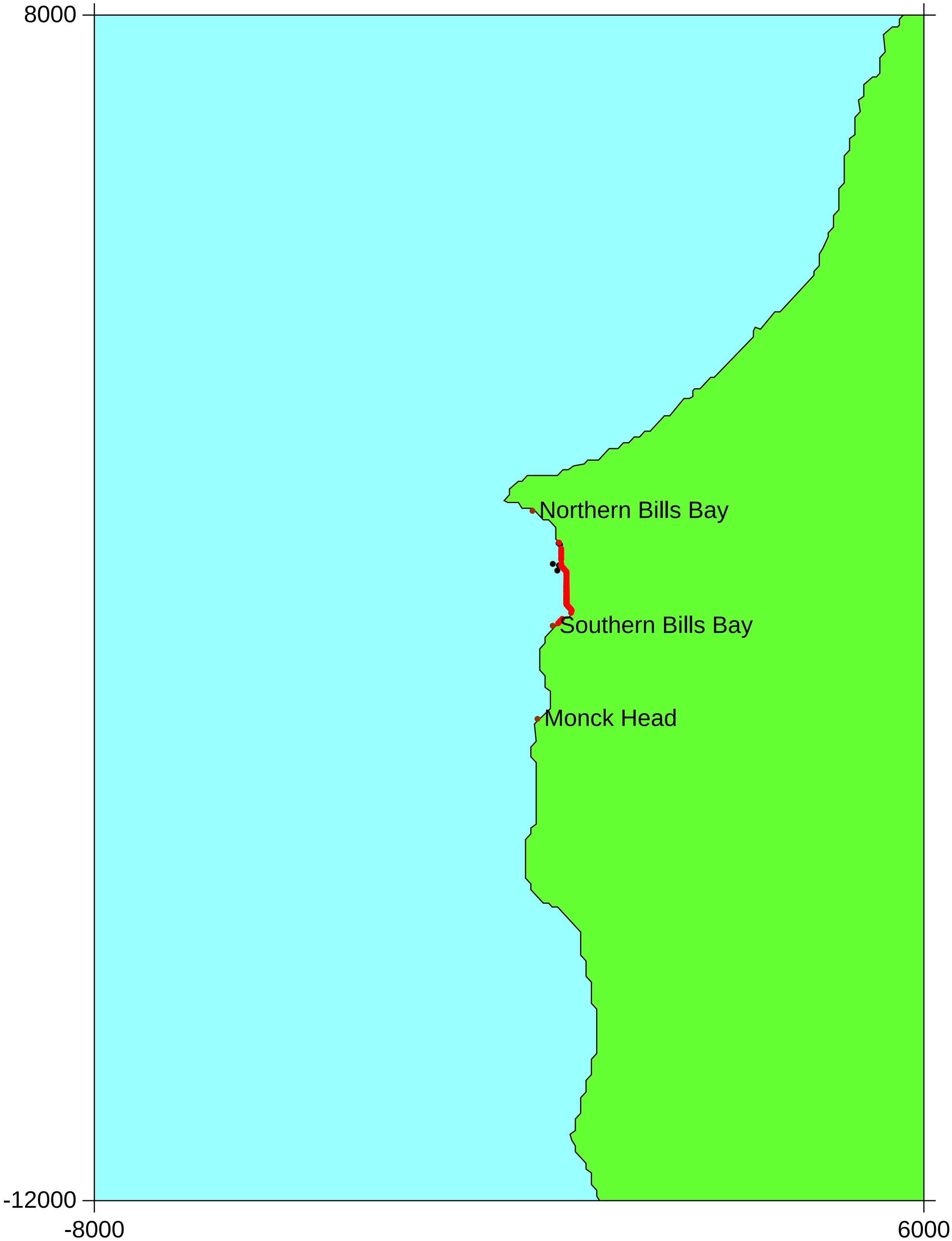
Run 18; Time: 1 hours; 2.7% in sea; 9.1% beached.



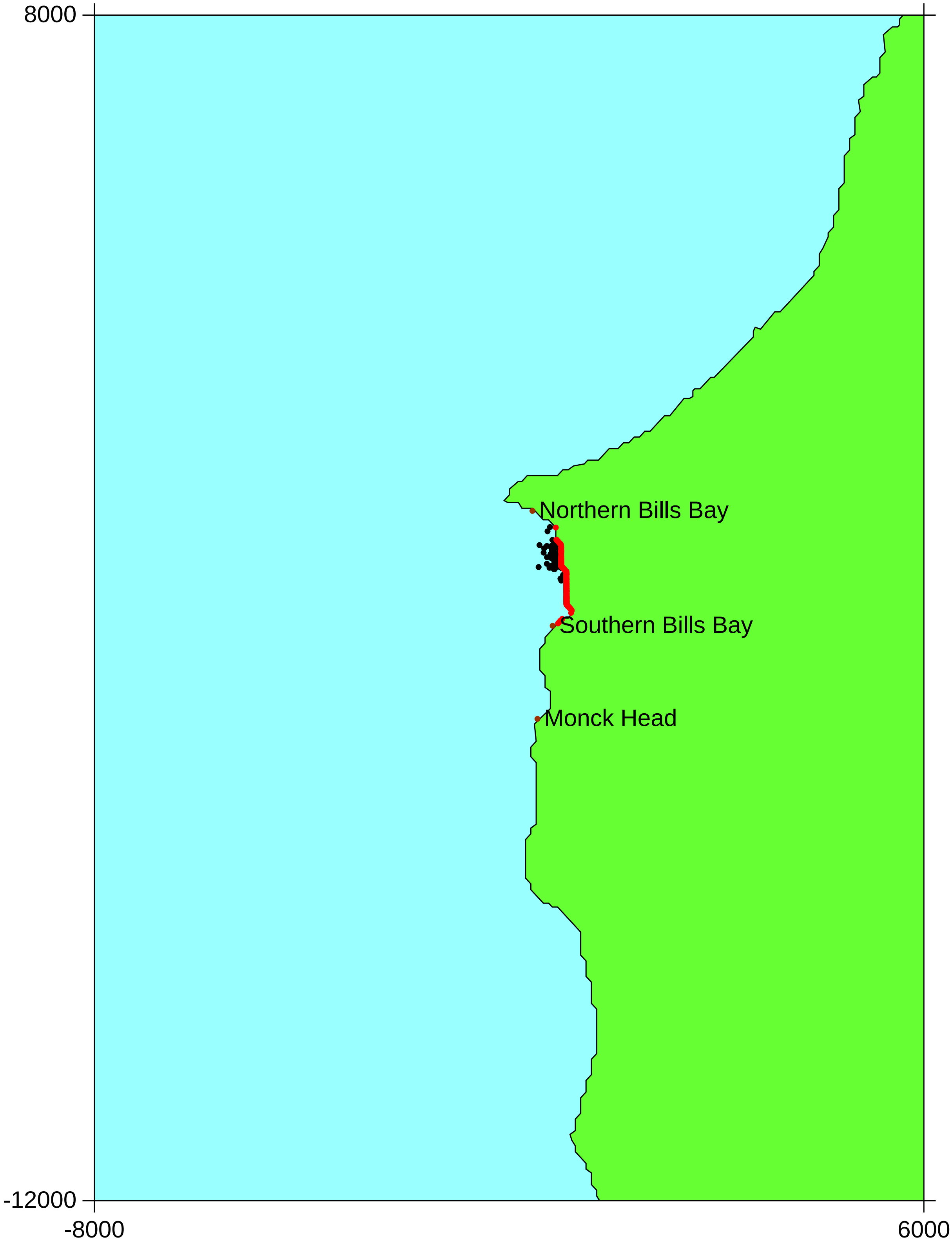
Run 17; Time: 3 hours; 11.8% in sea; 65.4% beached.



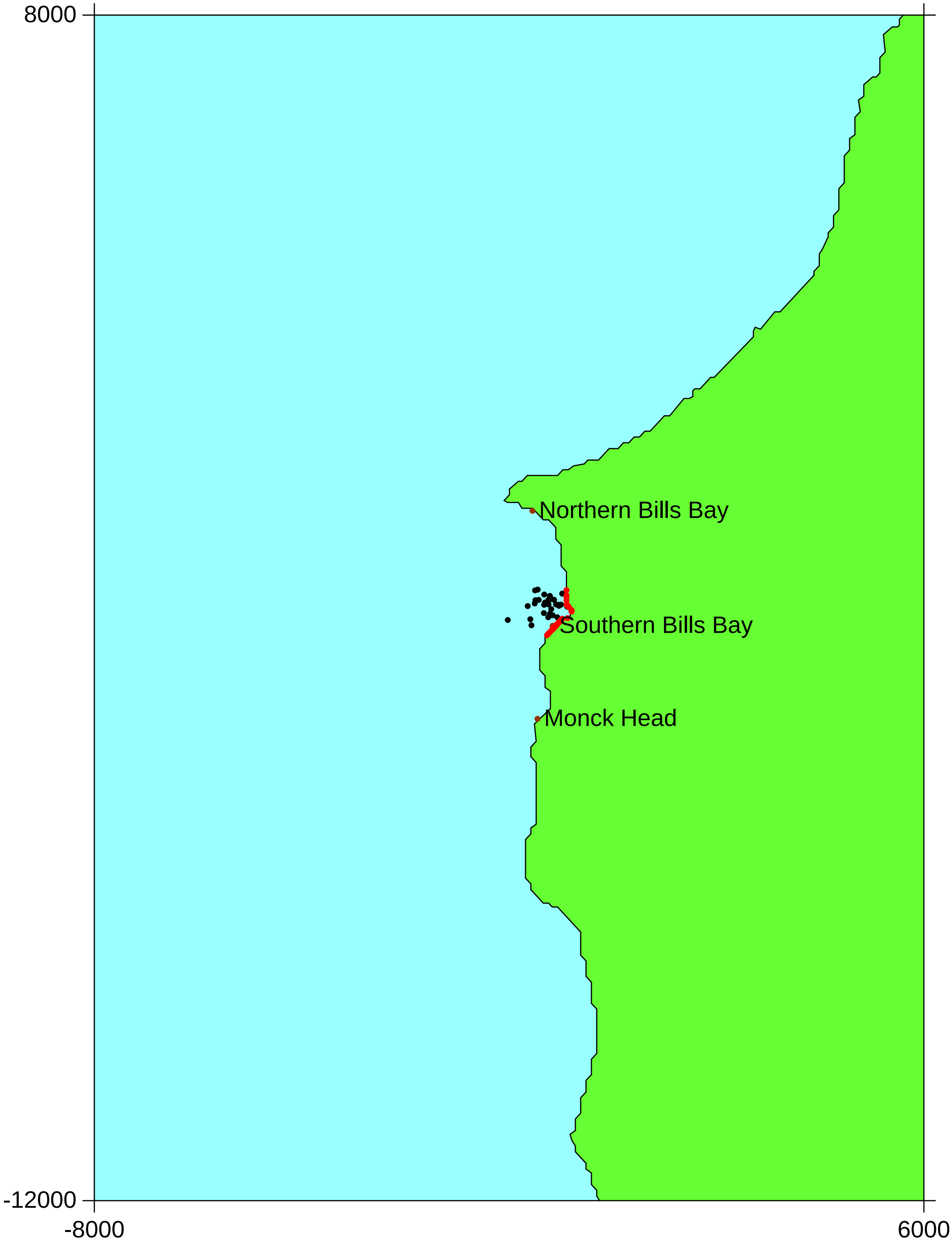
Run 16; Time: 1 hours; 0.5% in sea; 47.0% beached.



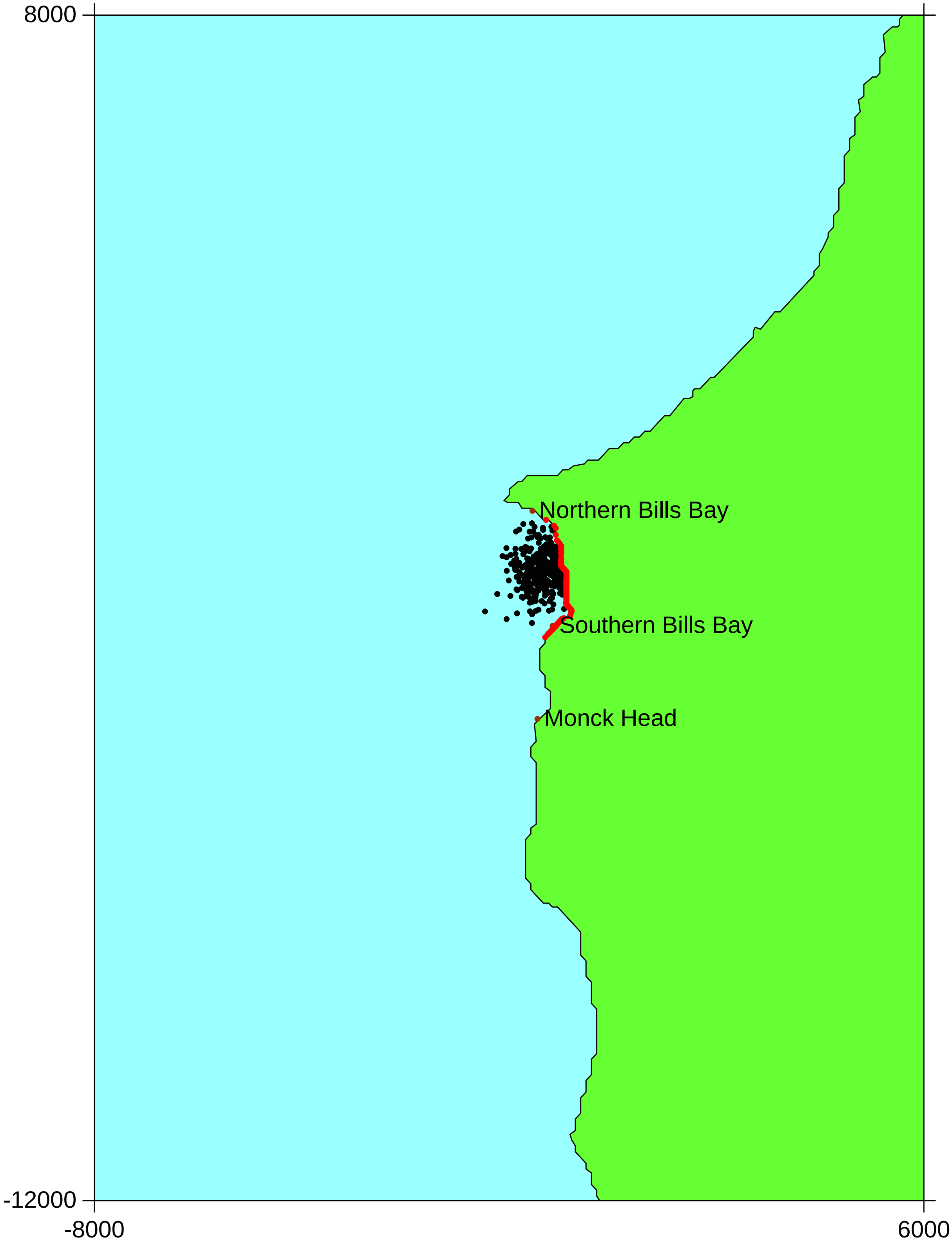
Run 15; Time: 1 hours; 6.6% in sea; 89.3% beached.



Run 12; Time: 1 hours; 2.9% in sea; 15.0% beached.



Run 11; Time: 3 hours; 35.1% in sea; 38.8% beached.



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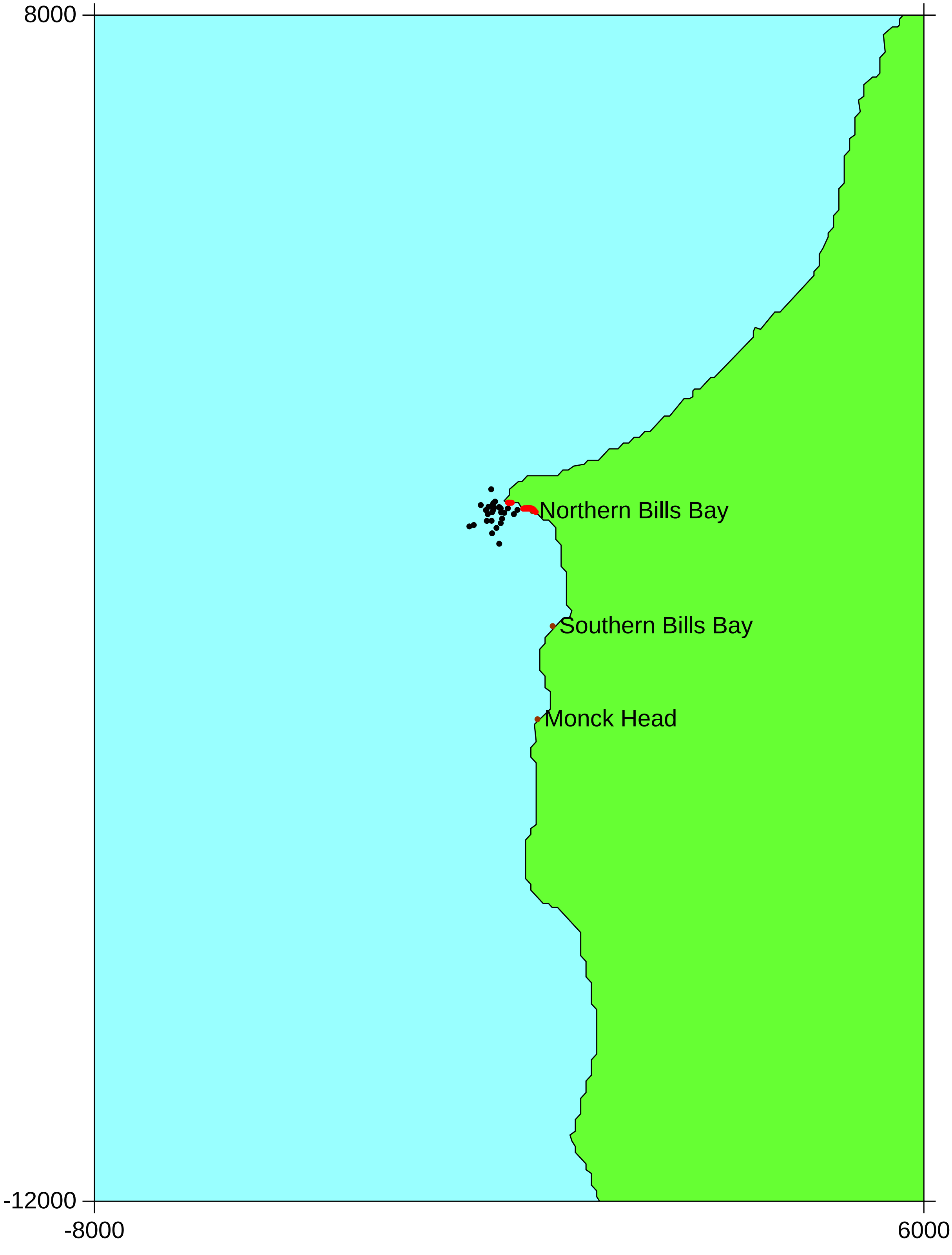
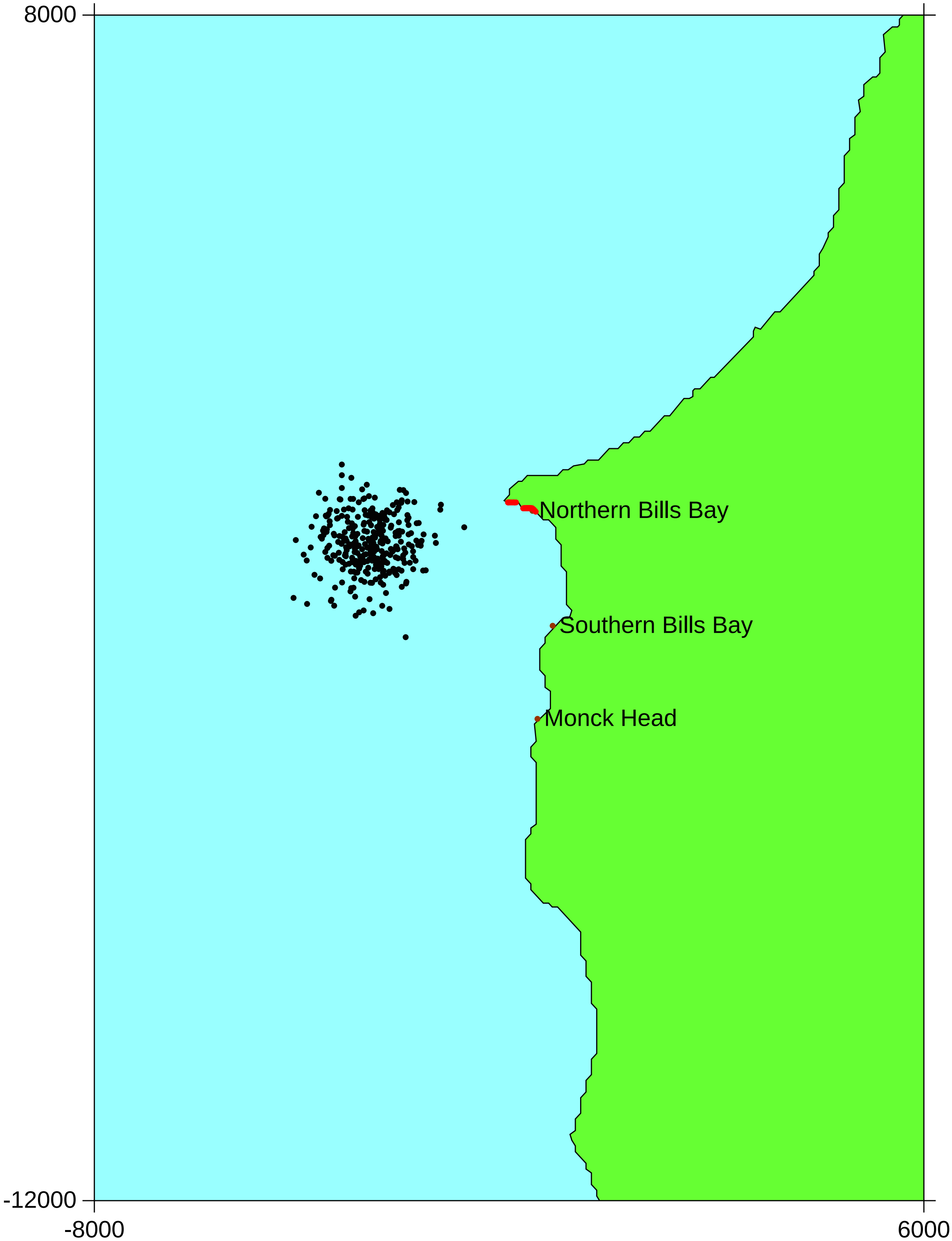


Run 09; Time: 6 hours; 33.5% in sea; 20.6% beached.



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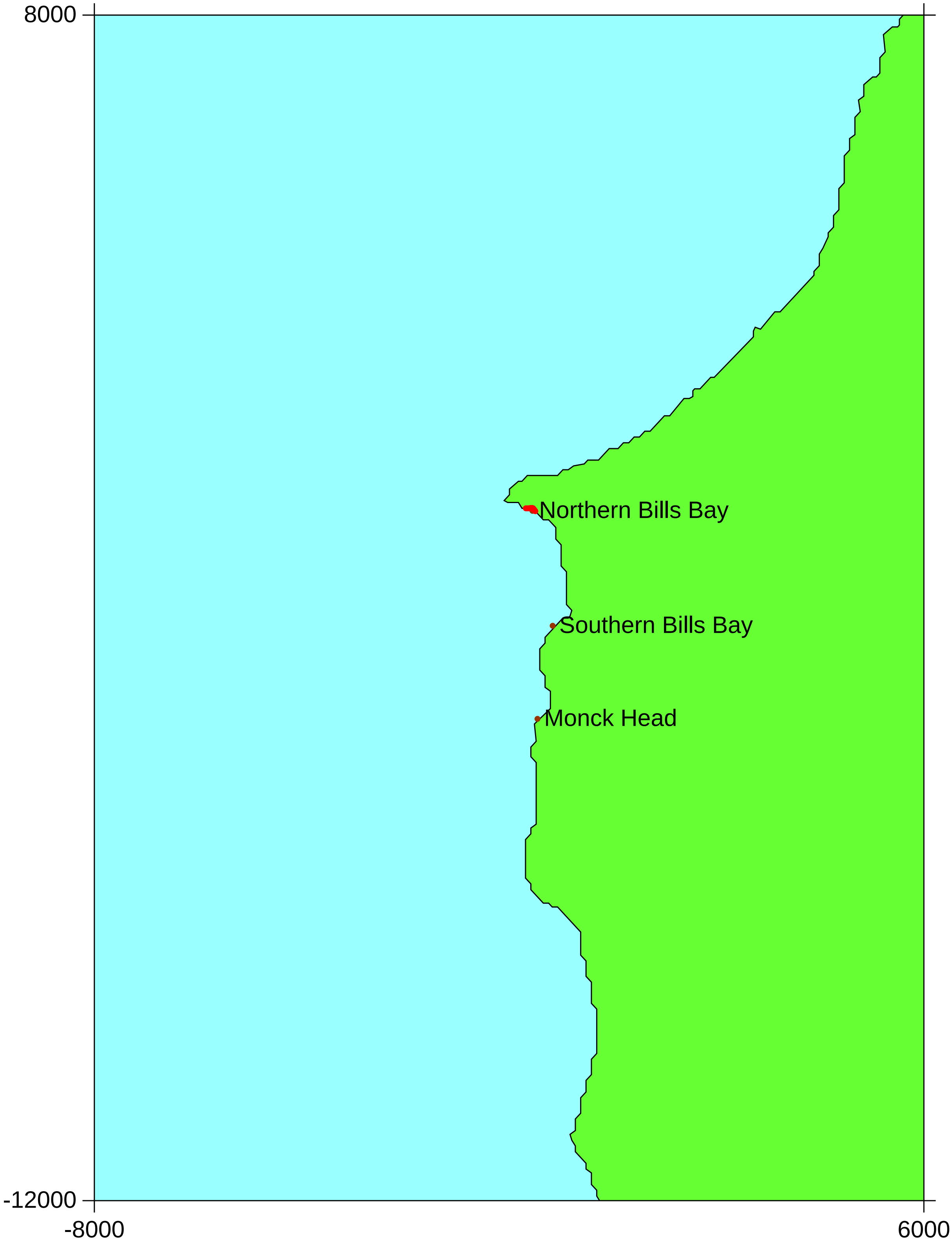

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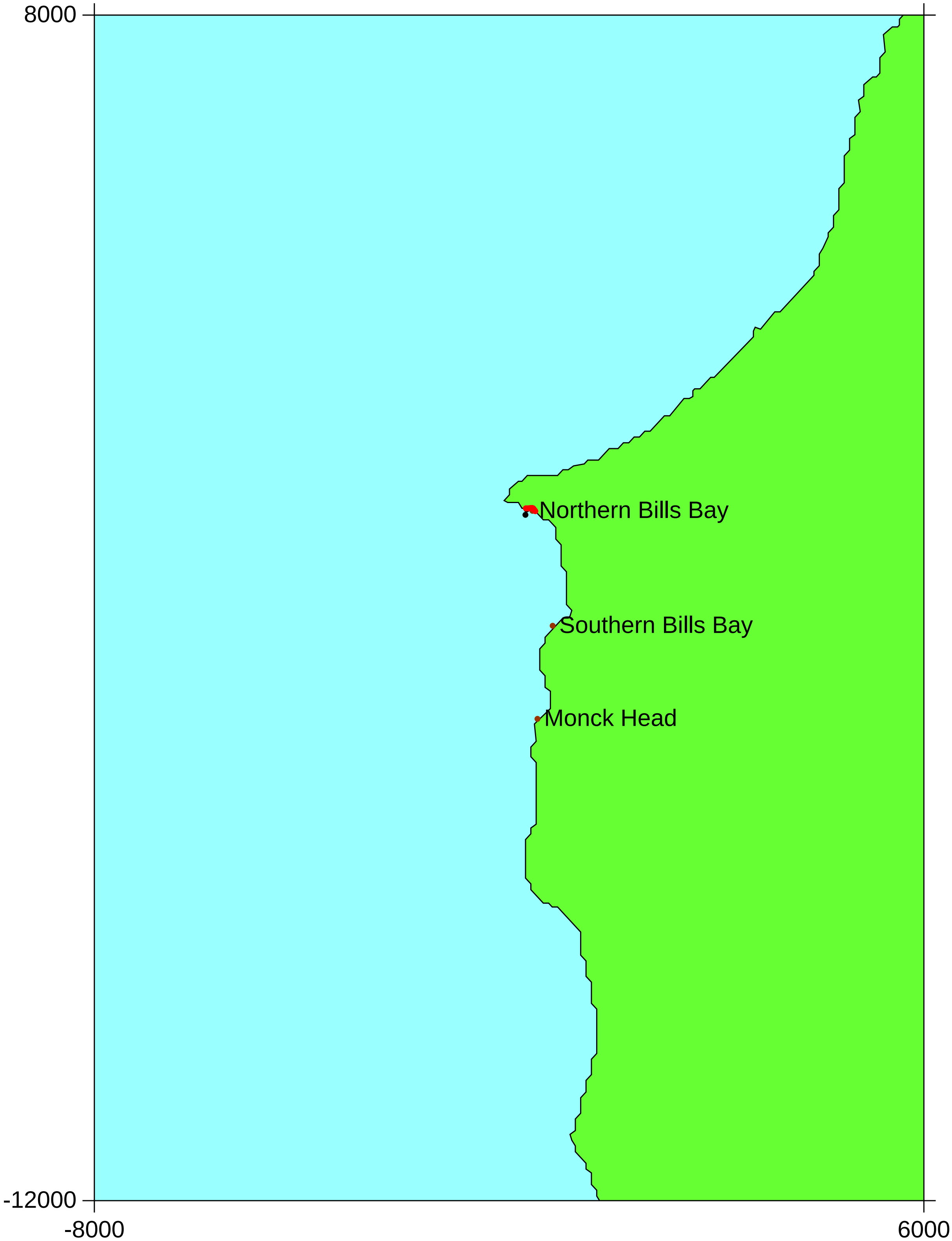

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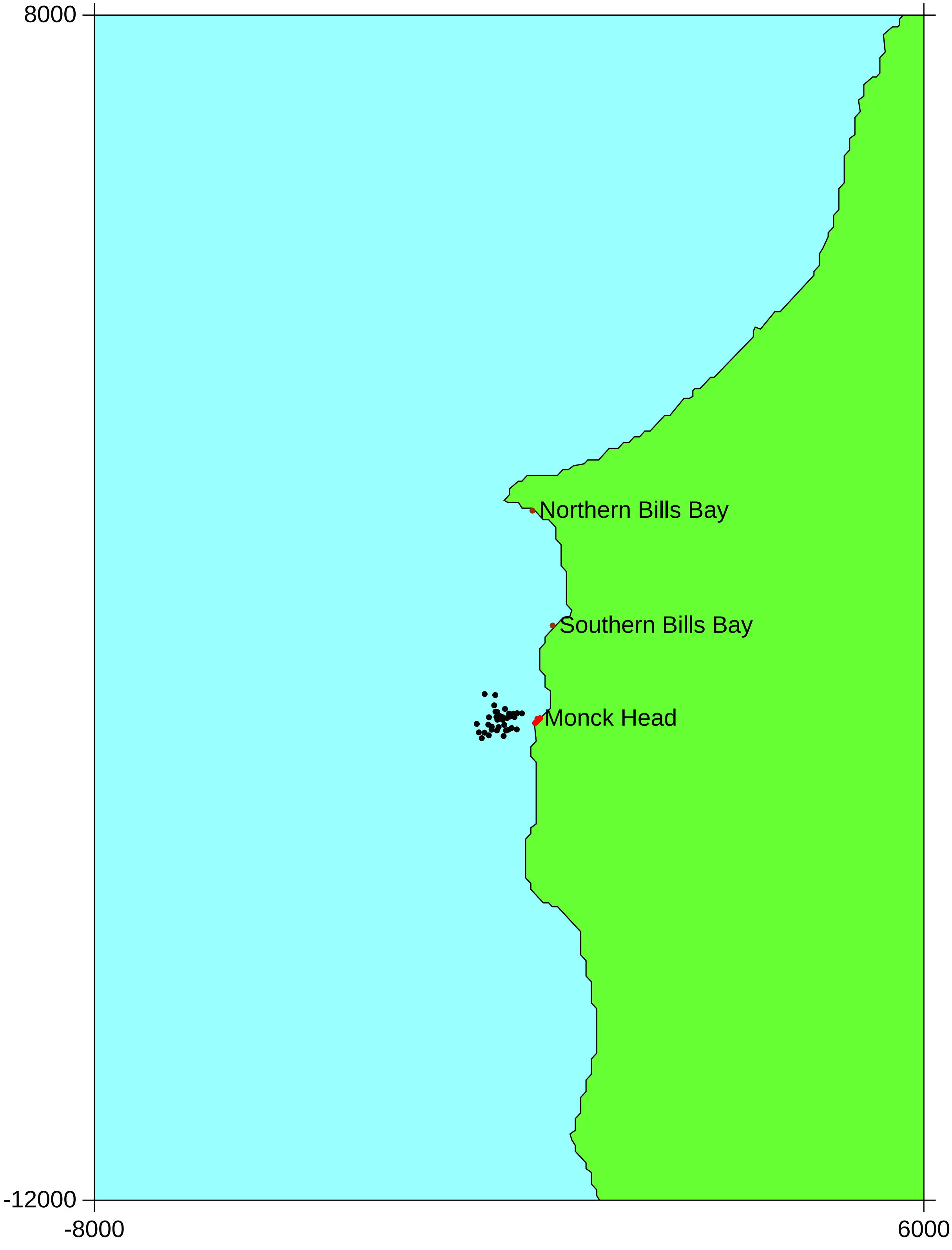

TECHNICAL APPENDIX 4
CORAL BAY BOATING FACILITY
TERRESTRIAL VEGETATION AND FAUNA STUDY

Prepared for:

DEPARTMENT FOR PLANNING AND INFRASTRUCTURE

Prepared by:

GOBLE-GARRATT AND ASSOCIATES
NINOX WILDLIFE CONSULTING

In collaboration with:

DAL SCIENCE & ENGINEERING PTY LTD

MAY 2002

REPORT NO. 97/050/16

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PLATES

APPENDICES

EXECUTIVE SUMMARY

This report presents the results of a field survey of the vegetation and a desk survey of the fauna at three alternative sites in the vicinity of Coral Bay: Mauds Landing, North Bills Bay and Monck Head. These three sites have been proposed for the development of a boating facility; however, note that it is proposed that a facility only be developed at one of these three sites.

The field visit for the vegetation study was carried out in March 1998 as part of an environmental review of the boating facility proposal conducted by DAL Science & Engineering Pty Ltd (formerly D. A. Lord and Associates Pty Ltd). The fauna study was restricted to an extensive revision, and addition of a new habitat type to the provisional lists of vertebrate fauna in the Coral Coast Marina report (Ecologia, 1995).

MAUDS LANDING

At Mauds Landing, a series of low foredunes, parallel to the coastline, support a low and open hummock grassland (total cover approximately 50%) with a very simple species composition (9 perennial species were recorded). Immediately behind the foredunes is an open plain (relic foredune plain) with an open shrubland dominated by *Acacia coriacea* to approximately 1.5 metres. The substrate is firmer here than on the adjacent dunes, and protection is afforded by the series of foredunes. This leads to vegetation of greater stature, and with a more diverse species composition (23 species of perennial were recorded). There were no Priority species or species of particular interest present.

The two vegetation types distinguished at Mauds Landing are combined as one vertebrate habitat type (coastal dune scrub) due to the basic structural similarity of the vegetation, and the similarity in substrate. With the inclusion of the open beach as a separate habitat there are thus two vertebrate habitat types present at Mauds Landing. Total numbers of vertebrate species possibly present are as follows: native mammals–17; introduced mammals—6; birds–102; and reptiles–56.

NORTH BILLS BAY

Providing a boating facility at North Bills Bay with an access road from the Mauds Landing area would impact on three vegetation types. Initially access would be through an area of Shrubland on the relic foredune plain. The major part of the access route from the Mauds Landing area to North Bills Bay is through a largely undisturbed part of the parabolic dune system which covers most of Point Maud. Vegetation on these dunes is predominantly a Low Shrubland with isolated patches of larger shrubs which include *Acacia coriacea, Santalum spicatum* and *Heterodendrum oleaefolium.* The final vegetation type impacted is the Hummock Grassland of the foredunes along North Bills Bay. The vegetation here is species poor, much as it is on the foredunes at Mauds Landing. The dominant species is *Spinifex longifolius*, with clumps of *Atriplex isatidea* and *Acacia coriacea* shrubs emergent.

One species, *Acacia ryaniana*, (Priority 2) on the Department of Conservation and Land Management's Priority list, was recorded along the proposed route through the dunes.

As far as fauna is concerned, the three vegetation types distinguished for the North Bills Bay site can be combined as one vertebrate habitat type (coastal dune scrub). With the inclusion of the open beach as a separate habitat there are thus two vertebrate habitat types present in the area impacted by the proposal for North Bills Bay. Total numbers of vertebrate species possibly present are as follows: native mammals–17; introduced mammals—6; birds–102; and reptiles–56.

MONCK HEAD

The two dune based vegetation types distinguished at Monck Head are combined as one vertebrate habitat type (coastal dune scrub). The limestone pavement and low cliffs form a second distinct habitat type. Although most of the species possibly present on the limestone are shared with the dune habitat, it is very much poorer in potential vertebrate species. Total numbers of possible vertebrate species are as follows: native mammals—17; introduced mammals—6; birds—79; and reptiles—54.

At all of the sites, there will be impacts on the vegetation and fauna, due to the need for removal of some vegetation and disturbance to the habitat. The site where these impacts would be least is Mauds Landing and the biggest impact would be for the North Bills Bay proposal.

In all cases, clearing needs to be limited and monitored, and rehabilitation of disturbed areas not paved should proceed as soon as possible once construction is complete.

None of the vegetation or habitat types which may be impacted by the proposal are limited in distribution, either locally or regionally, and generally the impacts would be small, short term and easily managed.

-o0o-

1. INTRODUCTION

This report presents the results of a field survey of the flora and vegetation and a desk survey of the fauna of the proposed boating facility which has been proposed for one of three sites in the vicinity of Coral Bay: Mauds Landing, North Bills Bay and Monck Head. Coral Bay is a small holiday town on the north-west coast of Western Australia at approximately 23°S latitude (some 250 km north of Carnarvon).

Mauds Landing, is north of the town on a sloping north-westerly facing beach backed by extensive saline flats. North Bills Bay is situated north of the town of Coral Bay on a sheltered narrow west-south-west facing beach, backed by recent coastal dunes. Monck Head is south of the town on a west-facing coastline which is formed by a low limestone cliff and pavement, backed by low dunes.

The field visit for the flora and vegetation study was carried out in March 1998 as part of an environmental review of the boating facility proposal conducted by DAL Science & Engineering Pty Ltd (formerly D.A. Lord & Associates Pty Ltd).

The vegetation of the region has previously been surveyed, categorised and mapped at a scale of 1:1 000,000 by Beard (1975). Beard (1975) mapped the vegetation in the vicinity of Coral Bay as the Coastal Dunes System of the Carnarvon Botanical District. He described the vegetation as a variety of *Acacia* shrubland with Hummock grasses (*Triodia* and *Plechtrachne*) present in the understorey. This description was based on a detailed examination of the coast between Carnarvon and Quobba, some distance south of Coral Bay, but the descriptions of topography and vegetation accord well with the broader Coral Bay area.

An extensive survey of the flora and vegetation of the whole of the Carnarvon Basin was carried out by Payne *et al*. (1980) as part of an inventory of the rangelands. The proposed site for the development of a small boat harbour falls within their "Coast" Land System. This System is restricted to a narrow band along the coast north of Carnarvon and south of Shark Bay. The Coast Land System represents only 1.5% of the land area of the Carnarvon Basin as defined by their study.

The most recent and detailed examination of vegetation in the area is the study completed by Trudgen (1994) during an environmental review of a proposal for a marina development at Mauds Landing.

All three of these past studies of the vegetation in the area indicate a flora which is typical of the Eremaean (Arid) areas of Western Australia, but with some representatives of taxa more common in the south-west of the State. Shrublands are the predominant vegetation type with the Genus *Acacia* an important component of the flora. Trees are generally absent except along watercourses.

A desktop study of the vertebrate fauna was also carried out as part of the environmental studies for the marina proposal for Mauds Landing (Ecologia, 1994). This study provided a provisional list of species likely to occur in the area given the known distributions and habitat preferences, and concluded that close to 200 species might occur, if only as ephemeral visitors.

2. METHODS AND LIMITATIONS

The site survey for the flora and vegetation was carried out in March 1998. At all three sites the vegetation was broadly categorised using structural features and topography of the habitat. All species seen during traverses of the sites (and access routes in the cases of North Bills Bay and Monck Head) were recorded. Voucher specimens of any species not readily identified in the field were collected and pressed for later identification/verification at the Western Australian Herbarium. Notes were taken of the condition of the vegetation and of any existing disturbance.

The checklist of the vascular flora for the study sites is restricted almost entirely to perennial species due to the season in which the site was visited. The survey was non quantitative, and no attempt was made to sample systematically (i.e. on a grid or other system). However, all habitat types were covered, and all dominant species were recorded. Special care was taken to identify any of the Priority species on the Department on Conservation and Land Management's lists which were known to occur in the area.

The fauna study was restricted to an extensive revision, and addition of a new habitat type to the provisional lists of vertebrate fauna in the Coral Coast Marina report (Ecologia, 1994). This review was undertaken by Ninox Wildlife Consulting based on habitat and vegetation descriptions provided to them after the site visit. The provisional lists were prepared by reference to published distribution records, and from personal knowledge of the fauna of the north-west of Western Australia and the offshore islands.

The final list of species potentially present is based on published information, and is intended as an aid to understanding the conservation significance of specific habitats. The assumption underlying this provisional species list is that if a series of intensive surveys spread over all seasons and several years was conducted, all of the animals predicted would eventually be recorded. However, the list conservatively includes fauna which are remote possibilities for the study area.

3. RESULTS

3.1 MAUDS LANDING

3.1.1 Flora and vegetation

Two vegetation types were distinguished at Mauds Landing. A series of low foredunes, parallel to the coastline, support an open, low hummock grassland (total cover approximately 50%) with a very simple species composition (nine perennial species were recorded; see Plate 1). The dominant species is *Spinifex longifolius*. Small clumps of stunted *Acacia coriacea* occur scattered throughout. This is a forbidding environment for plant establishment due to the shifting nature of the sandy substrate, and the exposure to wind and salt spray. Any disturbance, such as the track southwards from Mauds Landing, is likely to remain unvegetated for long periods even if unused.

Immediately behind the foredunes is an open plain (relic foredune plain) with an open shrubland dominated by *Acacia coriacea* to approximately 1.5 metres (Plate 2). The substrate is firmer here than on the adjacent dunes, and protection is afforded by the series of foredunes. This leads to vegetation of greater stature, and a more diverse species composition (23 species of perennial were recorded). Other tall shrubs present are *Exocarpos aphyllus* and *Acacia tetragonophylla*. Low shrubs include *Threlkeldia diffusa, Olearia dampieri* and *Salsola kali*. *Spinifex longifolius* also occurs sporadically, but disappears from the vegetation with distance from the shore. Much of the area close to Mauds landing has been disturbed in the past, and there is an abundance of buffel grass (*Cenchrus ciliaris*), a species introduced to the pastoral areas as a fodder plant.

A full list of the species recorded for both of the vegetation types is in the table of species recorded in Appendix A.

There were no Priority species or species of particular interest present. The member of the Family Asteraceae (*Launea sarmentosa*), recorded along the track at Mauds Landing by Trudgen (1994) and which was of interest due to its limited known distribution, was not seen during this survey.

3.1.2 Fauna

The two vegetation types distinguished at Mauds landing are combined as one vertebrate habitat type (coastal dune scrub). This is feasible due to the basic structural similarity of the vegetation, and the similarity in substrate. With the inclusion of the open beach as a separate habitat there are thus two habitat types present at Mauds Landing. The total provisional species lists are provided in Appendix B. Total numbers of vertebrate species possibly present are as follows: native mammals–17; introduced mammals—6; birds–102; and reptiles–56.

The open beach mainly provides perching and foraging habitat for birds and some larger lizards. The dingo could also be expected to forage on the beach. Foxes which are present in the area, and feral cats which may be present, also use the beach for foraging and hunting.

Most of the wading birds, which form a large component of the expected species list, would only be present seasonally, and then only if the beach is shallow and sloping so that ample feeding areas are provided. As the beach falls away quite sharply at

Mauds Landing this would limit their occurrence there, and this makes the site less significant in terms of habitat for the species listed under the various treaties for the protection of migratory birds.

The use of the beach by Marine Turtles is discussed in Technical Appendix 5.

3.1.3 Potential impacts and opportunities

A significant, but unmaintained, road exists from Coral Bay to Mauds Landing and upgrading this road would have minimal impact on surrounding vegetation. There is a long history of activity at Mauds Landing itself, with old concrete footings and many tracks now present in the area proposed for the carpark and other facilities. There would be some loss of vegetation, but this is not considered to be significant, even in a local context.

New structures such as the breakwater and power poles may provide new habitat for some of the larger sea birds.

3.1.4 Mitigation measures

Restricting the carpark and other shore facilities to the area behind the foredunes would limit the potential for degradation of this erodeable habitat and its dune vegetation, and minimise the rehabilitation necessary after construction.

Strict limits should be set on the extent of clearing for construction, and heavy vehicles should be confined to existing tracks and to the construction area itself.

3.2 NORTH BILLS BAY

3.2.1 Flora and vegetation

Providing a boating facility at North Bills Bay, with an access road from the Mauds Landing area would impact on three vegetation types.

Starting at the end of the existing road to Mauds Landing, access would be through an area of shrubland on the relic foredune plain as described for Mauds Landing in Section 3.1.1 above. Closer to the saline flats on this plain some elements common to the saline communities also occur. These include *Atriplex vesicaria*, several small sub-shrubs belonging to the Chenopod family, and Salt water Couch (*Sporobolus virginicus*). This first part of the proposed route follows an existing track (Plate 3).

The major part of the access route from the Mauds Landing area to North Bills Bay is through a largely undisturbed part of the parabolic dune system which covers most of Point Maud (Plate 3 and Plate 4). Vegetation on these dunes is predominantly a low shrubland with isolated patches of larger shrubs that include *Acacia coriacea, Santalum spicatum* and *Heterodendrum oleaefolim*. A small population of shrubs of *Acacia rostellifera* occurs on the slopes of the first dune to be crossed after leaving Mauds Landing. The dominant low shrubs are *Pileanthus limacis, Thryptomene baeckeacea* and *Acacia spathulifolia*. The grass *Eulalia fulva* occurs throughout, and there may be some *Spinifex longifolius* in the dune swales. A total of 27 perennial species were recorded for this vegetation type. There are variations in both density and species composition dependant on the topographic position on the dunes. However the largest differences are more of a shift in dominance and the relative contribution of individual species, rather than in actual species composition. The vegetation tends to be of lower stature and density on the crests and upper slopes. Some areas are heavily invaded with Buffel Grass (*Cenchrus ciliaris*).

The final vegetation type impacted is the hummock grassland of the foredunes along North Bills Bay (Plate 5). The vegetation here is species poor, much as it is on the foredunes at Mauds Landing. The dominant species is *Spinifex longifolius*, with clumps of *Atriplex isatidea* and *Acacia coriacea* shrubs emergent. The vegetation does tend to be denser and taller than that at Mauds Landing, especially in the swales of the low parallel dunes. The increased height and density may be due to the relatively greater age and stability of the substrate or because this is a more sheltered site.

For a list of all of the species present in the vegetation types refer to the table in Appendix A.

Overall, the condition of the vegetation appeared to be good, if very dry. There is evidence of some historic disturbance and a track crosses the dunes closest to Mauds Landing. Goats were seen in the dunes, and would have some effect on the vegetation, both from disturbance to the substrate, and from browsing. This did not appear to be great at present, with little evidence of severe browsing levels. Similarly, evidence of rabbits (though possibly old unused burrows) was not reflected in damage to the vegetation.

3.2.2 Fauna

As far as fauna usage is concerned, the three vegetation types distinguished for the North Bills Bay proposal can be combined as one habitat type (coastal dune scrub). This is feasible due to the basic structural similarity of the vegetation, and the similarity in substrate. With the inclusion of the open beach as a separate habitat there are thus two habitat types present in the area impacted by the proposal for North Bills Bay. The total provisional species lists are presented in Appendix B. Total numbers of vertebrate species possibly present are as follows: native mammals–17; introduced mammals—6; birds–102; and reptiles–56.

The open beach mainly provides perching and foraging habitat for birds and some larger lizards. The dingo could also be expected to forage on the beach. Foxes which are present in the area, and feral cats which may be present, also use the beach for foraging and hunting.

Most of the wading birds which form a large component of the expected species list would only be present seasonally, and then only if the beach is shallow and sloping so that ample feeding areas are provided. The significance of the Tern roosting and breeding area north of the proposed site and the use of the beach by marine turtles is presented in Technical Appendix 5. These species are all significant from a conservation point of view.

Feral goats were seen in the dune system close to Mauds Landing during the site visit, and there was evidence of past presence of rabbits and recent presence of foxes. All six of the feral mammals possibly present would also utilise the beach for hunting and foraging.

3.2.3 Potential impacts and opportunities

None of the habitats or vegetation types present are restricted either regionally or locally (Beard, 1975). Construction of the boating facility at North Bills Bay would have a relatively large impact on the vegetation in that an access road would need to be cleared and constructed through a largely undisturbed area of the parabolic dunes. Payne *et al*. (1980) note that the parabolic dune land unit is quite stable when vegetated, but is highly susceptible to wind erosion when foredunes or dune crests are degraded or disturbed. This would present management problems where the access road crosses dunes, as providing an all weather road would require some cut in these areas.

Dependant on the exact route chosen through the dunes, some individuals of the priority species *Acacia ryaniana* could be lost during the clearing. This would however not deplete the local population, as very few individuals would be likely to be impacted due to the widespread but scattered distribution of the plants.

The proposal would have a very small impact on the fauna assemblage in the dunes once the disturbance associated with construction is complete. New structures such as a jetty or power poles may provide new habitat for some of the larger sea birds and birds of prey.

3.2.4 Mitigation measures

Clearing for the access road and facilities at North Bills Bay should be kept to the absolute minimum, and the limits of clearing should be clearly marked and monitored during construction. The access route should be planned to include as few dune crossings as possible and these should be stabilised and rehabilitated as soon as possible after construction is complete to limit erosion problems in the long term.

Design of the access road through the dunes to include bends and curves would be positive in limiting the speed of road users, and might help in minimising possible road kills. In this respect a low speed limit should also be imposed on the completed road.

3.3 MONCK HEAD

3.3.1 Flora and vegetation

Depending on the exact siting of the boating facilities at Monck Head, there are three vegetation types which may be impacted. Immediately inland of Monck Head are parabolic dunes with the same vegetation community type present as found at North Bills Bay (Section 3.2.1). *Pileanthus limacis, Acacia coriacea* and *Atriplex isatidea* are the predominant perennial shrub species, which along with *Spinifex longifolius* form an open low shrubland. Some of this vegetation is degraded due to ongoing physical disturbance (Plate 6). In particular, the dune adjacent to the headland is severely disturbed and eroded by several vehicle tracks in deep sand. The early stages of a "blowout" appear to be developing on this dune.

North of the parabolic dunes, and for all of the existing and proposed access routes to and from the Coral Bay townsite, the vegetation is a very low shrubland on small dunes and flats formed by pink/orange sands (Plate 7). Much of this community has been overrun by Buffel Grass (*Cenchrus ciliaris*), which appears to have replaced the native grasses and many of the shrubs. Low shrubs and sub-shrubs still present include *Scaevola cunninghamii, Dipteracanthus australasius, Sida* and *Corchorus* species, *Dianella revoluta* and some *Rhagodia preissii*. In total, 23 species of perennial were recorded in this vegetation type, which is still relatively species rich for the area. The Buffel Grass invasion means however, that although well vegetated and stable, the community is far from in good condition. The one dune crossing along the existing track is severely broken up with signs of continuing erosion. All tracks in this area are deeply incised in places, but this does not appear to have led to spreading erosion problems in areas other than the dune crossing.

All along the coastline at Monck Head is a limestone pavement of varying widths and with varying densities of vegetation cover (Plate 6). The low and wind-clipped vegetation can best be described as a sparse low shrubland with plants distributed where there are pockets of sand or cracks forming rootholds in the limestone.

The species composition differs markedly from that of the surrounding dunes. Important members of the community are *Ficus platypoda, Scaevola spinescens, Scaevola crassifolia, Heliotropium pachyphyllum, Ipomoea pes-caprae, Capparis spinosa, Myoporum montanum* and some occasional *Spinifex longifolius*. A total of 22 perennial species were recorded in this vegetation type. For a listing of all of these species refer to the table in Appendix A. This vegetation type appeared in good condition.

No priority species or other species of special interest were recorded at Monck Head.

3.3.2 Fauna

The two dune based vegetation types distinguished at Monck Head are combined as one habitat type (coastal dune scrub) for vertebrates due to the basic structural similarity of the vegetation, and the similarity in substrate. The limestone pavement and low cliffs form a second distinct habitat type. Although most of the species possibly present on the limestone are shared with the dune habitat, it is very much poorer in potential vertebrate species. This is due to the inherent lack of cover, and the absence of a burrowable substrate. The total provisional species lists are presented in Appendix B. Total numbers of possible vertebrate species are as follows: native mammals—17; introduced mammals—6; birds—79; and reptiles—54.

The limestone pavement provides open foraging area for some of the larger lizards, whist shrubs present here such as the *Ficus* and *Myoporum* have fruit which would be sought after by some birds. The low cliffs may provide perching sites for the larger sea birds.

All of the feral mammals predicted for the area may also use the limestone pavement as well as the dunes for browsing or foraging.

3.3.3 Potential impacts

The existing tracks to Monck Head from Coral Bay provide ready made access routes for the proposed facility. Some clearing and levelling would be required, and thus there would be some loss of vegetation. This is not considered to be significant, particularly as the vegetation along the route and in the proposed carpark area is dominated by Buffel Grass. Very little vegetation need be lost on the limestone pavement as it is naturally sparsely distributed. Construction of a boat ramp off the low limestone cliff would necessitate minor excavation. This could open up new pockets and crevices for long-term colonisation by surrounding species. None of the habitats or associated vegetation types are restricted, either locally or regionally (Beard, 1975).

Impacts on the fauna would be local and mostly confined to disturbance during the construction period. None of the vertebrate species potentially present would be endangered by the proposal, although there would conceivably be some loss of individuals, especially among the smaller mammals and reptiles.

The opportunity exists for the eroded dune crossing to be rehabilitated during construction.

3.3.4 Mitigation measures

Positioning the road, carpark and associated facilities in the area of pink/orange dunes would avoid further disturbance to the highly erodeable parabolic dunes, which should be avoided if possible.

Strict limits should be set on the extent of clearing for the road and proposed facilities, and construction vehicles should be confined to existing tracks and to the construction site itself. Rehabilitation of disturbed areas not paved should be undertaken as soon after construction is complete as is possible to limit possible erosion.

4. GENERAL DISCUSSION AND RECOMMENDATIONS

At all of the potential sites there will be impacts on the vegetation and fauna, due to the need for removal of some vegetation and disturbance to the habitat. The site where these impacts would be least is Mauds Landing and the biggest impact would be for the North Bills Bay proposal.

At all three sites, clearing would need to be limited and monitored, and rehabilitation of disturbed areas not paved should proceed as soon as possible once construction is complete.

None of the vegetation or habitat types which may be impacted by the proposal are limited in distribution, either locally or regionally, and generally the impacts would be small, short-term and manageable.

5. REFERENCES

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PLATES

Plate 1 View of the foredune vegetation (hummock grassland) at Mauds Landing showing the existing track

Plate 2 **Acacia coriacea** ***shrubland on the relic foredune plain at Mauds Landing***

Plate 3 View of the vegetation of the parabolic dunes along the access track to the North Bills Bay

Plate 4 Another view of the vegetation of the parabolic dunes along the access track to the North Bills Bay

Plate 5 Hummock grassland on the relic foredunes at North Bills Bay

Plate 6 Disturbed parabolic dune fronted by sparsely vegetated limestone pavement at Monck Head

Plate 7 View across the low shrubland on the pink/orange dunes at Monck Head

APPENDIX A
CHECKLIST OF VASCULAR FLORA

Appendix A Checklist of vascular flora

Note:

* = Species not native to the area

P2= Priority Two species on the Department of Conservation and Land Management's Priority list. These are defined as "Taxa which are from one or a few (generally less than 5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as "rare flora" but are in urgent need of further survey.

		MAUDS LANDING			
		NORTH BILLS BAY			
			MONCK HEAD		
	Relic Foredune Plain	**Foredunes (Relic Foredunes)**	**Parabolic Dunes**	**Relic Parabolic Dunes**	**Limestone Platform and Cliff**
Family POACEAE					
* *Cenchrus ciliaris*	x		x	x	x
Eulalia aurea	x	x	x		x
Spinifex longifolius		x	x	x	
Sporobolus virginicus	x				x
Triodia pungens	x			x	x
Family DASYPOGONACEAE					
Acanthocarpos preissii			x		x
Family PHORMIACEAE					
Dianella revoluta var. *divaricata*	x			x	
Family MORACEAE					
Ficus platypoda					x
Family SANTALACEAE					
Exocarpos aphyllus	x		x		
Santalum spicatum			x	x	
Familay CHENOPODIACEAE					
Atriplex isatidea		x	x	x	
Atriplex vesicaria ssp.	x				
Enchylaena tomentosa				x	
Rhagodia preissii ssp. *obovata*	x	x	x	x	
Salsola kali	x		x		
Sclerolaena sp.				x	x
Sclerolaena uniflora	x				
Suaeda arbusculoides	x				
Threlkeldia diffusa	x	x	x		
Family AMARANTHACEAE					
Ptilotus exultatus	x				
Family NYCTAGINACEAE					
Boerhavia coccinia					x
Commicarpus australis			x	x	
Family AIZOACEAE					
Carpobrotus sp.	x	x	x	x	x
Gunniopsis sp.					x
Portulaca sp.	x				
Family LAURACEAE					
Cassytha aurea var. *aurea*			x	x	
Family CAPPARACEAE					
Capparis spinosa					x
Family PITTOSPORACEAE					
Pittosporum phylliraeoides					x
Family MIMOSACEAE					
Acacia coriacea ssp. *coriacea*	x	x	x	x	x
Acacia rostellifera			x		
P2 *Acacia ryaniana*			x		
Acacia spathulifolia			x		
Acacia tetragonophylla	x				x
Family CAESALPINEACEAE					

	MAUDS LANDING				
	NORTH BILLS BAY				
			MONCK HEAD		
	Relic Foredune Plain	**Foredunes (Relic Foredunes)**	**Parabolic Dunes**	**Relic Parabolic Dunes**	**Limestone Platform and Cliff**
Senna glutinosa ssp. *chatelliana*				x	
Family PAPILIONACEAE					
Indigofera brevidens				x	
Family ZYGOPHYLLACEAE					
Zygophyllum fruticulosum			x		
Family EUPHORBIACEAE					
Euphorbia drummondii					x
Family SAPINDACEAE					
Heterodendrum oleaefolium			x	x	x
Family MALVACEAE					
Corchorus sp.				x	
Sida fibulifera	x			x	
Family FRANKENIACEAE					
Frankenia pauciflora	x				x
Family MYRTACEAE					
Pileanthus limacis			x	x	
Thryptomene baeckeacea			x		
Family PLUMBAGINACEAE					
Muellerolimon salicorniaceum	x				
Family CONVOLVULACEAE					
Ipomoea pes-caprae					x
Family BORAGINACEAE					
Heliotropium pachyphyllum					x
Trichodesma zeylanicum		x	x	x	
Family SOLANACEAE					
Solanum sp.				x	
Family ACANTHACEAE					
Dipterocanthus australasius				x	
Family MYOPORACEAE					
Eremophila sp.			x		
Myoporum montanum					x
Family GOODENIACEAE					
Dampiera incana var. *incana*			x		
Scaevola crassifolia					x
Scaevola cunninghamii				x	
Scaevola spicigera			x		
Scavola spinescens	x				x
Family ASTERACEAE					
Angianthus cunninghamii			x		
Olearia axillaris	x				
Oleria dampieri ssp. *dampieri*	x	x	x		

APPENDIX B
CHECKLIST OF POTENTIAL VERTEBRATE SPECIES

Appendix B Checklist of potential vertebrate species

SPECIES	COMMON NAME	Conservation Status	Fauna Habitats		
			Open Beach	Coast. Dune/ Scrub	Lime-stone
NATIVE MAMMALS					
TACHYGLOSSIDAE					
Tachyglossus aculeatus	Short-beaked Echidna		x	x	x
DASYURIDAE					
Ningaui timealeyi	Pilbara Ningaui			x	
Sminthopsis macroura	Stripe-faced Dunnart			x	x
Sminthopsis youngsoni	Lesser Hairy-footed Dunnart			x	x
MACROPODIDAE					
Macropus robustus	Euro			x	
Macropus rufus	Red Kangaroo			x	
EMBALLONURIDAE					
Saccolaimus flaviventris	Yellow-bellied Sheath-tail Bat			x	x
Taphozous georgianus	Common Sheath-tail Bat			x	x
MOLOSSIDAE					
Nyctinomus australis	White-striped Mastiff Bat			x	x
Chaerephon jobensis	Northern Mastiff Bat			x	x
VESPERTILOINIDAE					
Chalinolobus gouldii	Gould's Wattled Bat			x	x
Eptesicus finlaysoni	Western Cave Eptesicus			x	x
Nyctophilus geoffroyi	Lesser Long-eared Bat			x	x
Scotorepens greyii	Little Broad-nosed Bat			x	x
MURIDAE					
Notomys alexis	Spinifex Hopping Mouse			x	
Pseudomys hermannsburgensis	Sandy Inland Mouse			x	x
CANIDAE					
Canis familiaris dingo	Dingo		x	x	x
	Possible Species Richness		**2**	**17**	**13**
INTRODUCED MAMMALS					
Felis catus	Feral Cat		x	x	x
Mus domesticus	House Mouse			x	x
Rattus rattus	Black Rat		x	x	x
Oryctolagus cuniculus	European Rabbit			x	x
Vulpes vulpes	Fox		x	x	x
Capra hircus	Goat			x	x
	Possible Species Richness		**3**	**6**	**6**
BIRD SPECIES					
CASUARIDAE					
Dromaius novaehollandiae	Emu			x	
PELECANIDAE					
Pelecanus conspicillatus	Australian Pelican		x		
ANHINGIDAE					
Anhinga melanogaster	Darter		x		x
PHALACROCORACIDAE					
Phalacrocorax carbo	Great Cormorant		x		x
Phalacrocorax melanoleucos	Little Pied Cormorant		x		x
Phalacrocorax sulcirostris	Little Black Cormorant		x		x
Phalacrocorax varius	Pied Cormorant		x		x
PHAETHONTIDAE					
Phaethon rubricauda	Red-tailed Tropic Bird	Schedule 1	x	x	x
PANDIONIDAE					
Pandion haliaetus	Osprey		x		x
ACCIPITIRIDAE					
Aquila audax	Wedge-tailed Eagle			x	x
Circus assimilis	Spotted Harrier			x	x
Elanus notatus	Black-shouldered Kite			x	x
Elanus scriptus	Letter-winged Kite			x	x
Haliasturindus	Brahminy Kite		x		x
Haliastur sphenurus	Whistling Kite			x	x
Hiraaetus morphnoides	Little Eagle			x	x
Lophoictinia isura	Square-tailed Kite			x	x
Haliaeetus leucogaster	White-bellied Sea Eagle	CAMBA	x		x

SPECIES	COMMON NAME	Conservation Status	Fauna Habitats		
			Open Beach	Coast. Dune/ Scrub	Lime- stone
Accipiter cirrhocephalus	Collared Sparrowhawk			x	x
Accipiter faciatus	Brown Goshawk			x	x
Hamirostra melanosternon	Black breasted Buzzard			x	x
Milvus migrans	Black Kite			x	x
FALCONIDAE					
Falco berigora	Brown Falcon			x	x
Falco cenchroides	Australian Kestrel		x	x	x
Falco longipennis	Australian Hobby			x	x
Falco peregrinus	Peregrine Falcon	Schedule 4		x	x
TURNICIDAE					
Turnix velox	Little Button-quail			x	
BURHINIDAE					
Burhinus neglectus	Beach Thick-knee		x		
HAEMATOPODIDAE					
Haematopus longirostris	Pied Oystercatcher		x		
Haematopus fullginosus	Sooty Oystercatcher		x		x
CHARADRIIDAE					
Pluvialis squatarola	Grey Plover	CAMBA	x		
Pluvialis dominica	Eastern Golden Plover		x		
Charadrius leschenaultii	Large Sand Plover	CAMBA Schedule 3	x		
Charadrius melanops	Black-fronted Plover		x		
Charadrius ruficapillus	Red-capped Plover		x		
Charadrius veredus	Oriental Plover		x		
Charadrius mongolus	Mongolian Plover	CAMBA	x		
SCOLOPACIDAE					
Arenaria interpres	Ruddy Turnstone	CAMBA	x		
Numenius madagascariensis	Eastern Curlew	CAMBA	x		
Numenius phaeopus	Whimbrel	CAMBA	x		
Calidris alba	Sanderling	CAMBA	x		
Calidris acuminata	Sharp-tailed Sandpiper	CAMBA	x		
Calidris ferruginea	Curlew Sandpiper	CAMBA	x		
Calidris ruficollis	Red-necked Stint	CAMBA	x		
Tringa brevipes	Grey-tailed Tatler	CAMBA Schedule 3	x		
Tringa nebularia	Greenshank	CAMBA	x		
Tringa stagnatilis	Marsh Sandpiper		x		
Tringa hypoleucos	Common Sandpiper	CAMBA Schedule 3	x		
Limosa lapponica	Bar-tailed Godwit	CAMBA Schedule 3	x		
LARIDAE					
Gelochelidon nilotica	Gull-billed Tern		x		x
Hydroprogne caspia	Caspian Tern	CAMBA	x		
Sterna anaephetus	Bridled Tern		x		x
Sterna bengalensis	Lesser Crested Tern		x		x
Sterna dougallii	Roseate Tern		x		x
Sterna fuscata	Sooty Tern		x		x
Sterna neries	Fairy Tern		x		x
Sterna bergii	Crested Tern		x		x
Larus novaehollandiae	Silver Gull		x		x
CACATUIDAE					
Cacatua roseicapilla	Galah			x	x
Cacatua sanguinea	Little Corella			x	
PLATYCERCIDAE					
Barnardius zonarius	Port Lincoln Ringneck			x	x
CUCULIDAE					
Chrysococcyx basalis	Horsefield's Bronze Cuckoo			x	
Chrysococcyx osculans	Black-eared Cuckoo			x	
Cuculus pallidus	Pallid Cuckoo			x	
AEGOTHELIDAE					
Aegotheles cristatus	Owlet Nightjar			x	x
CAPRIMULGIDAE					
Caprimulgus guttatus	Spotted Nightjar			x	x

		Conservation Status	Fauna Habitats		
SPECIES	**COMMON NAME**		**Open Beach**	**Coast. Dune/ Scrub**	**Lime-stone**
ALCEDINIDAE					
Halcyon pyrrhopygia	Red-backed Kingfisher		x	x	x
Halcyon sancta	Sacred Kingfisher		x	x	x
MEROPIDAE					
Merops ornatus	Rainbow Bee-eater			x	x
ALAUDIDAE					
Mirafra javanica	Singing Bushlark			x	
HIRUNDINIDAE					
Cheramoeca leucosternum	White-backed Swallow			x	x
Hirundo ariel	Fairy Martin			x	x
Hirundo neoxena	Welcome Swallow			x	x
CAMPEPHAGIDAE					
Coracina novaehollandiae	Black-faced Cuckoo-shrike			x	x
Lalage sueurii	White-winged Triller			x	x
MOTACILLIDAE					
Anthus novaeseelandiae	Richard's Pipit		x	x	x
MUSCICAPIDAE					
Melanodryas cucullata	Hooded Robin			x	
Oreocica gutturalis	Crested Bellbird			x	x
Petroica goodenovii	Red-capped Robin			x	
Rhipidura leucophrys	Willie Wagtail			x	x
Colluricincla harmonica	Grey Shrike-thrush			x	
TIMALIIDAE					
Pomatostomus superciliosus	White-browed Babbler			x	
SYLVIIDAE					
Cinclorhamphus cruralis	Brown Songlark			x	
Cinclorhamphus mathewsi	Rufous Songlark			x	
MALURIDAE					
Malurus lamberti	Variegated Songlark			x	
Malurus leucopterus	White-winged Fairy-wren			x	
ACANTHIZIDAE					
Acanthiza uropygialis	Chestnut-rumped Thornbill			x	
Sericornis brunneus	Redthroat			x	
Sericornis fuliginosus	Calamanthus			x	
MELIPHAGIDAE					
Manorina flavigula	Yellow-throated Miner			x	
Lichenostomus virescens	Singing Honeyeater			x	
Lichmera indistincta	Brown Honeyeater			x	
EPHTHIANURIDAE					
Ephthianura tricolor	Crimson Chat			x	x
GRALLINIDAE					
Grallina cycanoleuca	Australian Magpie-lark		x		x
ARTAMIDAE					
Artamus cinereus	Black-faced Woodswallow			x	x
Artamus leucorhynchus	White-breasted Woodswallow			x	x
Artamus minor	Little Woodswallow			x	x
Artamus personatus	Masked Woodswallow			x	x
CRACTICIDAE					
Cracticus nigrolgularis	Pied Butcherbird			x	x
Cracticus torquatus	Grey Butcherbird			x	x
CORVIDAE					
Corvus bennetti	Little Crow		x	x	x
Corvus orru	Torresian Crow		x	x	x
	Possible Species Richness		**48**	**61**	**58**
REPTILES					
Lizards					
GEKKONIDAE					
Crenadactylus ocellatus	Clawless Gecko			x	x
Diplodactylus alboguttatus				x	
Diplodactylus conspicillatus				x	
Diplodactylus ornatus				x	x
Diplodactylus rankini				x	x
Diplodactylus stenodactylus				x	x
Diplodactylus strophurus				x	

		Conservation Status	Fauna Habitats		
SPECIES	**COMMON NAME**		**Open Beach**	**Coast. Dune/ Scrub**	**Lime-stone**
Gehyra variegata	Tree Dtella			x	x
Heteronotia binoei	Binoe's Gecko			x	x
Nephrurus levis				x	
PYGOPODIDAE					
Aprasia fusca				x	
Delma butleri			x	x	
Lialis burtonis	Burton's Snake Lizard		x	x	x
Pygopus nigriceps	Hooded Scaly-foot		x	x	x
AGAMIDAE					
Ctenophorus maculatus	Spotted Dragon		x	x	
Ctenophorus nuchalis				x	
Ctenophorus reticulatus				x	x
Diporiphora winneckei			x	x	
Pogona minor	Bearded Dragon			x	x
Tympanocryptis parviceps			x	x	x
SCINCIDAE					
Cryptoblepharus carnabyi				x	x
Cryptoblepharus plagiocephalus	Fence Skink			x	x
Cyclodomorphus melanops			x	x	
Eremiascincus richardsonii	Broad-banded Sand Swimmer			x	x
Lerista elegans				x	
Lerista haroldi			x	x	
Lerista lineopunctulata			x	x	
Lerista muelleri				x	
Lerista nichollsi				x	
Lerista planiventralis				x	
Lerista praepedita				x	x
Lerista uniduo			x	x	
Menetia greyii	Grey's Skink			x	x
Menetia surda				x	
Morethia lineoocellata				x	x
Morethia ruficauda				x	x
Tiliqua multifasciata	Centralian Blue-tongued Lizard		x	x	x
VARANIDAE					
Varanus acanthurus					x
Varanus brevicauda				x	
Varanus giganteus			x	x	x
Varanus gouldii	Gould's Monitor		x	x	x
Varanus tristis			x	x	x
Turtles					
CHELONIIDAE					
Caretta caretta	Loggerhead Turtle	Schedule 1	x		
Chelonia mydas	Green Turtle		x		
Eretmochelys imbricata	Hawksbill Turtle		x		
Snakes					
TYPHLOPIDAE					
Rhamphotyphlops diversus				x	
Rhamphlotyphlops grypus				x	
Rhamphlotyphlops hamatus				x	
BOIDAE					
Morelia stimsoni	Stimson's Python			x	x
ELAPIDAE					
Demansia calodera	Black-necked Whipsnake			x	
Demansia psammophis	Yellow-faced Whipsnake			x	
Furina ornata	Orange-naped Snake			x	x
Pseudechis australis	Mulga Snake		x	x	x
Pseudonaja modesta	Ringed Brown Snake			x	
Pseudonaja nuchalis	Gwardar			x	x
Simoselaps littoralis	West Coast Banded Snake			x	x
Suta fasciata	Rosen's Snake			x	x
	Possible Species Richness		**18**	**53**	**29**

TECHNICAL APPENDIX 5
CORAL BAY BOATING FACILITY
SURVEY OF THE MARINE HABITATS AND ASSESSMENT OF CONSERVATION VALUES OF MARINE FAUNA AND FLORA

Prepared for:

DEPARTMENT FOR PLANNING AND INFRASTRUCTURE

Prepared by:

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In collaboration with:

DAL SCIENCE & ENGINEERING PTY LTD

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APPENDICES

1. INTRODUCTION

The Ningaloo Reef is one of five coral reef provinces recognised in Western Australia (CALM, 1994). It is the largest fringing-barrier reef system in Australia and most of it lies within the tropical belt of the Indo West Pacific Faunal Region. It extends 260 km southwards from North West Cape, Western Australia, from about 21° 50' S to 23° 35' S (Veron, 1993). It is the only well developed reef system close to the shore in clear water due to the close proximity of the continental shelf edge in the area and the clear oceanic water with minimal terrestrial run-off (CALM, 1994).

The area of interest for this study is in the vicinity of Coral Bay (Figure 1). The region is typified by a shallow reef-flat, well-developed back-reef and large lagoon with coral extending almost continuously from the reef-flat to the shore. The exception is to the north of Point Maud opposite Cardabia Passage where oceanic water flows through the break into a large sandy lagoon. Three possible alternative sites for the development of a boating facility were examined: Mauds Landing, North Bills Bay and Monck Head. However, note that it is proposed that a boating facility be developed at only one of these sites.

1.1 MAUDS LANDING

Mauds Landing is located within the large sandy lagoon opposite Cardabia Passage. Strong water and sand movement occur in the lagoon due to the relatively low degree of protection from the outer reef. A limestone platform exists to the north of the sandy point which is important for a number of communities.

1.2 NORTH BILLS BAY

North Bills Bay is located to the south of Point Maud within the calmer waters of Bills Bay. Two beach rock ridges mark the southern region of this site and a large limestone platform forms the substrate for much of this area. Superimposed on the platform are old dead and live coral communities. Much of the dead reef resulted when, in March 1989 following a coral spawning event, the spawn was retained in the bay resulting in anoxic conditions which led to the death of most corals and animals (Simpson, 1993).

1.3 MONCK HEAD

The intertidal zone in this region comprises a limestone platform that extends into the shallow subtidal zone. Oceanwards is a sandy lagoon with patch reefs of increasing size towards the reef edge. The headland (Monck Head) extends out into the lagoon providing shelter to the north, from the prevailing south westerlies and associated water movement.

2. METHODS AND LIMITATIONS

2.1 METHODS

Field work was conducted over three days from 25 to 27 March 1998. Spot dives were made at 19, 17 and 14 sites at Mauds Landing, North Bills Bay and Monck Head, respectively (Figure 1). Additional spot dives were made at two sections of reef which have heavy boat traffic; ten dives between Monck Head and the current launch site at Coral Bay, and nine dives along the channel between Monck Head and Point Maud (Figure 1). Each spot dive covered an area of approximately 30 m in radius, and the depth, habitat, coral or benthic species, and GPS location were recorded. GPS readings were from a hand-held Trimbel GPS unit. Photographs of representative habitat types were taken using a Nikonos V underwater camera. Refer to Appendices 1 to 3 for coordinates of dives sites and habitat descriptions.

Habitat maps were constructed for Mauds Landing (Figure 2), North Bills Bay (Figure 3) and Monck Head (Figure 4) using a combination of aerial photographs, information from the spot dives, and personal knowledge of the area and then compared, and adjusted if necessary, against the habitat map of BBG 1995.

2.2 LIMITATIONS

With only three days of fieldwork, the less common, mobile, cryptic or seasonally abundant species are less likely to be seen than the common and abundant species, and so are under-represented in this report.

Locations of spot dives on the map were determined using a hand held GPS and are accurate to ±25–30 m. Several sites (21, 28, 29, 36, 38, 54 and 56) when plotted on the map, were located on the land and had to be manually moved to the coast. For the map presentation, the these sites were shifted westward until they were over the water. The location of the habitat boundaries shown should be considered to be indicative only.

3. EXISTING MARINE PLANT COMMUNITIES AND FAUNA

3.1 MARINE MACROPHYTE COMMUNITIES

3.1.1 Macroalgal communities

Little research has been done on the macroalgal communities at Ningaloo Reef. However, red, green and brown macroalgae appear to be well represented in the Coral Bay region. Examples include red calcareous algae, turfing green algae and the brown alga *Sargassum* spp., all of which are common on the shallow reefs in the North Bills Bay region. Marsh (1978) recorded *Lithothamnion*, *Padina* and *Turbinaria* spp. from transects at Point Maud, Bills Bay and north of Monck Head during winter. Green macroalgal communities, particularly turfing algae, are important food sources for algal grazers including green turtles (*Chelonia mydas*) and parrotfishes (Scaridae).

Mauds Landing

Macroalgal communities are not well developed at Mauds Landing and their occurrence is mostly restricted to regions where there is firm substrate available for attachment, even if this substrate is not exposed. For example, five of the eight records of macroalgae found in the Mauds Landing region were associated with the limestone platform that is covered by sand in places (Appendix 1).

North Bills Bay

The old reef structure and extensive limestone pavement provide suitable substrates for the attachment of macroalgae which is abundant at this site (Plate 1). Genera sighted include *Padina* and *Caulerpa* spp., and green and brown filamentous algae (Appendix 2).

Monck Head

The macroalgal communities at Monck Head are not as extensive as those at North Bills Bay. Where macroalgae does exist, it is always in association with, either the limestone pavement extending from the shore immediately north of the headland, or with dead coral (Appendix 3).

3.1.2 Seagrass communities

Seagrass communities in the Coral Bay region are sparse. Only *Halophila ovalis* was recorded from this study, although *Posidonia coriacea* occurs four kilometres north-east of Mauds Landing (BBG, 1995). *Posidonia coriacea* is a temperate genus and this is the most northern occurrence of this species and is considered to be regionally significant, whereas *Halophila ovalis* is a tropical species, and is widespread throughout the Ningaloo Reef and Rowley Shelf region (BBG, 1995). Although *Halophila ovalis* is eaten by dugongs (*Dugong dugon*), their widespread occurrences make it of limited regional significance. Seagrass beds, presumably *Halophila* species, at Norwegian Bay and the lagoon north of Bruboodjoo Point, 57 km and 15 km north of Mauds Landing respectively, have been identified by the Australian Heritage Council (1997) as important feeding areas for *Dugong dugon*.

Mauds Landing

Halophila ovalis is very sparse in this region and was recorded once in the nineteen spot dives done at Mauds Landing (Appendix 1). It occurred in the shallow sand overlying limestone.

North Bills Bay

No seagrasses were recorded at this site.

Monck Head

Halophila ovalis is sparsely and patchily distributed in this region. It is found usually as a 'fringe' around the base of patch reefs and occasionally in shallow sand overlying limestone (Plate 2, Appendix 3).

3.2 MARINE FAUNAL COMMUNITIES

Ningaloo Reef consists of five different reef areas: fore-reef, reef-crest, reef-flat, back-reef and sandy lagoon with scattered patch reefs. The reef-crest, reef-flat and back-reef to a lesser extent, are exposed to high-energy oceanic water causing strong tidal currents to flow across the reef. The zonation of coral species and morphologies reflects the distribution of currents, with extremely robust corals (e.g. 'brain corals', *Platygyra* and *Goniastrea*) occupying the reef-crest, and corals resistant to strong surge occupying the reef flat (e.g. *Acropora digitifera* and *Acropora aspera*). Delicate branching and foliose corals (e.g. *Echinopora lamellosa* and foliose *Montipoora*) are generally found in the calmer lagoonal waters. Within these habitats, the reef supports a diverse array of animal and plant communities including 217 species of hard corals (Veron and Marsh, 1988), at least 11 species of soft corals (May *et al.,* 1983), 464 species of fish (Allen, 1980), 97 species of echinoderms (AHC, 1997), at least 600 species of molluscs (Wells 1980, cited from May *et al.,* 1983), an unknown number of crustaceans, but including the commercially important western rock lobster (*Panulirus cygnus*) as well as the painted and ornate rock lobsters (*Panulirus versicolor* and *Panulirus ornatus* respectively). However, there is a poor inventory of other groups of animals and plants including sponges, bryozoans, foraminiferans, hydrozoans, jellyfish, worms, sea squirts and macroalgae. These groups are represented at Ningaloo Reef, but little work has been done to quantify the numbers of species of each.

3.2.1 Scleractinian coral communities

Ningaloo Marine Park has a rich and diverse scleractinian coral fauna with 217 species in 54 genera described (Veron and Marsh, 1988). There is generally little coral in the lagoons, the notable exception being the lagoon at Coral Bay. The Coral Bay region between Point Maud and Point Anderson is rich in species with 68 species being recorded (Marsh, 1978; 1980; 1989). Ningaloo Reef is dominated by corals from the families Acroporidae, Poritidae and Faviidae and these families are well represented in the Coral Bay region. Other families present in the region include Pocilloporidae, Siderastreidae, Agariciidae, Fungiidae, Oculinidae, Merulinidae, Mussidae, Pectiniidae, Caryophylliidae and Dendrophylliidae. The only non-scleractinian coral family that is abundant at Ningaloo is Milleporidae.

Bills Bay has an extensive lagoonal coral assemblage, and is one of the few locations along the Ningaloo Reef where well-developed coral communities are accessible to swimmers and divers from the shore. The importance of this area has long been recognised and has been a marine reserve for over 20 years (BBG, 1995). Many of the corals and associated reef communities in the Bay suffered severe mortalities in 1989 due to anoxic conditions following the coral spawning in 1989 (Simpson *et al.,* 1993). Recovery of the area has been slow and has been exacerbated by nutrient leaching from the caravan parks' wastewater disposal system (Simpson and Field, 1995).

Mauds Landing

There are no substantial coral communities in close proximity to Mauds Landing. The closest communities are near the backreef of Ningaloo Reef, 2 km west of Mauds Landing, and Stanley Pool, 9 km north of Mauds Landing (BBG, 1995). However, there are isolated patch reefs associated with the limestone pavement that provide foci for reef fish communities (Appendix 1, Plate 3). They are generally multi-specific but fairly small.

North Bills Bay

The coral communities at North Bills Bay generally appear to be in a better condition that the rest of Bills Bay and are therefore likely to be an important source of coral recruits for the rest of the Bay. Immediately oceanwards of the beach rock at North Bills Bay, is the old reef structure which runs as a belt parallel to the beach rock. It is still solid and does not show much sign of erosion. This structure is important because it provides essential substratum for coral recruitment and attachment. The highest coral cover and diversity observed in North Bills Bay occurred on this old reef structure (Appendix 2). Further into the Bay, are scattered isolated dead and partially alive bommies on top of limestone pavement. Both the bommies and the pavement provide important substrates for coral attachment and lots of coral recruits were observed (Plate 4, Appendix 2). Very little sand occurs in North Bills Bay and where it does, the patches are small. North Bills Bay is dominated by corals from the family Faviidae which is fairly unusual. Elsewhere on the reef, acroporids (Acroporidae) dominate the coral landscape.

Monck Head

Approximately 350 m offshore from Monck Head is an extensive coral community that extends almost continuously to Point Maud, and grows within a few metres of the shore approximately 600 m north of the headland. It is in this region that Marsh (1980) noted that ‘the richest and most diverse coral fauna’ occurred. Much of the nearshore lagoonal coral in this region is staghorn *Acropora* that covers large areas (Appendix 3, Plate 5). However, where there are gaps in the staghorn, a diverse range of coral species occur (Appendix 3). A small number of hard and soft corals also occur on the limestone platform that extends from the shore immediately north of the headland (Appendix 3).

Recommended Boating Track between Coral Bay and Monck Head

The coral communities between Coral Bay and Monck Head are dominated by tabular and staghorn *Acropora*. Multi-specific coral colonies form a loosely interconnected chain of patch reefs (Appendix 4). Most of the coral in this region (Sites 51 to 56) is well established and in good condition and with a high percent coverage (Appendix 4). However, once the Coral Bay headland is rounded the percentage of live coral quickly declines and the new communities are mostly characterised by Faviids (similar to those seen at North Bills Bay) (Sites 57 to 60, Appendix 4). Presumably this is still the effects of the extensive die-off caused by the spawning event in March 1989.

Recommended Boating Track from Monck Head to Point Maud

The coral communities adjacent to the channel are well developed and in good condition (Appendix 5). Unlike the mid-lagoonal reefs near Monck Head where staghorn *Acropora* dominates, the coral in the channel represents a large number of genera and species. Although the average depth of the channel is over 5 m, many of the coral colonies grow close to the surface and form a wall of coral in many places (Appendix 5). Many of the coral colonies are large in size that indicates that they are old. Some of these larger colonies are also the more delicate ones, including foliose *Montipora* and *Echinopora lamellosa* (Appendix 5).

3.2.2 Marine molluscs

Most of the molluscs found on Ningaloo have tropical distributions and a number of these do not occur further south (May *et al.,* 1983). Limited surveys for molluscs have resulted in at least 433 species listed (Wells, 1980), but there are probably more (May *et al.,* 1983, BBG, 1995). During these surveys many species were new records for Western Australia, which may be due to the uniqueness of the habitats along the North West Cape (May *et al.,* 1983). One of the most common molluscs found is *Drupella cornus*, a corallivorous gastropod which is responsible for the death of approximately 75% of the coral on the back-reef of Ningaloo (Stoddart, 1989). Other molluscs commonly seen include clams (Tridacnidae), trochids (Trochidae), turbin shells (Turbinidae), sea hares (Aplysiidae), mussels (Bivalvia), Oysters (Pteriidae), chitons (Chitonidae), cowries (Cypraeidae), surf clams (Donacidae), periwinkels (Lottorinidae), limpets (Acmaeidae and Patellidae), muricids (Muricidae) and nudibranchs.

3.2.3 Echinoderms

The echinoderm fauna at Ningaloo is depauperate with only 56 genera and 90 species recorded (Marsh, 1980). Most are widespread Indo-Pacific coral reef species at or near the southern limit of their distribution (May *et al.,* 1983). Common holothurians found in the Coral Bay region include *Holothuria atra* (the black holothurian), *Holothuria hilla*, *Microthele nobilis* and *Stichopus chloronotus*, while the starfish *Linkia laevigata* and *Nardoa galatheae* are two conspicuous and common starfish (Marsh, 1980). Other echinoderms recorded from the Coral Bay region include an echinoid *Echinometra mathaei*, a crinoid *Comanthus parvicirrus*, an asteroid *Ophidiaster granifer*, and an ophiuroid, *Ophiomastix mixta* (Marsh, 1980).

3.2.4 Crustaceans

There is a diverse, but not well published, crustacean fauna at Ningaloo, although many species are cryptic and nocturnal. Three crayfish occur in the Coral Bay region, the western rock lobster (*Panulirus cygnus*), which is the most common, the painted rock lobster (*Panulirus versicolor*) and the ornate rock lobster (*Panulirus ornatus*) (BBG, 1995). The ghost crab (*Ocypode ceratophthalmia*) is a common inhabitant of the sandy intertidal zone throughout the Coral Bay region.

Mauds Landing

Due to the shifting nature of the sand and low nutrient levels, it is thought that a fairly depauperate benthic fauna occurs at Mauds Landing. Despite this, on a number of spot dives a variety of benthic fauna were seen on the sandy plain, including, sea pens (*Virgularia* sp?), tube anemones, sand dollar tests (Laganidae) and crab burrows, while hydroids, ascidians and molluscs occurred on the old jetty pylons (Appendix 1). There is also a mussel bed (*Brachiodontes* sp) 3 km from Mauds Landing (BBG, 1995). Echinoderms are commonly found in sandy areas and starfish (Asteroidea), heart urchins (Spatangidae) and holothurians (Holothuroidea) are expected to occur in the region.

North Bills Bay

Littorinids, barnacles, oysters (*Saccostrea* sp.), chitons and limpets occur on the limestone beach rock in the intertidal zone at North Bills Bay. Starfish (Asteroidea), sea urchins (Echinoidea), molluscs, crustaceans, and polychaete worms (Serpulidae and Terebellidae) are all expected to be represented in the region.

Monck Head

Giant clams (*Tridacna maxima*), the sea hare (*Aplysia* sp.), black holothurians (*Holothuria atra*) and a soft coral (*Sinularia* sp.) were recorded from the limestone reef platform just north of the headland. There are a number of isolated coral heads on this platform where molluscs and crustaceans have their refugia.

3.2.5 Turtles

Ningaloo Reef is included in the distributions of five species of turtle: green turtle (*Chelonia mydas*), loggerhead turtle (*Caretta caretta*), hawksbill turtle (*Eretmochelys imbricata*), flatback (*Natator depressus*) and leathery turtle (*Dermochelys coracea*) (Cogger, 1992; Commonwealth of Australia, 2000). All are migratory and are expected to occur in the Coral Bay region at some time during the year. The green turtle is abundant all year round suggestive of a large resident population at Ningaloo.

Loggerheads feed in deep water while hawksbill and juvenile green turtles are carnivorous, feeding on crustaceans, shellfish and sponges. There is little information on the diet of leathery turtles but it is thought they feed on jellyfishes in sub-tropical and temperate waters (Cogger, 1992, Cogger *et al.,* 1993). Adult green turtles feed on algae and seagrass (Woodward-Clyde, 1992). Green turtles breed from November to late February with nesting continuing until late-March, and the last of the hatchlings appearing by the end of May (Woodward-Clyde 1992, R. Prince *pers comm.,* 1994). Loggerhead and hawksbill turtles breed throughout the year (R. Prince *pers comm*., 1994), while the leathery turtle does not seem to breed in the tropics (Cogger, 1992). Hatchlings generally emerge from nests at night and crawl immediately towards the ocean and swim away from land (Salmon and Witherington, 1995, Goff *et al.,* 1998). Hatchlings appear to locate the ocean by orientating away from elevated silhouettes and towards a low unbroken horizon (Carr and Ogren, 1960, Salmon *et al.,* 1992).

Mauds Landing

Nesting of loggerhead and green turtles at Coral Bay has been monitored for several years by Peter Mack and, more recently, by Kristen Anderson. Around 80 nests are laid each year beginning near the tip of Point Maud and extending past Oyster Bridge (opposite the Cardabia homestead). This is considered to be a fairly large and significant rookery for these turtles (R. Prince *pers comm.,* 1998) and may become more important in the future given the high harvesting in Indonesia.

North Bills Bay

Turtles do not regularly nest in the North Bills Bay region. Monitoring of beaches in Bills Bay during the 1997/98 season showed no nesting activity (K. Anderson *pers comm.,* 1998).

Monck Head

Green and loggerhead turtles nest on the larger beaches south of Monck Head. During the last breeding season around 20 nests were laid, one as late as mid-March (K. Anderson *pers comm*., 1988).

3.2.6 Sharks and rays

Ningaloo Reef supports a diverse and abundant shark and ray populations. The whale shark, *Rhiniodon typus,* is the largest shark and occurs on the seaward side of the reef between November and June. It is thought that these sharks appear at Ningaloo to coincide with the annual mass coral spawning during autumn. Although whale sharks occur along the entire length of the reef, they are less common at Coral Bay than further north (BBG, 1995), and swimming with these sharks is a popular tourist attraction.

Sharks are most common on the seaward side of Ningaloo Reef (BBG, 1995), the largest of these, apart from the whale shark, is the tiger shark (*Galeocerdo cuvier*). Hammerhead sharks (*Sphyrna* spp.) are also found in the Coral Bay region and apparently form schools in autumn near Stanley Pool, 9 km north of Mauds Landing (BBG, 1995). Sharks found inside the reef in the Coral Bay region include tawny nurse sharks (*Nebeius ferrugineus*), lemon sharks (*Negaprion acutidens*), black (*Carcharinus melanopterus)* and white tip (*Triaenodon obesus)* and grey reef (*Carcharinus amblyrhynchos*) sharks and other whalers (Carcharhinidae), and wobbegongs (Orectolobidae). The creek whaler (*Carcharinus fitzroyensis*) is endemic to Australia.

Rays, including stingrays (Dasyatididae, Gymnuridae and Urolophidae), manta rays (Mobulidae), eagle rays (Myliobatidae), electric rays (Torpedinidae), numbfish (Hypnidae) and shovelnose rays (Rhinobatidae), are commonly found in the sandy regions of Coral Bay and Mauds Landing. The numbfish (*Hypnos monopterygium*) and the electric ray (*Torpedo macneilli*) are both endemic to Australia (Last and Stevens, 1994).

Mauds Landing

Cardabia Passage is a large, relatively deep passage linking the lagoon adjacent to Mauds Landing with the ocean. Many sharks have been sighted in this region however it is unknown how important this area is to sharks (BBG, 1995). Feeding depressions of rays were sighted in the lagoon (Appendix 1) and it is likely that Mauds Landing is an important feeding area for rays.

North Bills Bay

Near the beach rock ridges in North Bills Bay, schooling sharks (possibly *Carcharhinus limbatus*) are often seen (BBG, 1995). It is thought that these sharks come into the bay to breed. Black and grey-tip reef sharks (*C. melanopterus* and *C. amblyrhynchos*) also occur in the area and it is suggested that this area may be a nursery area for these species (Norman, in prep.).

Monck Head

Tawny nurse sharks (*Nebeius ferrugineus*), lemon sharks (*Negaprion acutidens*), black and white tip reef sharks (*Carcharhinus* species) and other whalers (Carcharhinidae) are regularly seen in this region. Many rays were sighted on the sandy bottom near Monck head including the abundant blue-spotted fantail stingray (*Taeniura lymma*). This appears to be a well-used feeding location judging by the number of feeding depressions observed.

3.2.7 Fish

The fish fauna at Ningaloo is well documented. It is a species rich fish fauna with 464 species from 81 families identified (Allen, 1980). This is partly because Ningaloo encompasses two biogeographic zones, the West Oceanic Zone and the Central West Coast Zone, where many sub-tropical fishes at the northern limit of their range and tropical fishes at the southern limit of their range occur together. Also, the southward-flowing Leeuwin Current which originates in the tropics, and the close proximity of the reef to the continental shelf edge, is believed to be partially responsible for the high diversity of tropical fish found at Ningaloo (Hutchins, 1994).

Mauds Landing

Mauds Landing supports a relatively impoverished fish fauna due to the homogeneity of the sand habitat. Occasional schools of pelagic fish such as trevally (Carangidae) and mullet (Mugilidae) are sighted (BBG, 1995). However, isolated patch reefs provide foci for fish. For example, at Site 2 (Appendix 1; Plate 3), at a mult-specific coral patch reef balchin gropers (*Choerodon rubescens*), spangled emperors (*Lethrinus nebulosus*), bristle-toothed surgeon fish (*Ctenochaetus strigosus*), lemon damsels (*Pomacentrus moluccensis*), green moon wrasses (*Thalassoma lutescens*), thick lipped wrasse (*Hemigymnus melapterus*), cleaner fish (*Labroides dimidiatus*), green chromis (*Chromis cinerascens*), black damsels (*Paraglyphidodon melas*), reticulated dascyllus (*Dascyllus reticulatus*), and scissortail sergeants (*Abudefduff sexfasciatus*) were sighted.

North Bills Bay

Surprisingly few fish were observed at North Bills Bay relative to the other two sites. The most common fish seen was a territorial algal grazer, the black damsel (*Paraglyphidodon melas*). Lemon damsels (*Pomacentrus moluccensis*) were also noted. This is most likely to be due to the lack of diverse habitat in the Bay. Although there has been significant recruitment of corals into the Bay, many of them are too small to provide adequate habitat for fish.

Monck Head

The well developed coral reef near to Monck Head provides ideal habitat for a diverse array of fish. Many families of fish were sighted in this region, including wrasses (Labridae), damselfishes (Pomacentridae), gobies (Gobiidae), cardinal fishes (Apogonidae), parrot fishes (Scaridae), surgeon fishes (Acanthuridae), butterfly fishes (Chaetodontidae), box fishes (Ostraciidae), leatherjackets (Monacanthidae), trigger fishes (Balistidae), rabbit fishes (Siganidae), angel fishes (Pomacentridae), goat fishes (Mullidae), scorpion fishes (Scorpionidae), flute mouth fishes (Fistularidae), gar fishes (Hemirhamphidae), long tom fishes (Belonidae), cat fishes (Plotosidae), lizard fishes (Synodontidae), moray eels (Muraenidae), and three families which are targeted by recreational fishers, emperor fishes (Lethrinidae), sweetlips (Haemulidae) and cod fishes (Serranidae).

3.2.8 Marine-associated birds

Forty species of waders and 36 species of seabirds are expected to occur in the Coral Bay region (Appendix 6). Of these, 8 species of waders, and 14 species of seabirds are resident, the remaining birds are either migrants or nomadic. The rocky shoreline interspersed with shallow sandy intertidal beaches provide diverse habitats for foraging waders, while the abundance of baitfish beyond the outer reef is an important food source for seabirds including the two most common families, Laridae (gulls and terns) and Procellariidae (wedge-tailed shearwaters).

Mauds Landing

In 1992, under the Control of Vehicles (Off-road Areas) Act 1978, Point Maud was gazetted as a Bird Roosting Sanctuary and vehicle access is prohibited (BBG, 1995). The 'tern-roost' at Point Maud is a refuge area for at least 12 different species of birds (Appendix 6). Over 590 birds were sighted at the point but the size of the flocks of terns seen taking off from the point suggest at least double the number of birds use the area (G. Begg *pers comm.,* 1998). Brahminy kites, ospreys and sea eagles roost in the cliffs north of Mauds Landing and are sighted frequently near Point Maud (BBG, 1995). Ospreys nest in the radio tower at Coral Bay.

North Bills Bay

Four species of waders were recorded on the water's edge at Skeleton Bay: the black-winged stilt, great egret, eastern reef egret (dark form) and grey-tailed tattler (Appendix 6, G. Begg *pers comm*.). The beach rock platform interspersed with sand is likely to provide a range of habitats for invertebrates that are eaten by waders.

Monck Head

Ospreys were sighted roosting on the Maud Sanctuary zone sign. Although no other birds were seen, it is also likely to be a foraging area for waders because of the rocky platform and adjacent sandy beaches.

3.2.9 Marine mammals

Ningaloo Marine Park is an important area for marine mammals. The following species have been sighted in the park: dugong (*Dugong dugon*); bottle-nose dolphin (*Tursiops aduncus*); humpback whale (*Megaptera novaeanglia*); killer whale (*Orcinus orca*); minke whale (*Balaenoptera acutorostrata*); fin whale (*Balaenoptera physalis*); blue whale (*Balaenoptera musculus*); southern right whale (*Eubalena australis*); and Australian sea lion (*Neophoca cinerea*). Humpback whales are often sighted west of the fore-reef when they move to and from their calving grounds further north (ANPWS, 1990).

Mauds Landing

Dugons, including cows with calves, are regularly sighted at Mauds Landing. One of their feeding grounds is only 15 km north of the landing and it is likely that Mauds Landing is within their home range. Bottlenose dolphins are common at Ningaloo and are expected to occur regularly at Mauds Landing. In June 1994, a pod of humpback dolphins was sighted 3 km north of Mauds Landing, but are thought to be occasional visitors to the area (BBG, 1995).

North Bills Bay

Dugongs and bottle-nose dolphins are regularly sighted in the lagoon near Coral Bay, south of North Bills Bay. (ANPWS, 1990).

Monck Head

It is expected that both dugongs and dolphins occur in this region too.

4. CONSERVATION VALUE AND PROTECTION OF MARINE FLORA AND FAUNA

There is no reef system similar to Ningaloo Reef in Australia and therefore it has a high conservation value. The Coral Bay region is exceptional in that coral communities are continuous from the reef flat and back reef to the lagoon and shore. Bills Bay and the reef immediately north of Monck Head are two of few sites at Ningaloo where corals can be viewed by swimmers from the shore, and must be considered to be regionally significant. The continued tourist interest in this region is only assured by the continued persistence and health of the reef and its associated biota.

4.1 FLORA

No species are listed as in need of protection under the Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act 1999 or the State Conservation and Land Management Act 1984, but all are protected within the Marine Park.

4.2 FAUNA

All invertebrates are protected within the Ningaloo Marine Park except those listed as food or bait species (BBG, 1995). All organisms are protected within the Sanctuary Zones including the Maud Sanctuary Zone, which encompasses the North Bills Bay site.

4.2.1 Whale sharks

Whale sharks within the Ningaloo Marine Park are protected under the Wildlife Conservation Act 1950–1975 (P. Connolly CALM *pers. comm.,* 1997).

4.2.2 Turtles

Under the Wildlife Conservation Act 1950–1975, loggerhead and leathery turtles are listed as Schedule 1 species (fauna which are rare or likely to become extinct and in need of special protection). Loggerhead turtles are also protected under the Commonwealth EPBC Act 1999 and are listed as protected.. Leathery, green flatback and and hawksbill turtles are listed as vulnerable under the Commonwealth EPBC Act1999.

4.2.3 Fish

The potato cod (*Epinephelus saillus*) and the Queensland groper (*Epinephelus lanceolatus*) are protected under the Fish Resources Management Act 1994.

4.2.4 Waders and seabirds

The Commonwealth government has signed international treaties which affects the endangered species and migratory birds in the area. The treaties are: the Convention on International Trade in Endangered Species, the Japan-Australia Migratory Birds Agreement, and the China-Australia Migratory Birds Agreement (JAMBA and CAMBA respectively). A number of species are protected by these agreements (Appendix 6); the little tern (*Sterna albifrons*) is presently under consideration for listing as a threatened species under the Commonwealth EPBC Act 1999.

4.2.5 Marine mammals

Under the Wildlife Conservation Act 1950–1975 humpback, fin, blue and southern right whales are listed as fauna which are rare or likely to become extinct and in need of special protection (Schedule 1). The humpback (vulnerable), blue (endangered), fin (vulnerable) and southern right (endangered) whales are also protected by the Commonwealth EPBC Act 1999. The fin whale is listed as vulnerable by the International Whaling Commission (AHC, 1997). Dugong is listed as vulnerable in the IUCN Red Data Book (IUCN, 1982) and as fauna in need of special protection (Schedule 4, Wildlife Conservation Act, 1996). The Australian sea lion is also listed as a Schedule 4 mammal under the Wildlife Conservation Act 1950–1975.

5. POTENTIAL IMPACTS

The construction of a boating facility at Mauds Landing, North Bills Bay or Monck Head is not anticipated to have a significant long-term effect on the marine fauna and flora of the regions. However, it is the use of these facilities that has the potential to have significant impact over long periods of time. In addition, visitation to Coral Bay is expected to increase with time, and through the construction of the boating facility, easy access to the reef will be facilitated. It is anticipated that this will lead to greater boating and fishing pressures throughout the region that are not necessarily site specific.

5.1 MAUDS LANDING

The most significant impact of a boating facility at Mauds Landing will be on turtle nesting activities. Unless adequate precautions are taken, lighting from the facility will interfere with hatchling orientation and in many cases will result in death. Mortality of nests and hatchlings through four-wheel drive activities currently exists.

Another impact of the boating facility and associated boat traffic will be on dugong resident times in the vicinity. It is unlikely that dugongs will use the area as regularly as they do now. With increased numbers of boats near Mauds Landing, it is likely that more boats will go north towards Stanley Pool and Bruboodjoo Point. As this is a major feeding area for dugongs, there is the strong possibility that feeding will be disrupted. Stanley Pool is also thought to be a breeding area for hammerhead sharks and increased fishing and boating activity in the area during the breeding season may also be disruptive.

5.2 NORTH BILLS BAY

It has been noted that 'across Coral Bay itself, some of the finest areas of coral were seen and are at considerable risk from the passage of boats across the bay and particularly from anchor damage since most of the corals are fragile corymbose and foliose species' (March, 1980). Although less than ten percent of the corals survived the coral spawning of 1989 (Simpson *et al*., 1993), there is substantial evidence that corals are recruiting into the bay, particularly to the fringe of limestone reef closest to the shoreline. This area has shown good recovery since the coral spawn event of 1989 and with signs of coral recruitment.

A boating facility at North Bills Bay would result in some loss of corals and limestone reef: the breakwater has a total footprint of approximately 0.4 ha and it expected that approximately 0.1 to 0.2 ha of this area would be corals and/or limestone reef. The area inside the breakwater is ca. 0.7 ha and up to ca 0.1 ha of corals and limestone reef may need to be removed to provide a navigable water depth of at least –1.5 m Chart Datum within the harbour.

A facility located at North Bills Bay may also adversely impact upon the breeding/nursery area for 'schooling sharks' located near the limestone beach rocks due to easier access to the location and increased human activity in the area.

5.3 MONCK HEAD

During the construction of a boat ramp at Monck Head there will be localised impact on the corals and other invertebrate fauna on the shallow limestone platform. This impact is not considered to be significant in a regional sense, nor of long duration.

It is expected that the construction of a boat ramp at Monck Head will lead to an increased usage of the channel across Mauds Sanctuary to Cardabia Passage in the north. The coral communities adjacent to the existing channel are spectacular, well developed and in excellent condition. However, in many places, the tops of the reef are in very shallow water and careful navigation through this region is required. With increased boat usage through this area, there is increased risk of damage to the corals.

6. MITIGATION MEASURES AND RECOMMENDATIONS

6.1 SPECIFIC MITIGATION MEASURES AND RECOMMENDATIONS

6.1.1 Mauds Landing

Some of the current mortality to turtle nests and hatchlings is due to foxes and indiscriminate four-wheel driving practices. This can be minimised by preventing beach access to four-wheel drive vehicles and by placing mesh grids over turtle nests to prevent foxes from digging up the eggs (Yerli *et al.,* 1997).

Lighting may also affect the behaviour of breeding turtles. Short wavelength lighting has been shown to disrupt turtle orientation and sea-finding ability (Philobosian, 1976; Salmon *et al.,* 1992, Salmon and Witherington, 1995). It is recommended that lighting of the boating facility use lamps with as long a wavelength as possible, for example sodium lamps. At present, only high pressure sodium (HPS) lamps are available which still emit some short wavelength light. It is recommended that amber filtering lenses be place over the HPS lamps to further reduce short wavelength light emissions. However, these measures may not completely eliminate the risk to hatchlings and other light management techniques should be used in conjunction with the filters and HPS lamps (R. Prince *pers comm.,* 1998). These include preventing light from reaching the beach, and only having lights come on when they're needed.

6.1.2 North Bills Bay

Adequate steps for the protection of the 'schooling' shark breeding/nursery area should be taken. This includes education of the public against harassing the sharks, and encouraging the appreciation of these fish and their important role in the ecosystem. The impact on the coral communities in this area can be minimised by careful siting of the boating facility.

6.1.3 Monck Head

The corals adjacent to the existing channel between Monck Head and Cardabia Passage are at risk from boat damage. The channel should be clearly marked. At present channel markers are widely spaced and not easily seen unless the light is optimal. The same holds for the recommended boating track between Coral Bay and Monck Head.

Construction of a road and parking facility at Monck Head should ensure that dust is minimised and the dune system not destabilised as increased sedimentation from the land into the water could have an adverse effect on the corals near the shoreline, particularly as many of them are not sediment tolerant.

Ospreys roost on both north and south sanctuary zone signs (Begg *pers comm.,* 1998). If a car and trailer park were to be constructed at Monck Head, it is likely that the ospreys would be too disturbed to roost on the signs. As tall roosting sites are in short supply, it is recommended that a few roosting platforms be provided away from the car park.

6.2 GENERAL MITIGATION MEASURES AND RECOMMENDATIONS

It is recommended that moorings be provided for boats at popular sites in the region to minimise damage to corals. Moorings should be designed to have minimal impact, for example moorings with single attachment points and no sweeping chains.

An education program should be instigated to raise public awareness of the damage and implications of dropping anchors on coral.

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FIGURES

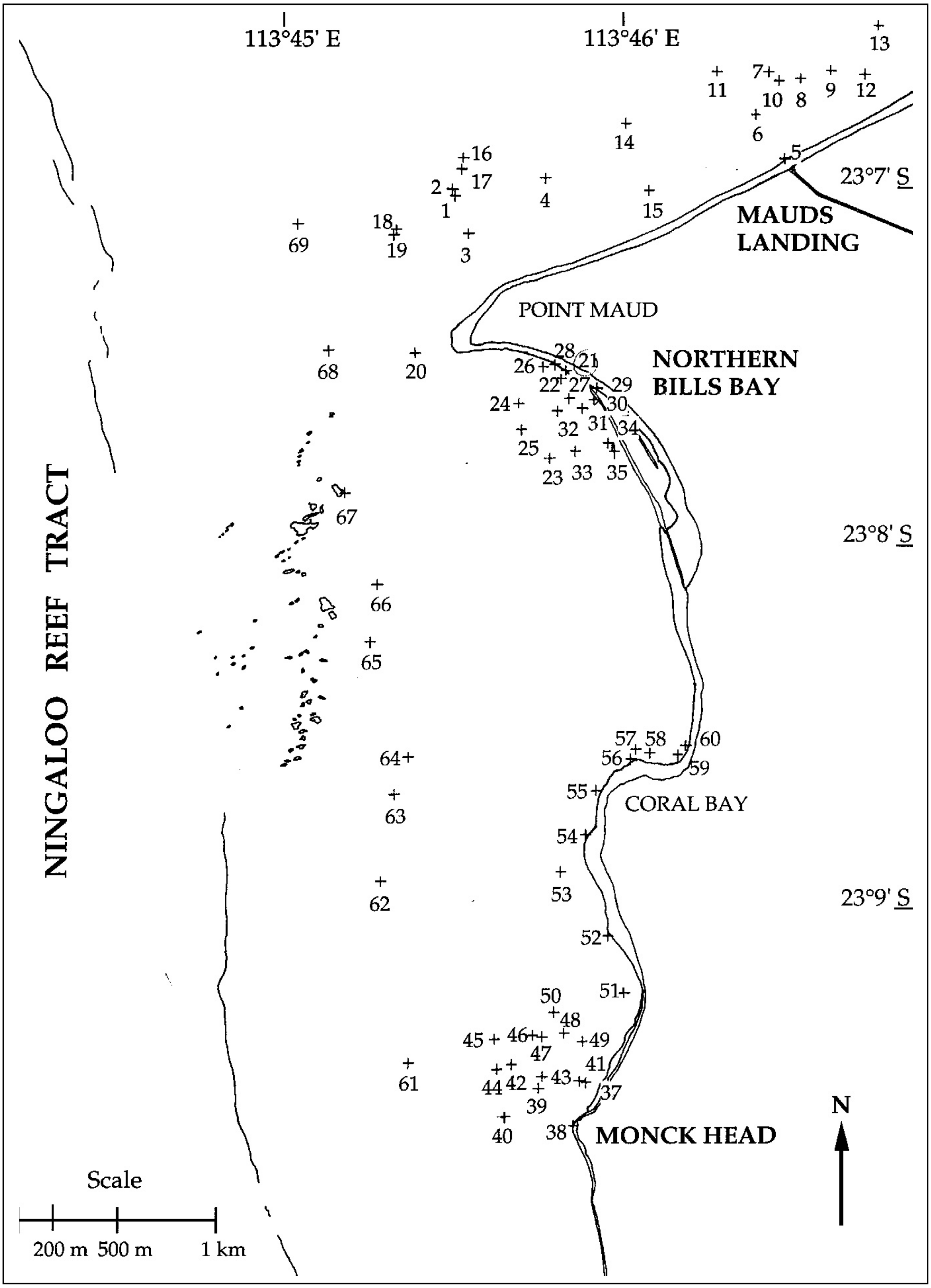

Figure 1 Map showing location of study sites at North Bills Bay, Mauds Landing and Monck Head

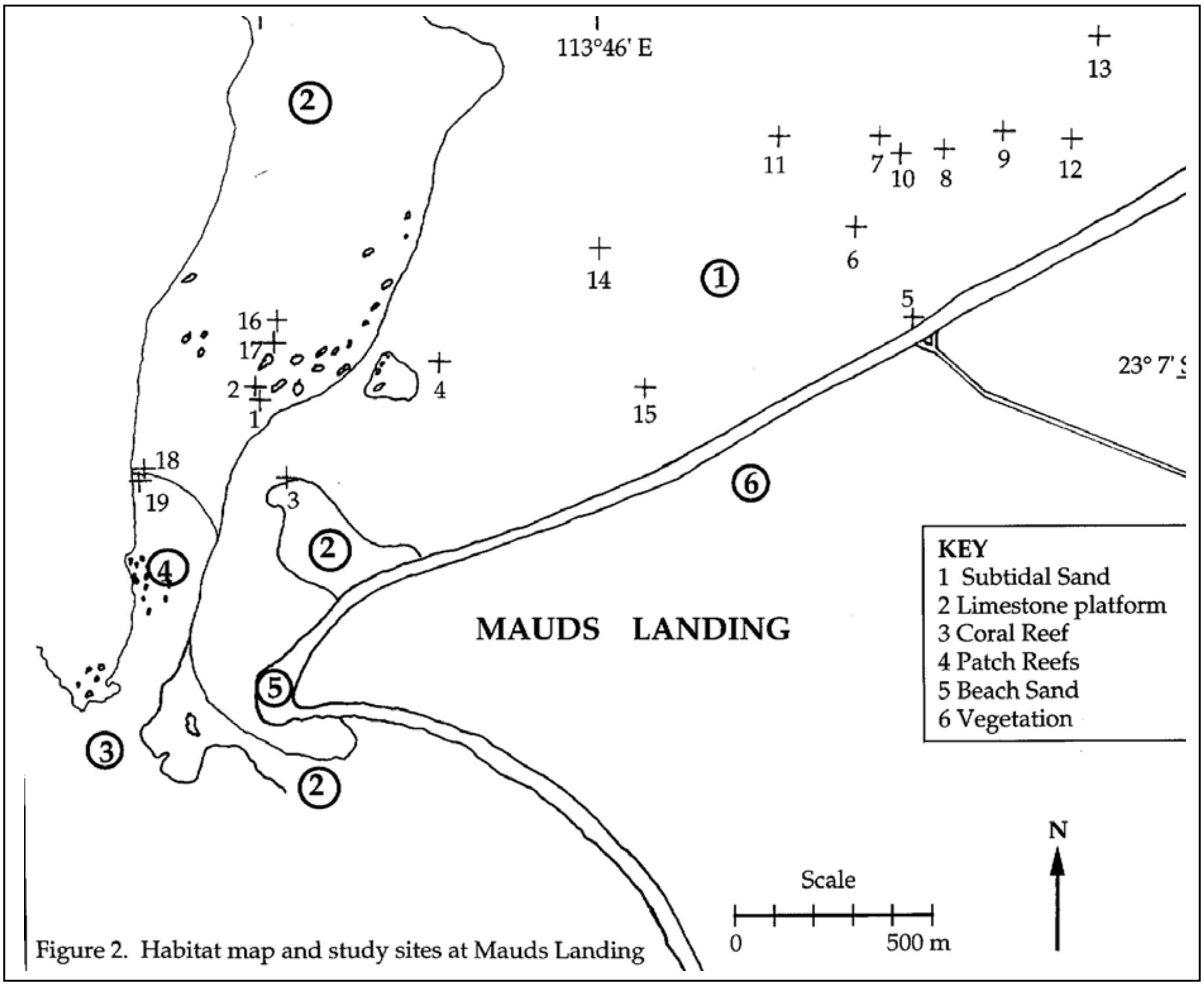

Figure 2 Habitat map and study sites at Mauds Landing

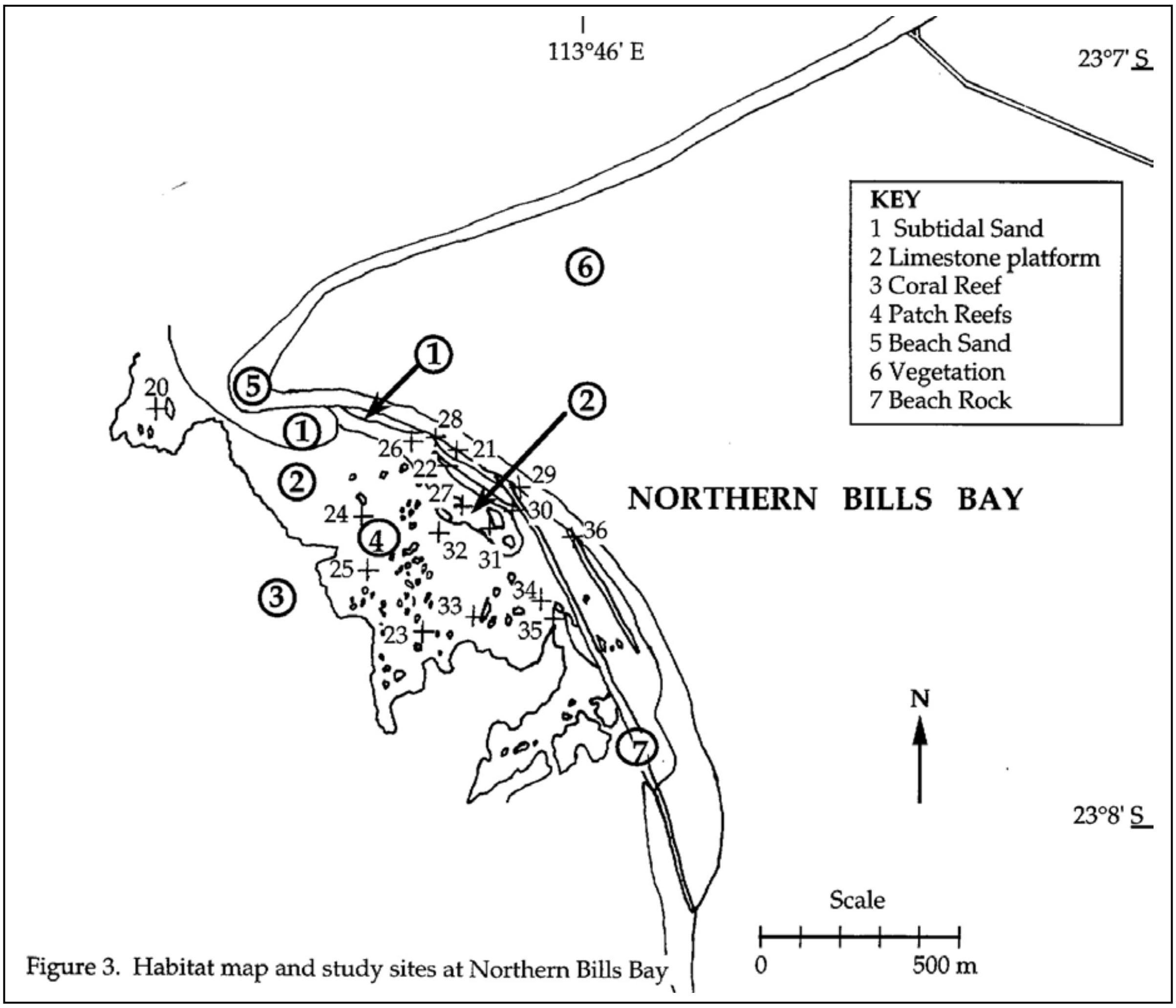

Figure 3 Habitat map and study sites at North Bills Bay

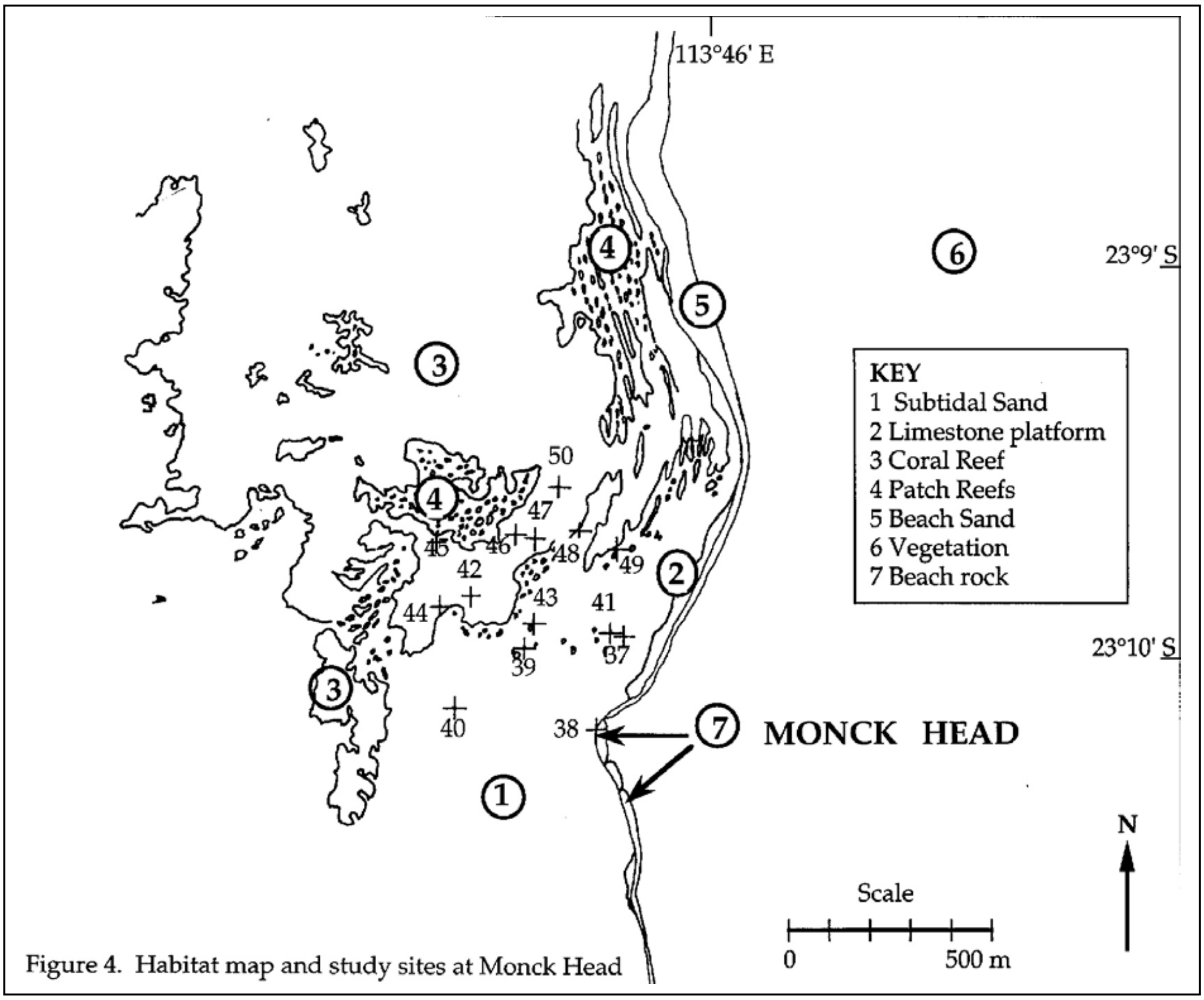

Figure 4 Habitat map and study sites at Monck Head

PLATES

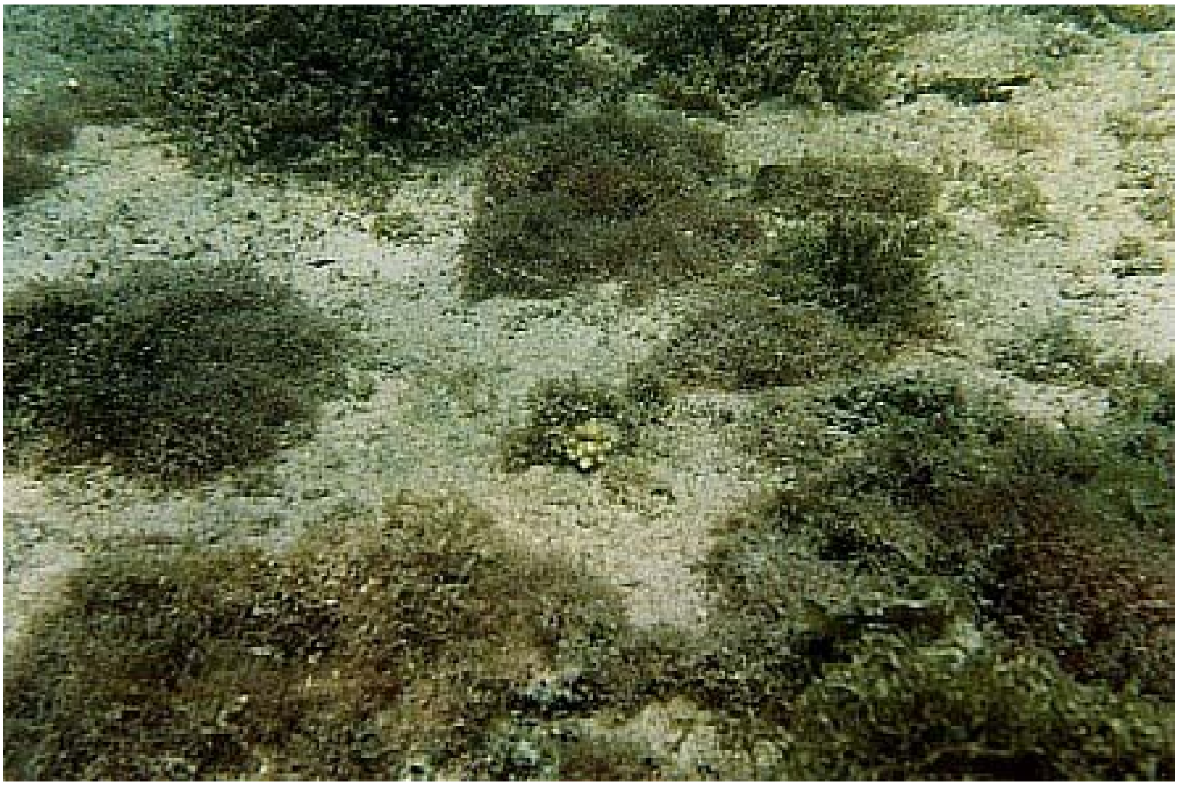

Plate 1 Macroalgal communities at North Bills Bay

Plate 2 Halophila ovalis forming a 'fringe' at the base of a patch reef near Monck Head

Plate 3 Patch reef as a focus for fish, Mauds Landing

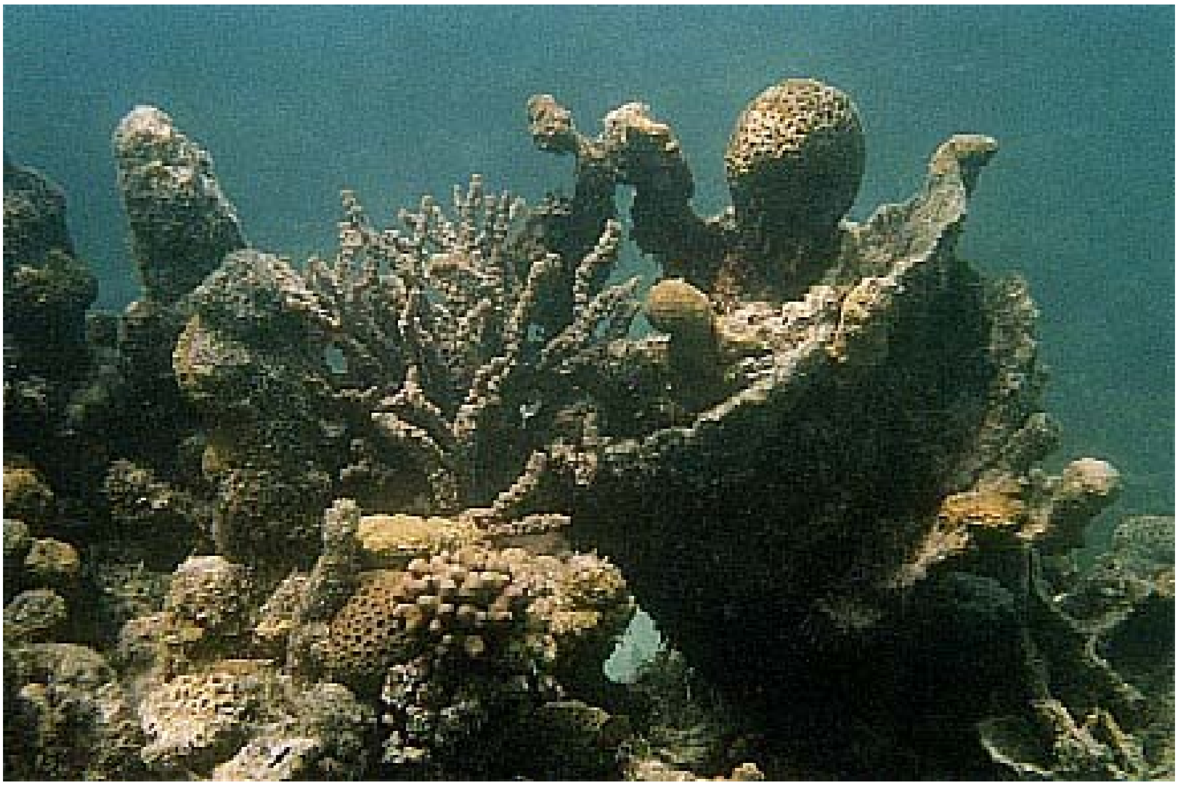

Plate 4 Old reef structure showing existing coral recruitment, North Bills Bay

Plate 5 Staghorn coral, **Acrophora** *sp., at Monck Head*

APPENDICES

Appendix 1 Mauds Landing dive site locations and habitat descriptions

SITE	LATITUDE (AGD84)	LONGITUDE (AGD84)	DEPTH (M)	HABITAT DESCRIPTION
1	23° 7.038' S	113° 45.499' E	4.7	Sand, some *Caulerpa* and other macroalgae
2	23° 7.003' S	113° 45.488' E	6.9	Isolated, multi-specific coral patch reef; focus for many fish species including balchin groper and spangled emperor
3	23° 7.129' S	113° 45.528' E	6.9	Small staghorn *Acropora*
4	23° 6.974' S	113° 45.759' E	4.0	Sand with isolated limestone rocks covered with *Sargassum*
5	23° 6.925' S	113° 46.464' E	2.5	Bare sand, old jetty pylons are foci for hydroids, ascidians, macroalgae, gastropods, crustaceans, juvenile fish including banner fish and fan bellied leather jacket
6	23° 6.800' S	113° 46.385' E	3.5	Sand
7	23° 6.775' S	113° 46.415' E	3.8	Sand
8	23° 6.809' S	113° 46.515' E	3.6	Sand with anemones and crab burrows
9	23° 6.763' S	113° 46.600' E	3.4	Sand
10	23° 6.702' S	113° 46.447' E	3.8	Sand with sea pens
11	23° 6.725' S	113° 46.283' E	4.0	Sand with large area of algal film
12	23° 6.748' S	113° 46.704' E	3.6	Sand
13	23° 6.540' S	113° 46.737' E	4.7	Sand
14	23° 6.812' S	113° 46.016' E	4.8	Sand, with some coral rubble, the larger pieces colonised by *Padina, Sargassum* and other macroalgae
15	23° 7.030' S	113° 46.062' E	3.2	Sand
16	23° 6.909' S	113° 45.515' E	6.3	Sargassum
17	23° 6.943' S	113° 45.514' E	5.6	Sargassum and other macroalgae, and *Halophila ovalis* mixed with fairly small (0.7 x 0.4 m) staghorn and plate *Acropora*, and *Seriatopora*
18	23° 7.114' S	113° 45.316' E	8.3	Sand with stingray feeding depressions
19	23° 7.118' S	113° 45.307' E	5.7	Staghorn and plate *Acropora*, *Seriatopora* and *Montipora*. Some dead staghorn with macroalgae growing on branches.

Appendix 2 North Bills Bay dive site locations and habitat descriptions

SITE	LATITUDE (AGD84)	LONGITUDE (AGD84)	DEPTH (M)	HABITAT DESCRIPTION
20	23° 7.454' S	113° 45.378' E	3.9	Much of the old reef structure still intact, but covered with fine filamentous green algae. Some fringes of live *Montipora* on outer margins of otherwise dead heads, lots of recruits post 1989 including Faviids, Fungids and Acroporids. Fish seen in the vicinity were mostly algal grazers.
21	23° 7.503' S	113° 45.848' E	2.7	Old reef structure still solid with lots of coral recruits post 1989 including *Echinopora lamellosa, Merulina ampliata Cyphastrea, Hydnophora, Favites, Potites, Montastrea, Galaxea* and Fungids. Lots of macroalgae, *Caulerpa*?
22	23° 7.524' S	113° 45.802' E	3	Very similar to Site 21 with same Faviid species dominating, but with some caespitose/corymbose *Acropora* and small (± 1m diam.) isolated sand patches
23	23° 7.542' S	113° 45.756' E	3	Large dead bommie with green macroalgae and lots of coral recruits, *Cyphastrea, Platygyra, Porites* and *Acropora* just off the bommie
24	23° 7.602' S	113° 45.673' E	3.6	Limestone pavement with macroalgae and thin layer of sand. Few isolated, mostly dead bommies, with some *Cyphastrea* and *Acropora* heads
25	23° 7.673' S	113° 45.682' E	4.1	Sand patch and dead coral covered with algae and a few small coral recruits
26	23° 7.605' S	113° 45.752' E	3.7	Limestone pavement with macroalgae and the occasional coral head. One large corymbose *Acropora* (± 90 cm) and some Faviids
27	23° 7.567' S	113° 45.818' E	2.6	Old reef structure still solid with lots of coral attached including *Echinopora lamellosa, Merulina ampliata, Cyphastrea, Hydnophora, Porites, Galaxea, Acropora, Favites* and Fungids
28	23° 7.507' S	113° 45.885' E	2.6	Dominated by *Echinopora lamellosa* on old reef, also *Cyphastrea, Merulina ampliata, Acropora, Porites* and Faviids. Occasional sand patches
29	23° 7.558' S	113° 45.949' E	2.0	Sand with large pieces of coral rubble and a few isolated patchreefs dominated by *Cyphastrea*. Just north of this sites there was an almost monospecific stand of *Echinopora lamellosa*, small heads (± 30 cm) but lots of them
30	23° 7.586' S	113° 45.895' E	1.3	Limestone beachrock ridge with *Echinopora lamellosa, Merulina ampliata, Cyphastrea,* and *Favites*
31	23° 7.613' S	113° 45.861' E	4.1	Limestone pavement with macroalgae, sand and a few Faviids
32	23° 7.623' S	113° 45.789' E	4.0	Low lying isolated dead coral colonies with some recolonization by the Faviids *Cyphastrea* and *Montastrea*, and macroalgae including *Padina.* One *Cypbastrea* (*microopthalmia?*) colony looked as though it had recruited pre-1989
33	23° 7.725' S	113° 45.844' E	4.4	Sand bottom with large well developed coral patch reefs with lots of *Cyphastrea, Echinopora lamellosa, Porites, Goniastrea, Galaxea, Merulina ampliata, Platygyra* and corymbose/caespitose *Acropora*
34	23° 7.717' S	113° 45.926' E	3.2	Lots of smaller (<3 m) coral patch reefs with sand in between, dominated by macroalgae but also plenty of Faviids, *Porites, Acropora,* and *Echinopora lamellosa*
35	23° 7.642' S	113° 45.948' E	1.5	Beach rock edge with *Cyphastrea, Porites, Acropora, Montipora,* Fungids and macroalgae
36	23° 7.616' S	113° 46.010' E	0.5	Top of beach rock (innermost one)

Appendix 3 Monck Head dive site locations and habitat descriptions

SITE	LATITUDE (AGD84)	LONGITUDE (AGD84)	DEPTH (M)	HABITAT DESCRIPTION
37	23° 9.488' S	113° 45.853' E	1.5	Sand, shorewards is a limestone platform with *Acropora* heads, soft coral, sea hare *Aplysia*, juvenile butterfly cod (*Pterois volitans*), and macroalgae
38	23° 9.604' S	113° 45.819' E	1.1	Sand
39	23° 9.591' S	113° 45.704' E	3.8	Sand with a large (15 x 5 m) coral bommie nearby, mostly *Acropora* but also *Platygyra, Merulina* and other Faviids. Other bommies in the area have a fringe of *Halophila ovalis* around base
40	23° 9.577' S	113° 45.604' E	4.2	Sand
41	23° 9.486' S	113° 45.831' E	1.2	Sand
42	23° 9.426' S	113° 45.621' E	3.4	Sand with small (<3 x 2 m) isolated patch reefs, mostly *Acropora* with *Halophilia ovalis* round base
43	23° 9.466' S	113° 45.728' E	3.5	Thin layer of sand over limestone pavement and larger (± 5 x 3 m) patch reefs
44	23° 9.442' S	113° 45.584' E	1.7	Extensive staghorn *Acropora* thickets, some *Seriatopora caliendrum, Echinopora lamellosa* and *Montipora*
45	23° 9.362' S	113° 45.573' E	2.8	Swathe of broken staghorn covered with macroalgae, mostly *Padina* and *Dictyota*. Staghorn *Acropora* dominated landscape with some *Seriatopora caliendrum,* foliose *Montipora, Goniastrea* and *Acropora aspera*
46	23° 9.341' S	113° 45.689' E	3.6	Staghorn *Acropora* thicket with ± 10 x 5 m clearing with *Montipora, Seriatopora caliendrum, Platygyra, Merulina, Hydnophora, Galaxea*
47	23° 9.351' S	113° 45.726' E	2.9	Staghorn *Acropora*
48	23° 9.346' S	113° 45.778' E	3.4	Staghorn *Acropora* on edge of backreef, limestone pavement shorewards with some sand and lots of young (> 5 years) *Acropora*
49	23° 9.372' S	113° 45.840' E	3	Sand with small (< 2 x 2 m) patch reefs
50	23° 9.282' S	113° 45.756' E	1.8	Sand

Appendix 4 Channel from Coral Bay to Monck Head, dive site locations and habitat descriptions

SITE	LATITUDE (AGD84)	LONGITUDE (AGD84)	DEPTH (M)	HABITAT DESCRIPTION
51	23° 9.229' S	113° 45.962' E	2.9	Well established tabular *Acropora* in excellent condition, some staghorn, caespitose and corymbose *Acropora,* and *Montipora*
52	23° 9.062' S	113° 45.906' E	3.1	Staghorn and tabular *Acropora*, some caespitose and corymbose *Acropora*, limestone pavement showing between colonies
53	23° 8.894' S	113° 45.797' E	3.5	Limestone pavement with numerous, loosely interconnected, patch reefs. Dominant genus *Acropora* (corymbose, caespitose and staghorn), with *Stylophora pistillata, Montipora* and some macroalgae on limestone
54	23° 8.784' S	113° 45.879' E	4.0	Limestone pavement with staghorn and tabular *Acropora* , and foliose *Montipora,* but with some old dead tables covered with macroalgae. Quite a lot of macroalgae, generally *Dictyota*. Very little damage done by channel buoy
55	23° 8.672' S	113° 45.878' E	3.7	Limestone pavement with single coral heads or small (< 2 x 2 m) patch reefs with tabular and staghorn *Acropora, Montipora, Echinopora lamellosa* and *Pcillopora damicornis*
56	23° 8.589' S	113° 45.985' E	2.5	Limestone pavement with lots of coral heads as discrete patch reefs and loosely interconnected multi-specific colonies and young *Acropora* recruits. Mostly *Acropora,* some *Pocillopora damicornis,* foliose and encrusting *Montipora, Galaxea, Goniopora*, soft corals and sponges. A few dead staghorn *Acropora* thickets totally covered in macroalgae
57	23° 8.566' S	113° 45.997' E	3.0	Dead coral pieces, old damage
58	23° 8.560' S	113° 46.026' E	1.6	Old dead reef structure with lots of recruits, mainly *Cyphastrea, Favia, Echinopora lamellosa, Fungia, Merulina, Favites, Galaxea, Pocillopora damicornis*, and large (2 - 3m diam.) *Porites* colony covered with a thin layer of sediment.
59	23° 8.569' S	113° 46.132' E	2.4	Thin layer of sand over limestone. Lots of old dead coral with fine layer of sediment over everything. Some live coral, mostly Faviids, including *Cyphastrea*. Some large Faviids, possibly survivors of the 1989 coral spawn
60	23° 8.545' S	113° 46.166' E	2.1	Sand over limestone. Old dead patch reefs with macroalgae. Little coral recruitment

Appendix 5 Recommended boating track between Monck Head and Point Maud, dive site locations and habitat descriptions

SITE	LATITUDE (AGD84)	LONGITUDE (AGD84)	DEPTH (M)	HABITAT DESCRIPTION
61	23° 9.431' E	113° 45.322' S	2.7	Sand at base of channel marker, with isolated patch reefs dominated by staghorn *Acropora* and some *Montipora*. Patch reefs ranging in size from 0.8 m to tens of meters. *Halophilia ovalis* fringe round base of reefs. Green algal mat covering the sand which extended hundreds of metres
62	23° 8.915' E	113° 45.249' S	4.1	Sand at base of channel marker, nearby patch reefs dominated by staghorn *Acropora* . Where there's a break in the staghorn thicket, *Seriatopora caliendrum, Echinipora lamellosa,* caespitose *Acropora*, Fungids and Faviids occur
63	23° 8.667' E	113° 45.284' S	6.3	Small (> 5 x 10 m) patches of sand surrounded by large well developed reef, dominated by foliose *Montipora* but also staghorn *Acropora*, encrusting *Montipora, Seriatopora caliendrum, Galaxea, Cyphastrea* and Faviids
64	23° 8.506' E	113° 45.335' S	7.4	Channel marker in patch of bare sand (± 20 x 10 m). Mooring rope with colonisation by *Pocillopora dzmicornis* (10 colonies), *Acropora digitifera* and other *Acroporids.* Very diverse and well developed reef surrounding sand patch with *Hydnophora, Galaxea,* caespitose and corymbose *Acropora, Montipora, Echinopora lamellosa, Merulina, Cyphastrea, Lobophyllia, Echinophyllia* and other Faviids. School of raccoon butterfly fish (*Chaetodon lunula*) and two trevally seen
65	23° 8.249' E	113° 45.224' S	7.5	Well developed, species rich reef with *Lobophyllia, Seriatopora caliendrum, Echinopora lamellosa, Cyphastrea,* foliose *Montipora* and Faviids. Old dead parts of the reef covered with macroalgae, mostly *Dictyota.* Mooring robe with *Pocillopora damicornis, Tubastrea, Acropora hyacinthus* and the alga *Caulerpa*
66	23° 8.103' E	113° 45.245' S	6.9	Very specious and well developed reef, forming a 5m drop off into a sandy patch. Genera include *Galaxea* (2 x 1 x 3 m bommie), foliose *Montipora, Echinopora lamellosa, Goniastrea, Seriatopora caliendrum, Merulina, Cyphastrea, Platygyra, Stylophora pistillata,* and the bulb-tentacle sea anemone (*Entacmaea quadricolor*) with red anemone fish (*Amphiprion rubrocinctus*)
67	23° 7.851' E	113° 45.148' S	5.4	Marker at large dead tabular *Acropora* bommie. Nearby large (10 x 7 m) corymbose *Acropora*, also *Lobophyllia, Platygyra, Montipora, Seriatopora caliendrum, Merulina, Pocillopora damicornis, Goniastrea, Millepora, Hydnophora, Acropora digitifera,* staghorn *Acropora, Echinopora lamellosa, Porites, Favites* and a moderate amount of dead coral colonised by macroalgae (mostly *Dictyota*)
68	23° 7.438' E	113° 45.135' S	3.9	Ring of bommies before final exit from northern Coral Bay Sanctuary zone. Large bommie dead on tope but with few coral recruits, tabular *Acropora* (, 1 m), encrusting *Montipora, Lobophyllia, Seriatopora caliendrum, Goniastrea*, Faviids, staghorn, caespitose and corymbose *Acropora* and Fungids
69	23° 7.096' E	113° 45.036' S	3.0	Limestone with sand layer. Macroalgae and a few small *Acropora, Porites*, Faviids and soft coral

Appendix 6 Sightings and expected occurrence of waders and seabirds in the Coral Bay region (compiled by Dr George Begg)

TAXON	FAMILY	COMMON NAME	TYPE	RES/MIG	SIGHTINGS	STATUS
Ardea alba	Ardeidae	Great Egret	Wader	Resident	1	CAMBA/JAMBA
Ardea novaehollandiae	Ardeidae	White-faced Heron	Wader	Migrant		Protected
Ardea pacifica	Ardeidae	Pacific Heron	Wader	Migrant		Protected
Ardea ibis	Ardeidae	Cattle Egret	Wader	Resident		Protected
Egretta sacra	Ardeidae	Eastern Reef Egret	Wader	Resident	1	CAMBA
Esacus magnirostris	Burhinidae	Beach Stone Curlew	Wader	Resident		JAMBA
Burhinus grallarius	Burhinidae	Bush Stone-Curlew	Wader	Resident		Protected
Charadrius australis	Charadriidae	Inland Dotteral	Wader	Nomadic	1	Protected
Charadrius leschenaultii	Charadriidae	Large Sand Dotterel	Wader	Migrant		CAMBA/JAMBA
Charadrius mongolus	Charadriidae	Mongolian Plover	Wader	Migrant		CAMBA/JAMBA
Charadrius ruficapillus	Charadriidae	Red-capped Dotterel	Wader	Resident	8	Protected
Charadrius veredus	Charadriidae	Oriental Dotterel	Wader	Migrant		Protected
Elseyornis melanops	Charadriidae	Black-fronted Dotterel	Wader	Nomadic		Protected
Erythrogonys cinctus	Charadriidae	Red-kneed Dotterel	Wader	Nomadic		Protected
Pluvialis dominica fulva	Charadriidae	Golden Plover	Wader	Migrant	3	CAMBA/JAMBA
Pluvialis squatarola	Charadriidae	Grey Plover	Wader	Migrant		CAMBA/JAMBA
Glareola maldivarum	Glareolidae	Oriental Pratincole	Wader	Migrant	6	CAMBA/JAMBA
Haematopus fuliginosus opthalmicus	Haematopodidae	Sooty Oystercatcher	Wader	Resident		Protected
Haematopus longirostris longirostris	Haematopodidae	Pied Oystercatcher	Wader	Resident		Protected
Pelecanus conspicillatus	Pelecanidae	Australian Pelican	Wader	Nomadic		Protected
Cladorhynchus leucocephala	Recurvirostridae	Banded Stilt	Wader	Migrant		Protected
Himantopus himantopus	Recurvirostridae	Black-winged Stilt	Wader	Nomadic	19	Protected
Recurvirostra novaehollandiae	Recurvirostridae	Red-necked Avocet	Wader	Nomadic		Protected
Actitis hypoleucas	Scolopacidae	Common Sandpiper	Wader	Migrant		CAMBA/JAMBA
Arenaria interpres	Scolopacidae	Ruddy Turnstone	Wader	Migrant		Protected
Calidris acuminata	Scolopacidae	Sharp-tailed Sandpiper	Wader	Migrant		CAMBA/JAMBA
Calidris alba	Scolopacidae	Sanderling	Wader	Migrant	35	CAMBA/JAMBA
Calidris canutus canutus	Scolopacidae	Red Knot	Wader	Migrant		CAMBA/JAMBA

TAXON	FAMILY	COMMON NAME	TYPE	RES/MIG	SIGHTINGS	STATUS
Calidris ferruginea	Scolopacidae	Curlew Sandpiper	Wader	Migrant		CAMBA/JAMBA
Calidris ruficollis	Scolopacidae	Red-necked Stint	Wader	Migrant		CAMBA/JAMBA
Calidris tenuirostris	Scolopacidae	Great Knot	Wader	Migrant		CAMBA/JAMBA
Limosa lapponica baueri	Scolopacidae	Bar-tailed Godwit	Wader	Migrant		CAMBA/JAMBA
Limosa limosa melanuroides	Scolopacidae	Black-tailed Godwit	Wader	Migrant		CAMBA/JAMBA
Numenius madagascariensis	Scolopacidae	Eastern Curlew	Wader	Migrant		CAMBA/JAMBA
Numenius minutus	Scolopacidae	Little Whimbrel	Wader	Migrant		CAMBA/JAMBA
Numenius phaeopus variegatus	Scolopacidae	Whimbrel	Wader	Migrant		CAMBA/JAMBA
Tringa breviceps	Scolopacidae	Grey-tailed Tattler	Wader	Migrant	1	CAMBA/JAMBA
Tringa glareola	Scolopacidae	Wood Sandpiper	Wader	Migrant		CAMBA/JAMBA
Tringa nebularia	Scolopacidae	Greenshank	Wader	Migrant		CAMBA/JAMBA
Tringa totanus	Scolopacidae	Common Redshank	Wader	Migrant		Protected
Threskiornis spinicollis	Threskiornithidae	Straw-necked Ibis	Wader	Nomadic		Protected
						Protected
Haliastur indus girrenera	Accipitridae	Brahminy Kite	Seabird	Resident		Protected
Pandion haliaetus cristatus	Accipitridae	Osprey	Seabird	Resident	4	Protected
Haliaeetus leucogaster	Accipitridae	White-bellied Sea-Eagle	Seabird	Resident		CAMBA
Diomedea chlororhynchos	Diomedeidae	Yellow-nosed Albatross	Seabird	Migrant		Protected
Anous stolidus pileatus	Laridae	Common Noddy	Seabird	Migrant		CAMBA/JAMBA
Larus novaehollandiae	Laridae	Silver Gull	Seabird	Resident	2	Protected
Larus pacificus georgii	Laridae	Pacific Gull	Seabird	Migrant		Protected
Sterna albifrons sinensis	Laridae	Little Tern	Seabird	Migrant	72	CW Schedule 1 CAMBA/JAMBA
Sterna anaethetus	Laridae	Bridled Tern	Seabird	Migrant		Protected
Sterna fuscata	Laridae	Sooty Tern	Seabird	Migrant		Protected
Sterna hirundo longinpennis	Laridae	Common Tern	Seabird	Migrant		JAMBA
Sterna nilotica macrotarsa	Laridae	Gull-billed Tern	Seabird	Migrant		Protected
Sterna bengalensis	Laridae	Lesser Crested Tern	Seabird	Resident		CAMBA
Sterna bergii	Laridae	Crested Tern	Seabird	Resident	17	JAMBA
Sterna caspia	Laridae	Caspian Tern	Seabird	Resident		CAMBA/JAMBA
Sterna dougallii	Laridae	Roseate Tern	Seabird	Resident	90	Protected
Sterna fuscata	Laridae	Sooty Tern	Seabird	Resident	23	Protected
Sterna nereis nereis	Laridae	Fairy Tern	Seabird	Resident	130	Protected
Chlidonias leucoptera	Lariidae	White-winged Tern	Seabird	Migrant	200	CAMBA/JAMBA

TAXON	FAMILY	COMMON NAME	TYPE	RES/MIG	SIGHTINGS	STATUS
Oceanites oceanicus	Oceanitidae	Wilson Storm-Petrel	Seabird	Migrant		CAMBA/JAMBA
Pelagodroma marina	Oceanitidae	White-faced Storm-Petrel	Seabird	Migrant		Protected
Phaethon rubricauda	Phaethontidae	Red-tailed Tropicbird	Seabird	Migrant		JAMBA
Fregata ariel	Phalacrocoracidae	Lesser Frigate Bird	Seabird	Resident		Protected
Phalacrocorax sulcirostris	Phalacrocoracidae	Little Black Cormorant	Seabird	Resident		Protected
Phalacrocorax varius	Phalacrocoracidae	Pied Cormorant	Seabird	Resident		Protected
Macronectes halli	Procellariidae	Northern Giant Petrel	Seabird	Migrant		Protected
Daption capense	Procellariidae	Cape Petrel	Seabird	Migrant		Protected
Macronectes giganteus	Procellariidae	Southern Giant Petrel	Seabird	Migrant		Protected
Pterodroma macroptera	Procellariidae	Great Winged Petrel	Seabird	Migrant		Protected
Pterodroma mollis mollis	Procellariidae	Soft-plumaged Petrel	Seabird	Migrant		Protected
Puffinus assimilis	Procellariidae	Little Shearwater	Seabird	Migrant		Protected
Puffinus carneipes	Procellariidae	Flesh-footed Shearwater	Seabird	Migrant		JAMBA
Puffinus huttoni	Procellariidae	Hutton's Shearwater	Seabird	Migrant		Protected
Puffinus pacificus	Procellariidae	Wedge-tailed Shearwater	Seabird	Migrant		JAMBA
Sula bassana serrator	Sulidae	Australasian Gannet	Seabird	Migrant		Protected
Sula leucogaster plotus	Sulidae	Brown Booby	Seabird	Resident		CAMBA/JAMBA

TECHNICAL APPENDIX 6
CORAL BAY BOATING FACILITY
REPORT ON ARCHAEOLOGICAL AND ANTHROPOLOGICAL ISSUES

Prepared for:

DEPARTMENT FOR PLANNING AND INFRASTRUCTURE

Prepared by:

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In collaboration with:

DAL SCIENCE & ENGINEERING PTY LTD

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REPORT NO. 97/050/27

CONTENTS

TABLES

EXECUTIVE SUMMARY

An archaeological and anthropological (ethnographic) study of three alternative sites for a proposed boat launching facility at Coral Bay was undertaken by Dr Kate Morse, Mr Michael Robinson and Mr Philip Haydock of Michael Robinson and Associates: Mauds Landing, North Bills Bay and Monck Head. Note that it is proposed that a boating facility will only be developed at one of these three sites.

Archaeological research on Cape Range peninsula has established that the area has been occupied and used by Aboriginal people for at least 32,000 years. Previous anthropological and linguistic research supports the view that Coral Bay is within the traditional lands of the Baiyungu peoples.

The Register of Aboriginal Sites at the Aboriginal Affairs Department contains information about 12 Aboriginal sites within a 5–10 km radius of Coral Bay. The Baiyungu peoples and others have lodged a native title claim (WC 97/28) over an area which includes the proposed boat launching facility at Coral Bay.

FIELD SURVEY

A combined archaeological and anthropological survey was undertaken between 7–9 April 1998.

Representatives of the Baiyungu native title claimants, together with the Yamatji Land and Sea Council's anthropologist, participated in the field survey.

POTENTIAL IMPACTS

An archaeological site of low archaeological significance (soak) would be disturbed by the proposed access track at North Bills Bay. Erosion of dunes, risking exposure of skeletal material, is a possible consequence of development of North Bills Bay. An extensive, probably middle-Holocene, midden site was identified at Monck Head and this site is considered to be archaeologically significant.

MITIGATION

The access track at North Bills Bay should be realigned to avoid disturbance to this soak.

Recommendations—Mauds Landing

- It is recommended that Aboriginal people from the Yamatji Land and Sea Council be present during all ground disturbing work undertaken as part of the development of boating and car park facilities at Mauds Landing;
- If development is to go ahead at Mauds Landing the developer will need to apply under Section 18 of Aboriginal Heritage Act 1972 to disturb recorded archaeological sites P06180 and P06257;
- Ethnographic site P05715 should be avoided;
- If P05715 cannot be avoided, the developer will need to apply under Section 18 of Aboriginal Heritage Act 1972 to disturb it;
- Extreme care should be taken to avoid disturbance to Aboriginal burials during all ground disturbing activities; and
- Old government soaks should be avoided, as they are an important historical resource for Aboriginal people.

Recommendations—North Bills Bay

- It is recommended that Aboriginal people from the Yamatji Land and Sea Council be present during all ground disturbing work undertaken as part of the development of boating and car park facilities at North Bills Bay; and
- It is recommended that the road alignment be modified to avoid disturbance of the identified soak.

Recommendations—Monck Head

- It is recommended that Aboriginal people from the Yamatji Land and Sea Council be present during all ground disturbing work undertaken as part of the development of boating and car park facilities at Monck Head; and
- Only part of the Monck Head site (CBFS2) has been recorded. This extensive, probably middle Holocene midden site is considered to be archaeologically significant. It is recommended that further detailed documentation (including radiocarbon dating) and possible salvage of this site should be undertaken. Further inspection of areas to the south of Monck Head should be undertaken as part of this field recording.

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1. INTRODUCTION

1.1 BRIEF

The Department for Planning and Infrastructure (formerly Department of Transport) proposes to establish a new boat launching facility at Coral Bay, in North-Western Australia. Environmental consultants DAL Science & Engineering Pty Ltd (formerly D.A. Lord & Associates Pty Ltd) engaged Michael Robinson and Associates to carry out archaeological and ethnographic[1] assessments of the options as part of a broader Public Environmental Review (PER). Three alternative sites were identified for study: Mauds Landing, North Bills Bay and Monck Head. However, note that it is proposed that a boating facility is developed at only one of these three sites.

The brief was to prepare a technical appendix dealing with:

(a) Archaeological issues

- Sites of Aboriginal significance in the vicinity of the proposed development sites;
- Outcome of discussions with all the relevant people and authorities;
- Proposed measures to protect sites of Aboriginal significance; and
- Appropriate clearances to enable the project to proceed unencumbered.

(b) Ethnographic issues

- Ethnographic significance of the proposed development sites;
- Outcome of discussions with all the relevant people and authorities;
- Proposed measures to protect sites of ethnographic significance; and
- Appropriate clearances to enable the project to proceed unencumbered.

Although the two sets of issues were separately listed, given the similarity between them the archaeological and anthropological investigations were pursued together. This report presents the results of those investigations.

1.2 ARCHAEOLOGICAL AND ANTHROPOLOGICAL BACKGROUND

Archaeological investigations have been ongoing on Cape Range peninsula since 1985. Excavation and research in a number of small rock-shelters in the western foothills of Cape Range has provided the earliest unequivocal evidence for the use of coastal resources by Pleistocene Australians. It has documented that since at least 32,000 years ago the area was occupied by people who were finely adapted to their local environment, who had sophisticated coastally focussed subsistence strategies, and who maintained extensive trading and presumably also socio-economic networks over great distances. The discovery of shell beads dated more than 30,000 years old extends the age of human use of decorative ornaments in Australia to a time comparable with the earliest such evidence from Europe. The archaeological record from midden sites near Coral Bay at the southern extent of the peninsula has provided important evidence for the presence and subsequent decline during the

[1] Although the brief stipulated ethnographic investigation, this report prefers the term anthropology in most cases. Ethnography is a division of anthropology which emphasises empirical description. Anthropological enquiry is more broadly concerned with analysis and interpretation of the facts.

middle Holocene of a more diversified intertidal environment than exists today on this semi-arid stretch of the Western Australian coast (Morse 1993a,b).

From an early stage, the Coral Bay region has been associated in the literature with the Baiyungu[2] peoples. Daisy Bates (1913: 393) reported that a group she called the Baiung was amongst the tribes whose areas were from the Ashburton River south towards the Gascoyne River. Brandenstein (1967) placed a group he identified as the Baiong near Coral Bay, with the Talainji to the north, the Buduna to the east and the Maia and Ingarda to the south. Tindale (1974) placed a group called the Baijungu on the coast from Chabjuwardoo Bay south to Quobba Point, including Coral Bay. The linguist Peter Austin recently worked on the Baiyungu (Payungu) language and noted that:

"*Payungu country stretched from Middalya station in the east, north to Winning station, west to the Indian Ocean at Cardabia, Warroora, Gnaraloo, Quobba, Lake Macleod and east to Minilya and Manberry stations*". (Austin 1992: v).

By the end of the 19th Century, most of the land in the region had been taken up by the pastoral industry, and the original Aboriginal occupants became associated with the pastoral stations in and near their traditional countries. Fry *et al*. (1995:19) observe that relationships between the Aboriginal people and the pastoralists in this region were not always harmonious. Introduced diseases and violence took their toll on the Aboriginal population, which was reduced in number. Turner was told that in the vicinity of Coral Bay, the local people were afflicted by a highly contagious disease that affected whole families (Turner 1985: 21).

Despite the effects of white settlement, however, the Aboriginal people retained their connection to and knowledge of their traditional countries. When Turner (1985) researched the area proposed for the Ningaloo Marine Park, she was able to record 12 sites of cultural significance, including Point Maud near North Bills Bay. Baiyungu people today live on nearby Cardabia Station and at towns in the region like Onslow, Carnarvon and Geraldton.

1.3 REGISTERED ABORIGINAL SITES

The State Register of Aboriginal Sites, which is held in the Aboriginal Affairs Department, was searched for sites recorded within a 5–10 km radius of Coral Bay. Details of 12 sites listed in the Register are recorded in Table 1, below. Sites P01594 and P04352 are outside the area being considered for boat launching facilities. Files relating to the burial sites all note that the possibility of other burial material being present in the area is highly likely. Available ethnographic and ethnohistorical information (Turner, 1985; Rathe, 1990; Scurla, 1996) indicates the significance of this area to Aboriginal people.

1.4 NATIVE TITLE

The Coral Bay region is within an area that is the subject of a native title claim lodged under the *Native Title Act 1993* on 14 April 1997. The claim (WC97/28) was lodged on behalf of the following named claimants: R Crowe, E Edney, R McIntosh & S Crowe, S Dale, M Franklin, L Cooyou & G Cooyou, B Roberts, S Peck, P

[2] The spelling adopted here is used by the Native Title claimants in their application documents. The literature contains variant spellings of the group's name.

Salmon & R Dodd. This claim passed registration testing in July 1999 and mediation commenced in July 2000 and is continuing.

The application was made on behalf of the applicants and 'the Ingarda-Teddei people, the Baiyung and Talangi Peoples, and the Thalgari people as claimants.' As noted above, the documentary sources support the view that the Coral Bay area is the traditional country of the Baiyungu peoples.

Table 1 Registered aboriginal sites

Site No	Site Name	Site Type	Reference
P01594	*Point Anderson–skeleton*	*burial (collected?)*	*Site file*
P02064	Point Maud–skeleton	burial (collected?)	Site file
P04352	*Coral Bay– skeleton*	*burial (collected?)*	*Site file*
P05715	Mauds Landing	burial/ethnographic	Site file
P06132	Coral Bay–skeleton	Burial–stabilised	Site file
P06150	Mulanda Bluff midden	shell midden dated 7210 ± 70 yr BP	Kendrick & Morse (1990)
P06180	Mulanda Site 1	shell midden	Morse & Wright(1989)
P06257	Mulanda Site 2	shell midden	Morse & Wright (1989)
P06258	Mulanda Site 3	shell midden	Morse & Wright (1989)
P06259	Mulanda Site 4	shell midden	Morse & Wright (1989)
P06360	Coral Bay access road FS1	shell midden	Veth & Wright(1989)
P06361	Coral Bay access road FS2	shell midden dated 6270 ± 120 yr BP	Veth (1990)
P07593	Coral Bay TFS3	shell midden	Harris (1996)
P07594	Coral Bay TFS4	shell midden	Harris (1996)

Note: italics = outside survey area

2. FIELD SURVEY

2.1 PRELIMINARY

Prior to beginning field investigations, consultations were held with the Yamatji Land and Sea Council, the representative body for the area under the *Native Title Act 1993*. While it was clear that substantive issues relating to native title could not be dealt with at the level of the PER, it was agreed that the Council would assist the native title claimants in participating in a heritage survey of the possible boat launching sites.

Arrangements were made for a group of Aboriginal people, representing the native title claimants, to meet on location with archaeologist Kate Morse and heritage consultant Philip Haydock, who undertook the field inspections under the supervision of Michael Robinson. It was also agreed that Mr Tony Doulman, the Yamatji Land and Sea Council's anthropologist, would accompany the field party.

After travelling to the area on 7th April 1998, preliminary recording of archaeological sites was undertaken. The main anthropological and archaeological investigation of the area took place on the following day. Further recording took place on 9th April 1998.

The field party, including the Aboriginal consultants[3], met initially at Cardabia Station on the morning of 8th April 1998 and discussed the various development proposals and the survey area. Kate Morse explained that the search for registered sites in the Department of Aboriginal Affairs had provided details of 12 sites within a 10 km radius of Coral Bay, of which five were burial sites. The field party then travelled together to the survey area to carry out inspections.

[3] Mr Sid Dale, Mr Ernie Randall, Mrs Bella Randall, Mr John Dale, Mrs Mary Franklin, Mr Ron Barron and Mr Patrick Peck. Mr Tony Doulman (anthropologist) and Mr Rick Forsyth (YLSC Administration Officer) were also present.

3. METHODOLOGY

To make sensible and reasonable recommendations about archaeological sites, an assessment of the site's significance in scientific terms needs to be made (Fry et al., 1995). The significance of any archaeological site lies in the fact that it is a unique, non-renewable cultural resource, a database for reconstructing the cultural past and for testing propositions about human behaviour. In this context two key characteristics can be used to assess a site's significance: its representativeness and its research potential (Bowdler, 1984). It is important to understand however that what is recognised as archaeologically significant is not fixed in time or space. Archaeological significance is a "*mutable, even transformational quality which changes as the subject changes*" (Bowdler, 1984:1).

Sites of anthropological significance will generally reflect the cultural values placed on them by Aboriginal people. To discover those values, it is necessary to consult with the Aboriginal people who have knowledge about the traditional associations of the area, and who have the authority to speak about it under Aboriginal law. The Aboriginal consultants who accompanied the survey party were well placed to provide information about the significance of any sites in the area as they had lived and worked in the general area and had an intimate knowledge of its cultural features.

Despite the fact that the archaeological and anthropological enquiries had slightly different emphases, it was decided that the two investigations should proceed together.

3.1 MAUDS LANDING

At Mauds Landing an area centred on the existing track and approximately 500 m wide and 300 m back from the foreshore dunes was to be surveyed. Two small shell midden sites (P06180 and P06257) and a soak site (P05715) of ethnographic significance have previously been recorded in this area. The survey team discussed the area and then walked over to inspect the previously recorded sites. A series of transects was walked throughout the area.

3.2 NORTH BILLS BAY

The North Bills Bay site located on the coast at the northern end of Bills Bay. Access to this site is via a winding track through the extensive dune field to the coast. A detailed contour map provided by the Department for Planning and Infrastructure shows the proposed track following the flattest dune contours, but the exact position of the track is not yet finalised. The survey team drove along the proposed access route following a faint vehicle track that runs for part of the way to the Bills Bay site. Navigation of the proposed access route was completed following the contour map. The survey team stopped on a number of occasions to inspect features on the ground.

The proposed Bills Bay development will occur within an area of approximately 400 m^2. A series of parallel transects was walked throughout the area. Additional survey with Aboriginal people was also carried out from the vehicle.

3.3 MONCK HEAD

Monck Head is a small limestone headland to the south of Coral Bay. Development proposals here include a small boat launching ramp and car park, either at Monck

Head itself or at a number of other nearby points to the north. The approximate location of these ramps and the extent of the area to be surveyed was clearly marked on an aerial photograph provided by the Department for Planning and Infrastructure. The survey area includes the limestone headland at Monck Head itself and an area of dunes and tracks extending north for approximately 1.0 km and east some 100–200 m from the shore. The preferred location for car parks associated with the boat ramp is in the flat areas in front of the dunes.

4. RESULTS

4.1 MAUDS LANDING

4.1.1 Archaeology

This area is badly disturbed with vehicle tracks, and littered with a variety of rubbish including car parts, bottle glass, metal sheeting and old tyres. Sid Dale explained that a Main Roads Camp was once located here. Vegetation cover is dense but interspersed with discrete small sandy blowouts. As noted above, two archaeological sites and one ethnographic site have previously been recorded in the vicinity of Mauds Landing. The archaeological sites are midden and artefact scatters located in blowouts in the gently undulating dune landscape on the northern side of the track. Artefacts recorded at these sites include stone flakes, a fragment of basal grind stone and a number of fragments of early-mid 19^{th} Century bottle glass, two of which appear to have been flaked for use as tools. In addition, a variety of shell and other marine faunal material was recorded including a number of large fragments of baler (*Melo* sp.) and clam (*Tridacna maxima*) shell, as well as turtle bone and large bivalve shells. An element of storm beach material including numerous tiny bivalve and shell and coral fragments is present and mixed with archaeological material throughout the survey area (Morse and Wright, 1989).

A background scatter of humanly transported shell material and occasional stone artefacts is present throughout the Mauds Landing area. No new archaeological sites were identified during the survey at Mauds Landing.

4.1.2 Anthropology

The Aboriginal consultants identified Mauds Landing as the Baiyungu named-place Murlanda[4]. Sid Dale showed the group two government soaks and said there was a "stock route" across the area. He estimated that the wells were used until the 1930s. He pointed in the direction of a third government well in the area, but this was not located. He indicated that, as well as being used for stock purposes, Aboriginal people had also taken advantage of the wells as a water source.

It should be noted that Point Maud was identified by Rathe (1990) as a meeting ground for several tribes and a boundary line between northern and southern groups. Scurla (1996: 67) relates that Mauds Landing was the site of a large gathering of Aboriginal people.

Despite its prior associations and significance as an important meeting place, the Aboriginal people did not raise specific objections to a boat launching facility at the location.

[4] The townsite of Mauds Landing was named after the landing of the same name, which was discovered by the Captain of the schooner "Maud" about 1880. The "Maud" was owned by John Bateman of Fremantle, and named after his daughter Maud who was born in 1855. There is a noticeable similarity between the terms "Mauds Landing" and "Murlanda" and this may be a result of Aboriginal pronunciation of an English term.

4.2 NORTH BILLS BAY

4.2.1 Archaeology

The proposed route through the dunes to the North Bills Bay site is not yet finalised. Gary Enston at the Department for Planning and Infrastructure emphasised that the track would aim to follow the flattest route through the dunes avoiding sharp curves and tight corners. One archaeological site (Field Site CBFS1), a soak largely filled with vegetation and blown sand, was recorded in a deep blowout that will be cut through by the proposed track. A very sparse scatter of archaeological material extends over an area of 50 m north–south and 30 m east–west around the soak. Marine shells and fragments including baler shell (*Melo* sp.), oyster (*Saccostrea* sp.) turban (*Turbo* spp.) and pyramid shell (*Tectus pyramis*) are located around the soak amidst a group of sandalwood trees. At a distance of at least 400 m to the nearest shoreline, these shells have clearly been humanly transported to the soak. Baler shell is well known for its use as a water-carrying dish. No stone artefacts were recorded, but a single piece of rusty copper suggests the site was known about and perhaps used in historical times as well as in times past.

A series of parallel and zig-zag transects was walked throughout the proposed car and trailer park areas and access roads to the beach at North Bills Bay itself. Very dense coastal vegetation extends back from the beach itself a distance of some 20–25 m. Behind this are a series of low undulating partially vegetated dunes. Occasional large fragments of baler shell were noted in exposed sandy areas immediately behind the dunes. In the proposed car and trailer park areas fragments of baler shell and a number of bivalve shells were noted. One stone artefact, a broken silcrete flake, was recorded.

The coastal hinterland at Bills Bay is disturbed and has been grazed by sheep and goats. Available evidence suggests that a background scatter of archaeological material is present throughout the flat area behind the dunes. Further disturbance and continuing dune erosion is considered likely to expose additional archaeological material.

4.2.2 Anthropology

The Aboriginal consultants were present during the archaeological inspection of this site but did not identify the location as having any separate cultural significance.

4.3 MONCK HEAD

4.3.1 Archaeology

Archaeological material is present throughout the Monck Head area. The largest single exposure of midden material (CBFS2) is in a steep elongated north–south tending blowout some 60 m east of the southern corner of this small limestone headland. Midden material including numerous stone artefacts and at least seven species of marine molluscs, turtle bone and shell fragments, sea urchin, crab carapace and fish bone extends over an area of approximately 40 x 20 m.

A series of small sample squares, positioned to reflect the changing density in archaeological material across the blowout, was recorded. Due to the large numbers of broken and largely unidentifiable shell and bone fragments within each sample square, a 10 cm x cm sample of unidentified fragments was counted within the sample square to provide a further indication of the density of archaeological material. In addition, a number of stone artefacts outside the sample squares were selected and measured. These were chosen on the basis of type of stone material.

Some 5 m east of the blowout site a vehicle track cuts along the western edge of a large partially vegetated dune. Archaeological material including marine shell, stone artefacts and bone fragments, is eroding out of the edges of the track and is visible in exposed sandy patches and small blowouts in the dune surface. This pattern of archaeological visibility continues throughout the Monck Head survey area. Midden material was noted in small sandy blowouts and eroding from the edges of tracks over an area of at least 750 m north east of Monck Head and at least 250 m from the shore. The extent of material exposed is clearly a function of local disturbance and erosion. Immediately adjacent to the shoreline itself, storm beach material is also present and mixed with midden material. On several large flat limestone platforms located inland some 50 m from the shore, marine shells and stone artefacts are lightly cemented *in situ* in sandy pockets in the limestone surface. The occurrence of archaeological material clearly parallels the presence of small onshore rocky platforms. It is unknown, but presumed almost certain, that further archaeological material will be found south of Monck Head where onshore platforms occur.

The presence of Terebralia sp. shells on the Monck Head sites (Table 2) is worthy of note. Terebralia (*Terebralia sulcata* and *Terebralia palustris*) are mangrove gastropods and are strictly associated with soft substrates of the intertidal mangrove environment of tropical Australia (Wells, 1980). Mangrove systems typically form as fringes along tidal estuaries on relatively sheltered coasts. Today the nearest known population of both *Terebralia palustris* and *Terebralia sulcata* is in the Bay of Rest in Exmouth Gulf, and there is an outlier of *T. sulcata* at the mouth of the Gascoyne River, over 200 km south of Coral Bay. It seems unlikely that at the time the Monck Head was occupied, these species would have been transported over 200 km to the site, when other edible molluscs were available locally. This factor, together with evidence from several other dated midden sites near Coral Bay points to the existence of mangroves at or near the Monck Head site during the early-middle Holocene.

Table 2 Midden material recorded in sample squares Monck Head site CBFS2. SS - sample square

MARINE SPECIES	SS1 50 x 50cm	SS2 50 x 50cm	SS3 30 x 30cm	SS4 30 x 30cm	SS5 50 x 50cm
Melo sp.	4	3		2	4
Turbo spp.		2		1	2
Nerita sp.		4		2	3
Terebralia sp.		1	1		3
Tectus sp.	2				
Tridacna sp.				1	
Accanthopleura sp		4	1		1
Unident. frags	31	25	4	60	21
Turtle	20	14	22	19	17
Fish					1
Crab/Sea urchin					1

Three other sites in or near Coral Bay provide similar evidence. At Mulanda Bluff midden, located on a small but distinctive limestone feature on the eastern margin of an extensive hypersaline evaporation pan at Coral Bay, shell material is predominantly of mangrove affiliation and includes both species of Terebralia and oysters of the genus Saccostrea which attach to intertidal rocks, other shells or mangroves. The second site, located along the crest and upper slopes of a red siliceous dune on the southern margin of the evaporation pan some 3 km south west of Mulanda Bluff, consists of a scatter of stone artefacts and marine and mangrove shells including Terebralia sp. Samples of Cerebralia sp. shell from both sites have yielded radiocarbon ages of 7210 ± 70 yr BP (Wk1429) for Mulanda Bluff and 6270 ± 120 yr BP (Wk 1728) for the Coral Bay dune site (Kendrick and Morse, 1990; Veth, 1990).

The third site, Warroora midden, located on pastoral land in the southern reaches of Ningaloo Marine Park, is a surface scatter of marine and mangrove gastropods, bivalves, fish, crab and turtle bone, located today on an inland cliff, some 300 m from the present coast. A sample of marine shell collected *in situ* from the site surface yielded a radiocarbon age of 7810 ± 110 yr BP (SUA, 1735; Kendrick and Morse, 1982).

Morphostratigraphic evidence from pollen cores taken in northern Australia and South East Asia indicates that in response to changes in Holocene sea levels and sedimentation rates, extensive mangrove swamps developed and flourished during the middle Holocene for approximately 1000 years (Woodroffe *et al.,* 1985; 1988; Allen, 1987). Accumulating geomorphological, palaeontological and archaeological evidence from the North West Cape region suggests that as middle Holocene sea levels stabilised, mangroves were a more common environmental feature of the western margin of the peninsula, than they are today. Investigations indicate that the present-day evaporation pan at Coral Bay is a palaeolagoon that supported a thriving mangrove environment for at least 2200 years prior to about 5000 years ago (Kendrick and Morse, 1990). The adverse effects of coastal progradation together with the somewhat regressive nature of later Holocene sea level (Chappell *et al.,* 1983) effectively cut off this mangrove community from the sea and ultimately caused the decline and eventual disappearance of this coastal ecosystem.

The occurrence of Terebralia sp. in the Monck Head midden sites, suggests that radiocarbon dating of this site would yield a middle Holocene age. It also contributes to the growing body of evidence that at times in the past mangroves and a greater diversity of littoral to shallow sublittoral habitats were present on the western margin of the Cape Range Peninsula (Kendrick and Morse, 1982; 1990).

The pattern of artefactual material recorded at the Monck Head site supports this interpretation. As shown in Table 3, the stone artefact assemblage is dominated by small chalcedonic flakes. The only tool recorded is an adze. The majority of this material is made on brown and grey chalcedony which probably derives from Tertiary sediments located within the Carnarvon Basin. The extent of reduction evident on the adze material and the small size (<15 mm in length) of the chalcedonic flakes suggests that this stone source has been carefully curated and that the manufacture and maintenance of stone and wooden artefacts has taken place on site. A similar pattern is recorded at other mangrove-associated sites in the Cape Range region (Morse, 1993a and 1993b).

Mangrove wood is well documented in the Kimberley region of Western Australia, for its use in making log rafts, and is also recorded as being used to make fishing boomerangs (Smith and Kalotas, 1985). Given the sparsity of other wood sources in the almost treeless coastal environment, mangrove timber may also have been used to make some of the many other wooden artefacts used by Aboriginal people.

4.3.2 *Anthropology*

The proposed development site was investigated by the Aboriginal consultants and Philip Haydock while the archaeological inspection was taken place. No Aboriginal name for the location was known and people did not believe that the area had any separate cultural significance, apart from the archaeological evidence of its prior use.

Table 3 Stone artefacts recorded in sample squares Monck Head site CBFS2. SS - sample square, SM - selected and measured outside sample square

SS	ARTEFACT TYPE	RAW MATERIAL	Length (mm)	Width (mm)	Thickness (mm)	COMMENTS
SS1	broken flake	chalcedony	10	10	1	flat platform
SS2	broken flake	chalcedony	7	15	1	flat platform
SS2	broken flake	chalcedony	15	6	2	
SS3	flake	chalcedony	12	14	2	flat platform
SS3	broken flake	chalcedony	17	9	2	
SS4	flake	chalcedony	7	7	3	crushed platform
SS5	broken flake	chalcedony	17	20	2	flat platform
SS5	broken flake	chalcedony	12	15	2	crushed platform
SS5	Tula adze slug	chalcedony	14	22	10	65% undercut/ worked edge
SS5	Broken flake	calcrete	15	25	4	flat platform
SM	Flake	chalcedony	19	13	3	flat platform
SM	core fragment	chalcedony	12	20	10	4 flake scars
SM	flake	chalcedony	15	12	1	crushed platform
SM	flake	silcrete	12	17	3	gullwing platform
SM	flake	chalcedony	20	10	2	faceted platform
SM	core	chalcedony	12	16	11	5 flake scars
SM	flake	chalcedony	12	12	1	crushed platform

5. POTENTIAL IMPACTS

5.1 MAUDS LANDING

The development of boating and car park facilities at Mauds Landing will disturb two previously recorded archaeological sites and one ethnographic site. As noted above however, the Mauds Landing area is already substantially disturbed. Archaeological sites in this region have been adequately recorded and are considered to be of low archaeological integrity and significance. It is possible that further archaeological material and/or buried skeletal material may be exposed in the coastal dune area once ground disturbance is underway.

5.2 NORTH BILLS BAY

Site CBFS1 is located directly in the line of the proposed track access to the North Bills Bay car and trailer parking facilities. This site has been adequately recorded and is considered to be a low archaeological significance. However Aboriginal people with a direct historical link to the area stressed that this site should be avoided and an alternative route through the dunes should be found.

A main concern for the North Bills Bay site is that disturbance caused during construction of an access track to the boating facility will initiate erosion of the coastal dunes and may expose buried skeletal material. Construction of a boating facility and car and trailer parks will increase visitor access to coastal areas that are currently little used. In this context, the potential exists for uncovering additional Aboriginal sites, particularly skeletal material in the Holocene dunes.

5.3 MONCK HEAD

The Monck Head midden has already been disturbed and site integrity destroyed in part by recreational use of the Monck Head area and the development of four wheel drive tracks. New tracks and the continuing destruction of parts of the site closest to the coast is ongoing, predominantly through the tourist and local use of large three wheel motorbikes to access fishing areas. Development of boating facilities and car and trailer parks in this region will accelerate erosion, disturbance and ultimately destroy this site. Visitor use of the Monck Head area will increase and while good clearly marked tracks may limit destruction to off-track areas, the establishment or widening of tracks will increase disturbance and destruction of this site. Disturbance in dune areas, through active ground working or from accelerated dune erosion resulting from ground working, has the potential to expose buried skeletal material as well as further archaeological material.

6. MITIGATION MEASURES

6.1 MAUDS LANDING

Development should focus on the eastern side of the track to avoid disturbing old government soaks including site P05715.

6.2 NORTH BILLS BAY

The track should be realigned to avoid disturbance of the soak site (Site CBFS1).

6.3 MONCK HEAD

Tracks should be clearly marked to minimise off-track usage. Signs should also be installed to warn people not to ride in the dunes. The use of three wheel, wide base motorbikes should be discouraged by the placing of appropriate signs about dune stabilisation and erosion. No mention of the existence of the midden site should be made.

7. RECOMMENDATIONS

7.1 MAUDS LANDING

- It is recommended that Aboriginal people from the Yamatji Land and Sea Council be present during all ground disturbing work undertaken as part of the development of boating and car park facilities at Mauds Landing;
- If development is to go ahead at Mauds Landing the developer will need to apply under Section 18 of Aboriginal Heritage Act 1972 to disturb recorded archaeological sites P06180 and P06257;
- Ethnographic site P05715 should be avoided;
- If P05715 cannot be avoided, the developer will need to apply under Section 18 of Aboriginal Heritage Act 1972 to disturb it;
- Extreme care should be taken to avoid disturbance to Aboriginal burials during all ground disturbing activities; and
- Old government soaks should be avoided, as they are an important historical resource for Aboriginal people.

7.2 NORTH BILLS BAY

- It is recommended that Aboriginal people from the Yamatji Land and Sea Council be present during all ground disturbing work undertaken as part of the development of boating and car park facilities at North Bills Bay; and
- It is recommended that the road alignment be modified to avoid disturbance of the identified soak.

7.3 MONCK HEAD

- It is recommended that Aboriginal people from the Yamatji Land and Sea Council be present during all ground disturbing work undertaken as part of the development of boating and car park facilities at Monck Head; and
- Only part of the Monck Head site (CBFS2) has been recorded. This extensive, probably middle Holocene midden site is considered to be archaeologically significant. It is recommended that further detailed documentation (including radiocarbon dating) and possible salvage of this site should be undertaken. Further inspection of areas to the south of Monck Head should be undertaken as part of this field recording.

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TECHNICAL APPENDIX 7
CORAL BAY BOATING FACILITY
CONSULTATION WITH LOCAL AND STATE GOVERNMENT AGENCIES, INTEREST GROUPS AND LAND OWNERS

Prepared for:

DEPARTMENT OF TRANSPORT

Prepared by:

ENVIRONMENTAL ADVISORY SERVICES

AUGUST 2002

REPORT NO. 97/050/28

CONTENTS

TABLES

APPENDICES

EXECUTIVE SUMMARY

The primary purpose of the following study was to provide an opportunity for the proponent and organisations that were known to have an interest or relevant expertise, to exchange information and express their views and concerns regarding the proposed construction of a boating facility at Coral Bay. A secondary objective was to focus the study on reasonable alternatives and relevant issues to ensure that the resulting environmental impact assessment was relevant to the decision maker.

To facilitate the exchange of information regarding the proposed Coral Bay boating facility 33 different organisations, mainly government agencies with jurisdictional interests in the Coral Bay area and private and community organisations with vested interests in Coral Bay, were contacted by letter.

The issues raised during the scoping exercise were:

- The need for a small scale boating facility at Coral Bay is widely supported;
- There has been support for the establishment of a boating facility for recreation and charter boats at Mauds Landing for the past 13 years;
- There is still a difference of opinion over where the facility should be sited. Generally speaking, government agencies favour Mauds Landing whereas the ratepayers and residents of Coral Bay favour Northern Bills Bay. Reasons include its suitability in terms of factors such as protection from wind and weather, ease of mooring, direct visibility from Coral Bay and access to the North Passage;
- The scale of the facility being proposed was much greater than they had anticipated. Most people thought that a boat ramp and service/fuelling jetty would suffice;
- There was strong concern that pollutants originating from the facility would adversely affect Bills Bay, particularly if located at Monck Head due to the prevailing northerly currents;
- A fourth site for the proposed facility, namely the blow out area in Skeleton Bay, may warrant closer investigation;
- The Baiyungu peoples and others have lodged a native title claim over an area which includes the proposed boat launching facilities at Coral Bay; and
- To maintain and protect the natural resource base of Coral Bay, upon which the livelihood of many people currently depends, there is a need to address and improve upon the wide range of existing environmental management problems in the area.

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1. INTRODUCTION

Due to the increase in boating activity in the Coral Bay region there is a need for a boating facility. The Department for Planning and Infrastructure (DPI—formerly Department of Transport) is presently investigating the development of a boating facility which aims to remove all boating activity (except glass bottomed tour boats) from the southern end of Bills Bay. It is anticipated that this relocation of boating activity will help to minimise the physical damage to the coral formations, reduce the risk of fuel spills and increase the safety of swimmers in the southern end of Bills Bay.

To determine the views of the major interest groups a scoping study was conducted to:

- Enable an opportunity for the proponent, his consultants, the decision making authorities and interested and affected parties to exchange information and express their views and concerns regarding the proposed boating facility before an environmental impact assessment was undertaken; and
- Focus the study on reasonable alternatives and relevant issues to ensure that the resulting impact assessment is relevant to the decision maker.

2. SCOPING PROGRAMME

As stakeholder consultation is an important component of a Public Environmental Review (PER), the main aims of the consultation programme devised to satisfy this requirement were to establish who should be consulted; to decide on how they should be informed; and to ensure that sufficient background information was provided to assist Interested and Affected Parties (I&APs) to comment constructively and from an informed position during the course of the scoping exercise.

During the course of preparing the Notice of Intent (NOI) (DAL, 1997) the authorities listed in Section 2.1, below, were contacted by letter by Mr C. Flottmann (Manager New Development) of the DPI over the period 26 September to 29 October 1997.

Other than in the case of the local aboriginal community, representatives of whom were contacted directly by Michael Robinson & Associates over 7–9 April 1998 (see Section 2.3), and the owners of the Cardabia Station who were contacted by mail on the 27 March 1998, the authorities and interest groups listed in Sections 2.1 and 2.2 below were all contacted by letter on 11 March 1998 (**Appendix A**). In addition, personal interviews were conducted with as many persons as possible during the course of a field trip to Coral Bay in March 1998.

2.1 INVOLVEMENT OF DECISION MAKING AUTHORITIES (DMA'S)

Seventeen local and regional authorities, mainly government agencies with jurisdictional interests in the Coral Bay area, were contacted. These were:

- Shire of Exmouth;
- Shire of Carnarvon;
- Ministry for Planning (MFP);
- Gascoyne Development Commission (GDC);
- Office of Water Regulation (OWR);
- Department of Environmental Protection (DEP);
- Western Australian Tourism Commission (WATC);
- Fisheries Department of Western Australia (FDWA);
- Department of Conservation and Land Management (CALM);
- Australian Institute of Marine Science (AIMS);
- Western Australian Museum (WAM);
- Department of Resources Development (DRD);
- Department of Land Administration (DOLA);
- Australian Heritage Commission (AHC);
- National Native Title Tribunal (NNTT);
- National Parks and Nature Conservation Authority (NPNCA); and
- Marine Parks and Reserves Authority (MPRA).

2.2 INVOLVEMENT OF INTERESTED AND AFFECTED PARTIES

Sixteen private and community organisations with vested interests in the Coral Bay area were contacted and, where possible, representatives of these organisations were interviewed during the course of a field trip in March 1998. The latter are shown in **bold** in the list given below.

The I&APs involved in the study included:

- Carnarvon Tourist Bureau;
- Exmouth Tourist Bureau;
- Cape Conservation Committee;
- Conservation Council of Western Australia;
- **Coral Bay Adventures** (*Mr Doug Hunt*);
- Coral Bay Accommodation;
- **Coral Bay Hotel** (*Messrs Mark Privet and Bill Gibbings*);
- **Glass Bottomed Boats** (*Mr Ken Bailye*);
- **Yamatji Land and Sea Council**;
- **Coral Bay Backpackers and Ningaloo Reef Resort** (*Mr Bill Gibbings*);
- **Bayview Holiday Village** (*Dr W R Brogan*);
- **Ningaloo Reef Dive** (*Mr David Hall*);
- Coral Coast Marina Development;
- Dominator Fish Charters;
- Peoples Park Caravan Village; and
- The Manager of the **Cardabia Station** (*Mr Ron Barron*).

2.3 INVOLVEMENT OF NATIVE TITLE CLAIMANTS

The following section is drawn directly from Michael Robinson & Associates, 1998.

"*Prior to beginning field investigations, consultations were held with the Yamatji Land and Sea Council, the representative body for the area under the Native Title Act 1993. While it was clear that substantive issues relating to native title could not be dealt with at the level of the PER, it was agreed that the Council would assist the native title claimants in participating in a heritage survey of the possible boat launching sites.*

Arrangements were made for a group of Aboriginal people, representing the native title claimants, to meet on location with archaeologist Kate Morse and heritage consultant Philip Haydock, who undertook the field inspections under the supervision of Michael Robinson. It was also agreed that Mr Tony Doulman, the Yamatji Land and Sea Council's anthropologist, would accompany the field party.

After travelling to the area on 7 April 1998, preliminary recording of archaeological sites was undertaken. The main anthropological and archaeological investigation of the area took place on the following day. Further recording took place on 9 April 1998.

The field party, including the Aboriginal consultants, met initially at Cardabia Station on the morning of 8 April 1998 and discussed the various development proposals and the survey area. Kate Morse explained that the search for registered sites in the Department of Aboriginal Affairs had provided details of 12 sites within a 10 km radius of Coral Bay, of which five were burial sites. The field party then travelled together to the survey area to carry out inspections.

The Aboriginal consultants identified Mauds Landing as the Baiyungu-named place Murlanda. Sid Dale showed the group two government soaks and said there was a 'stock route' across the area. He estimated that the wells were used until the 1930s. He pointed in the direction of a third government well in the area, but this was not located. He indicated that, as well as being used for stock purposes, Aboriginal people had also taken advantage of the wells as a water source.

It should be noted that Point Maud was identified as a meeting ground for several tribes and a boundary line between northern and southern groups.

Despite its prior associations and significance as an important meeting place, the Aboriginal people did not raise specific objections to a boat launching facility at the location."

3. MEETINGS WITH LEAD GOVERNMENT AGENCIES

In addition to the writing of letters, several meetings were held with lead government agencies. The dates, attendees present and matters discussed at these meetings are summarised below.

3.1 MEETING WITH DEPARTMENT OF ENVIRONMENTAL PROTECTION (DEP)

Date: 4 February 1998

Venue: DEP offices, Perth

Attendees: Felicity Bunny (DEP)
Gary Enston (DPI)
Des Lord, Bruce Hegge (DAL)
George Begg (EAS)

Matters discussed:

- DEP's concern over development in the Maud Sanctuary Zone and preference for Mauds Landing as a site for the facility;
- DPI's s proposed combination of a larger facility at Mauds Landing and a small boat ramp at Monck Head;
- DEP's requirement for details concerning the forecasted usage of the facility, the source of the limestone needed for the breakwater and management plans for each of the three sites; and
- DEP's guidelines for the preparation of the PER.

3.2 MEETING WITH THE NATIONAL PARKS AND NATURE CONSERVATION AUTHORITY (NPNCA)

Date: 13 February 1998

Venue: CALM offices, Crawley

Attendees: MPRA members
Gary Enston (DPI)
Des Lord, Bruce Hegge (DAL)
Bruce Walker (CEO, Shire of Carnarvon)
Caz Muntz (Councillor)

Matters discussed:

- NPNCA's preference for Mauds Landing as a site for the facility;
- The Minister for Tourism's support for the Mauds Landing site in conjunction with a tourist resort;
- Concern over the likelihood of fuel spills from Monck Head drifting northwards into the swimming area of Southern Bills Bay;
- With the timing of a commercial facility at Mauds Landing being unknown, the need for action of some description within a period of 18 months; and
- The question of cost recovery from the facility.

3.3 MEETING WITH CORAL BAY TASK FORCE

Date: 13 February 1998

Venue: Ministry for Planning , Perth

Attendees: Doug Bathgate (GDC)
Jim Williamson (Department of Conservation and Land Management)
Bruce Walker (Shire of Carnarvon)
Caz Muntz (Councillor)
Derek Perez (Office of Water Resources)
Cleve Flottmann, Gary Enston (DPI)
Bruce Hegge (DAL)

Matters discussed:

- Merits of installing a boat launching ramp at Monck Head as soon as possible to alleviate pressure of small dinghies at southern Bills Bay and providing a larger development at Mauds Landing to cater for the larger commercial craft;
- The Shire of Carnarvon not wanting a 'temporary fix';
- DPI expressed concern over the possible unavailability of funds for development of the facility at Mauds Landing;
- General support for the comparative evaluation of all three sites; and
- The understanding that there was Government support for the Mauds Landing site.

3.4 MEETING WITH THE MARINE PARKS AND RESERVES AUTHORITY (MPRA)

Date : 2 April 1998

Venue: CALM offices, Fremantle

Attendance: Full Committee, Barry Wilson (Chair)
Gary Enston (DPI)
Bruce Walker (Shire of Carnarvon)
Des Lord, Bruce Hegge (DAL)
George Begg (EAS)

Matters discussed:

- The discrepancy between the position of the Maud Sanctuary Zone boundary on the hydrographic chart and that shown in the Ningaloo Marine Park Management Plan. The MPRA advised that the study team should work on the basis that the official boundary was that demarcated in the Ningaloo Marine Park Management Plan (a matter subsequently confirmed in writing by Mr Jim Sharp, Director of Parks, Recreation, Planning and Tourism);
- The MPRA's views that as the Maud Sanctuary Zone had been established primarily for the protection of marine life and had a long history of non-exploitation, that it should remain that way;
- The MPRA's preference for establishing the facility at Mauds Landing as it was outside the Maud Sanctuary Zone; well away from the

swimming/snorkelling area; had good access to the north passage and had better long term prospects for other forms of tourist related developments;

- The merits of building a launching ramp for dinghies at Monck Head; and
- Evidence of the regrowth of the coral at Northern Bills Bay since the mortalities reported on in 1989.

3.5 MEETING WITH CORAL BAY TASK FORCE

Date: 5 May 1998

Venue: Ministry for Planning , Perth

Attendees: Doug Bathgate (Gascoyne Development Commission, Chairman)
Jim Williamson (CALM)
Bruce Walker (Shire of Carnarvon)
Cleve Flottmann, Gary Enston (DPI)
Gary Casey, Sylvia Chan (Office of Water Regulation)
Adrian Vlok (DEP)
Ken McCracken (DOLA)
Bart Boelen (Office of the Minister for Tourism)
Eugene Ferraro, Jane Passarelli (MfP)
Des Lord, Bruce Hegge (DAL)
George Begg (EAS)

The meeting took the form of a brief presentation made by Dr Des Lord who outlined the findings of the PER, i.e. that of the three sites examined, no single option would satisfy all needs; that Mauds Landing was well suited as a site for the larger craft that needed to be catered for, whereas Monck Head was well suited to the launching and retrieval of small, trailerable boats (dinghies); that there was scope at Northern Bills Bay and Monck Head for reducing the scale of the facility by replacing the proposed breakwater with a jetty; and that the cultural significance of the Monck Head area was high.

Matters discussed:

- Approximate costs of construction ($4M for the Mauds Landing facility and $0.4M for a ramp at Monck Head)
- Whether the construction of a boat ramp and jetty within the Maud Sanctuary Zone was precluded in terms of the Ningaloo Marine Park Management Plan; and
- How charter boats would be catered for in the event of a boat ramp being built at Monck Head that was suitable only for the launching of dinghies.

4. RESULTS

4.1 PUBLIC ATTITUDES TOWARDS THE CONSTRUCTION OF BOATING FACILITIES IN 1988

In 1988 the draft Management Plan for the Ningaloo Marine Park which recommended that "*recreation and charter boating should be based at Mauds Landing where boat ramps, car parks and public facilities should be provided*" was circulated for comment (May & Albone, 1988).

Judging from the submissions received by CALM those considered to be of direct relevance to the study, i.e. the issues raised by the public concerning matters such as the provision of moorings, the construction of groynes, breakwaters and boat ramps in the Ningaloo Marine Park, are highlighted below:

- **Attitudes towards the establishment of moorings** (number of submissions = 8).

  Several respondents were clearly opposed to the idea of any moorings in sanctuary zones; others supported the idea because moorings had the potential to prevent coral damage; while others felt there should be no moorings for private boats, but moorings for commercial vessels only.

- **Attitudes towards the establishment of groynes and breakwaters** (number of submissions = 3).

  Several respondents objected to the construction of breakwaters in the Park; while others felt that the construction of breakwaters in the Park should be permissible only at Mauds Landing.

- **Attitudes towards the establishment of boat ramps** (number of submissions = 14).

  Several respondents were clearly opposed to the construction of any boat ramps in the Park on the grounds that facilities of this nature would lead to the depletion of fish stocks; others felt that a boat ramp should be provided only at Mauds Landing; and others were opposed to the establishment of ramps for large boats as the latter would lead to overfishing in the area.

4.2 WRITTEN RESPONSES FROM DECISION MAKING AUTHORITIES (DMA'S)

The following DMAs provided written responses (in order of reciept of first correspondance):

- Australian Heritage Commission (**Appendix B**);
- Western Australian Tourist Commission (**Appendix C**);
- National Native Trust Tribunal (**Appendix D**);
- Fisheries Department of Western Australia (**Appendix E**);
- Office of Water Regulation (**Appendix F**);
- Department of Environmental Protection (**Appendix G**);
- National Parks and Nature Conservation Authority (**Appendix H**);
- Department of Conservation and Land Management (**Appendix I**);
- Marine Parks and Reserves Authority (**Appendix J**);

- Department of Land Administration (**Appendix K**);
- Gascoyne Development Commission (Appendix L); and
- Ministry for Planning (Appendix M).

4.3 ISSUES RAISED BY DECISION MAKING AUTHORITIES

Generally speaking, all of the DMAs consulted were supportive of the proposed relocation of the current boating activity away from the southern end of Bills Bay.

The issues raised by the above-mentioned DMAs included the following:

- The need to ensure that Aboriginal heritage values are assessed in consultation with relevant Aboriginal communities;
- Confirmation of the existence of a native title claim over the Coral Bay area;
- The need to ensure that the national estate values of the Ningaloo Reef are considered;
- The advisability of locating the facility <u>outside</u> the Maud Sanctuary Zone because of localised, potentially negative impacts on benthic organisms, fish habitat, coral formations, seabird roosting and sediment movement; as well as the fact that the facility would require an amendment to the Ningaloo Marine Park Management Plan;
- The need for the marking of access channels through the reef for boat users;
- The need for the ongoing education of the boating public through signs and licensing conditions;
- The need for identification of the agency responsible for ongoing maintenance of the facility;
- The need for the preparation of a management plan which addresses issues such as rubbish removal and wastewater handling;
- The need for the provision of fish cleaning facilities, public toilets, car and coach parking;
- The need for careful consideration of aesthetic issues at the design stage;
- The need for the provision of power to enable lighting of the facility and the undertaking of minor boat repairs at the site;
- The need for the rights and interests of the current licensed water and/or sewerage services provider for Coral Bay to be taken into account;
- The need to ensure that establishment of the proposed boating facility does not conflict with the proposal by Coral Coast Marina for development of a resort at Mauds Landing;
- The increased compliance issues that will be associated with the development of a small-scale boating facility at Coral Bay from a fisheries management viewpoint;
- The undesirability of creating road access through the dunefields inland of North Bills Bay;
- Confirmation that the fuel spill modelling appears to be technically sound;
- Description of the process required for amending the Ningaloo Marine Park Management Plan;
- Strong support for the North Bills Bay site was expressed by the Gascoyne Development Commission and the Ministry for Planning in keeping with the recommendations of the Coral Bay Task Force report on infrastructure requirements for Coral Bay from December 1996; and

- The issue of saftey should be given due weight in the PER.

4.4 WRITTEN RESPONSES FROM I&APS

The following I&APs provided written responses:

- Bayview Coral Bay (representing the interests of Coral Bay Lodge; Holiday Village; Caravan Park; Arcade and Backpackers) (**Appendix L**);
- Glass Bottomed Boats (**Appendix M**); and
- Ningaloo Reef Resort (**Appendix N**).

The issues raised are summarised in **Table 1** in Section 4.6.

4.5 SUMMARY OF VERBAL RESPONSES FROM I&APS

During the course of the study a number of informal interviews were held with five I&APs. The views expressed are summarised as follows:

4.5.1 Coral Bay Adventures (Mr Doug Hunt)

- Monck Head was not favoured because the reddish coloured soil in the area would result in turbidity from the car park during periods of runoff and, in the event of a fuel spillage, pollutants would drift into Bills Bay;
- Northern Bills Bay was better suited to the establishment of a boating facility because the corals in the immediate area are in a poor condition. While anchors do not hold in the area because of the hard bottom, the site is sufficiently well protected to not require the construction of a breakwater. Initially, all that was considered necessary was a launching ramp and finger jetty with flexible sheeting hanging beneath it to suppress wave action;
- Charter boat operators will not want to moor their boats at Mauds Landing because, being out of the sight of the public visiting Coral Bay, the site would not be conducive to trade; and
- Typically 4–5 litres of fuel are spilt each week at the present boat launching site and the washing out of ice boxes by commercial fishermen that presently operate out of Coral Bay also pollute the water. In the past, the hand-feeding of fish with excessive amounts of bread, had similar effects.

4.5.2 Coral Bay Hotel (Messrs Mark Privet and Bill Gibbings)

- In the interests of security the facility should be visible from Coral Bay and because of the inexperience of the majority of the persons launching boats at Coral Bay, the more sheltered the site was the better. Consequently, Northern Bills Bay had the best potential.

4.5.3 Ningaloo Reef Dive (Mr David Hall)

- Northern Bills Bay was the best site for locating the proposed facility because of the substantial protection offered by Point Maud from wind and waves and the good access to the North Passage. However, with the wind blowing from the south, the retrieval of boats onto a trailer could be difficult;
- Mauds Landing was out of the question because of the large swells, soft erodible beach, environmental fragility and the highly valued marine species associated with the site such as nesting turtles, dugongs and manta rays. For

this reason the permission granted to allow jet skis to operate in the area was unwise;

- Monck Head would require upgrading of the existing road, a lot of work on the cliffed foreshore and, with a sandbar offshore, was too shallow; and
- It was noted that D. Hall patrols the beach as far as Oyster Bridge twice a day to check on turtle nests. However, he recognises that without adequate controls in the area, hire bikes and four wheel drive vehicles are having an adverse affect on dunes and beaches. The need for law enforcement was overdue.

4.5.4 Coral Bay Supermarket (Mr Caz Muntz)

- The facility must offer the same degree of protection as the present launching site. However, with the question of sewage treatment having finally been resolved a large influx of people, boats (including charter boats) and increased demand for water-based recreation can be expected in the very near future. Therefore a delay caused, for example, by the prohibitively high costs of siting the facility at Mauds Landing must be avoided;
- Because of the long distance from Coral Bay the pressure for further forms of development at Northern Bills Bay was a worrying aspect; and
- Monck Head is particularly attractive as a site for the launching and retrieval of dinghies because over 80% of dinghy owners travel south to fish in the Five Fingers area, south of the Maud Sanctuary Zone. Boats returning in the afternoon would also have the advantage of a following sea behind them.

4.5.5 Bayview Coral Bay (Dr W F Brogan)

- Mauds Landing was unsuitable as a site for the facility because of the high wave energy, the mobility of the coastline and the high costs (expected to be in the order of $15 million);
- Monck Head was unsuitable because of the difficulty of establishing moorings and the threat of fuel spills;
- In order to limit the pressure that too many people would exert on the environment, the establishment of a large facility was undesirable. The maximum carrying capacity of Coral Bay should be set at 3,000 people;
- On two occasions in the past jetties built in Southern Bills Bay have been destroyed by storm waves;
- A breakwater was not required at Northern Bills Bay and road access to the site from the airstrip could be feasible. There was also no reason why the site chosen in Northern Bills Bay could not be moved southwards;
- If technically feasible, the idea of locating the facility at Skeleton Bay was most attractive. In the past, boats as large as 38 feet long have been able to negotiate the entrance into Skeleton Bay;
- To the best of his knowledge the coral structures in the vicinity of Northern Bills Bay have been 'dead' since 1973.
- The idea of a split facility had no merit from an environmental point of view.

4.6 SUMMARY OF THE ISSUES RAISED DURING THE COURSE OF THE SCOPING STUDY

A summary of the issues raised during the course of the scoping study is presented in **Table 1**.

Table 1 Summary of the issues raised during the course of the scoping study

ISSUE RAISED	B	C	D	E	F	G	H	I	J	K	L	M	N	int
GENERAL ISSUES														
National estate value of Ningaloo Marine Park	*													
Aboriginal heritage values	*		*											
Existing Native title claim over area			*							*				
Marking of access channels		*						*				*	*	
Continued education of the boating public		*										*		
Responsibility for ongoing maintenance of the facility		*												
Waste disposal		*												
Aesthetic impacts		*												
Lighting of the facility		*												
Rights of licensed services provider					*									
Possible conflict with the Coral Coast Marina										*				
Increased need for compliance with fisheries regulations				*										*
Undesirability of creating two separate facilities												*		*
Need to limit the tourist population of Coral Bay												*		*
NORTHERN BILLS BAY														
Lack of and difficulty of road access							-	-			-			
Poor condition of coral formations											+			
Protection from wind and waves											+			
Visibility from Coral Bay											+			
Designation of area as a Sanctuary Zone				-		-		-	-					
Proximity to seabird roost at Point Maud							-	-			?			?
Amendment of Ningaloo Marine Park Management Plan								-	-					?
Subsequent precedent for further development														-
Accretion of marine sediments							-							
Nursery ground for reef sharks							-				?			?
MONCK HEAD														
Risk of pollution in Bills Bay due to current direction												-	-	-
Access to grounds south of Maud Sanctuary Zone														+
Existing road access							+				+			+
Non-visibility from Coral Bay											-			
Proximity to Coral Bay														+
Popularity as snorkelling area							+				-		-	-
Location within a designated recreation area							+							
Suitability for small (4.3 m) dinghies							+							
MAUDS LANDING														
Protection from wind and waves											-		-	-
All weather boating access to North Passage							+	+			+			
Non-visibility from Coral Bay											-			
Distance from Coral Bay														-
Disturbance of manta rays														-
Existing road access							+							
Coastal erosion													-	
Prohibitively high cost											-			-
Suitability for large charter boats and cruisers							+							
Location within a designated recreation area							+							
SKELETON BAY														
Access would cause minimal damage to dune vegetation													+	
Favourable wind and current direction													+	
Probable need for dredging													-	
Safety for launching													+	
Nursery ground for reef sharks							-							

KEY: ** matter needing attention*
+ perceived opportunity
- perceived constraint
? questionable
int *= Interviews (see Section 4.4)*

5. CONCLUSIONS

The scoping study identified the following main issues during the course of the NOI and the PER indicates that:

- The need for a small scale boating facility at Coral Bay is widely supported;
- There has been support for the establishment of a boating facility for recreation and charter boats at Mauds Landing for the past 13 years;
- There is still a difference of opinion over where the facility should be sited. Generally speaking, government agencies favour Mauds Landing whereas the ratepayers and residents of Coral Bay favour Northern Bills Bay. Reasons include its suitability in terms of factors such as protection from wind and weather, ease of mooring, direct visibility from Coral Bay and access to the North Passage;
- The scale of the facility being proposed was much greater than they had anticipated. Most people thought that a boat ramp and service/fuelling jetty would suffice;
- The north-directed current in the inner reef area mitigates against the use of Monck Head as a site for the facility. There was strong concern that pollutants originating from the facility would adversely affect Bills Bay;
- A fourth site for the proposed facility, namely the blow out area in Skeleton Bay, may warrant closer investigation;
- The Baiyungu peoples and others have lodged a native title claim over an area which includes the proposed boat launching facilities at Coral Bay; and
- To maintain and protect the natural resource base of Coral Bay, upon which the livelihood of many people currently depends, there is a need to address and improve upon the wide range of existing environmental management problems in the area.

6. REFERENCES

May R.F. and Albone P.D., 1988. *Ningaloo Marine Park Management Plan 12.* Summary of public submissions. Department of Conservation and Land Management.

Michael Robinson & Associates, 1998. *Coral Bay Boat Launching Facilities:* Report on archaeological and anthropological issues. Submitted to Department for Planning and Infrastructure.

APPENDIX A
COPY OF THE LETTER SENT BY
DEPARTMENT OF TRANSPORT TO AGENCIES AND PERSONS WITH DIRECT INTERESTS IN THE PROPOSED CORAL BAY BOATING FACILITY

D. A. LORD & ASSOCIATES Pty Ltd
Environmental Consultants
A.C.N. 010 879 464

97 Broadway, Nedlands, Western Australia
PO Box 3172, LPO Broadway, Nedlands. WA 6009 Australia
Telephone: (08) 9389 9669 Facsimile: (08) 9389 9660
E-Mail: dal@wantree.com.au

Dear Sir/Madam,

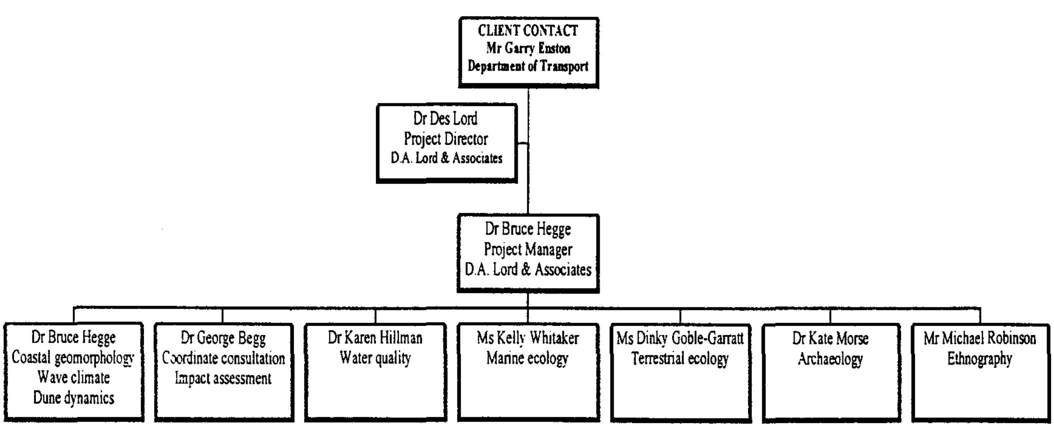
PROPOSED CORAL BAY BOATING FACILITY

The Shire of Carnarvon has approached the Department of Transport (DoT) to investigate the development of a small-scale boating facility in the vicinity of Coral Bay. In September 1997 we sought your input into this development to assist in the preparation of a Notice of Intent (NOI).

The NOI for the Coral Bay boating facility was submitted to the Environmental Protection Authority (EPA) in December 1997. The level of assessment was determined by the EPA to be a Public Environmental Review (PER) and was advertised by the EPA in mid-January 1998.

It is intended that the environmental studies associated with the PER examine all three of the sites shown in the attached sketch map for the development of the boating facility: namely Monck Head; Northern Bills Bay; and Mauds Landing. This approach was supported in recent meetings with the DoT, Department of Environmental Protection, the National Parks and Nature Conservation Authority and the Coral Bay Infrastructure Implementation Group. Arising from these discussions, a further option of developing a boating facility for the larger charter boats (with a two-lane boat launching ramp; a boat loading, fuelling and service facility; a breakwater; and a variety of moorings) at Mauds Landing, together with a small boat ramp at Monck Head for smaller trailable dingys, was discussed.

The DoT has appointed a study team headed by D.A. Lord & Associates to conduct an environmental study into the potential impacts of the Coral Bay boating facility. The study team, the composition of which is illustrated below, will be examining the potential terrestrial and marine impacts of this facility.



As part of the PER we are presently seeking input from interested and affected parties to ensure that all the important biophysical and socio-economic aspects of this development are considered from the outset, and to assist in the formulation of recommendations concerning the future management requirements of the facility.

If you wish to provide any additional comment on the proposed Coral Bay boating facility could you please respond directly to DAL before 17 April 1998.

Yours faithfully,

B Hegge

Dr Bruce Hegge
Principal Earth Scientist
Project Manager: Coral Bay Boating Facility

APPENDIX B
AUSTRALIAN HERITAGE COMMISSION

AUSTRALIAN HERITAGE
COMMISSION

Reference: 5/14/192/2
Contact Officer: Melinda Brouwer (020 6217 2141

RECEIVED
15 OCT 1997
050

8 October 1997

Dr Bruce Hegge
D.A. Lord & Associates
PO Box 3172
LPO Broadway
Nedlands WA 6009

Dear Dr Hegge

PROPOSED CORAL BAY BOATING FACILITY

Thank you for contacting the Commission about the above proposal. As you may be aware the Ningaloo Reef Marine Park is listed in the Register of the National Estate. A copy of the Commission's database information is attached for your information.

The Commission would suggest that the impact of the proposal on the national estate values of Ningaloo Reef be considered in your environmental assessment of the project, and would be happy to assist you in this regard.

In addition, the proponent should be made aware of their responsibilities under the Western Australian *Aboriginal Heritage Act 1972-80*. This legislation protects all Aboriginal places in Western Australia, whether they are listed or not. The proponent should ensure that Aboriginal heritage values are assessed in consultation and cooperation with relevant Aboriginal communities.

If you would like further information please contact Melinda Brouwer on the above number.

Yours sincerely

R Purdie

Dr Rosemary Purdie
Deputy Executive Director

MTA HOUSE 39 BRISBANE AVENUE BARTON ACT 2600 PHONE (02) 6217 2111 MTA FAX (02) 6217 2095 IBM FAX (02) 6217 2000
GPO BOX 1567 CANBERRA ACT 2601 AUSTRALIA

APPENDIX C
WESTERN AUSTRALIAN TOURISM COMMISSION

WESTERN AUSTRALIAN
TOURISM COMMISSION

34 Stuart Street
PO Box 973
Carnarvon WA 6701
Telephone 099 412 406
Facsimile 099 412 576

20 OCT 1997
050 – Sopping

15 October 1997

Our ref
Your ref

Dr Bruce Hegge
Project Manager - Coral Bay Boating Facility
D.A. Lord & Associates Pty Ltd
PO Box 3172
LPO Broadway
NEDLANDS WA 6009

Dear Bruce

PROPOSED CORAL BAY BOATING FACILITY

The Western Australian Tourism Commission welcomes the opportunity to provide input into the preliminary considerations for the development of the boating facility at Coral Bay. As a member of the Task Force investigating the settlements' infrastructure requirements, the Commission is pleased to note the progress in implementing the recommendations made.

There has been, and will continue to be, demand for space within the Bills Bay area for recreational and commercial operations. The interface between the swimming and boating public is becoming increasingly more dangerous as more visitors congregate in the area and more operators base themselves in the same place. The proposed facility will provide welcome relief and greater safety for all users and spread activity further along Bills Bay.

There will need to be clearly marked access areas for boat users wishing to shortcut through swimming areas. An increase in new users of the area will impact on coral unless users are made acutely aware of the safe access paths through the reef. Ongoing education of the boating public is required through signage at the site and through licencing conditions.

The agency responsible for ongoing management of the facility will need to be identified and have clearly defined obligations regarding rubbish removal, fee collection (if required), cleaning of public toilets and the general area. With a concentration of people at the site, there is likely to be rubbish build up on the ramp and in the adjacent area around moorings.

It is hoped that such things as fish cleaning facilities, public toilets and car parking will be provided at the site. The handling of waste water from the toilets and cleanliness of fish cleaning areas need to be incorporated into the management arrangement.

The comfort of the visitor should be provided for through shelters with seating and appropriate boarding facilities to gain safe access to commercial operators in particular. A couple of designated coach parking bays located in close proximity to these boarding facilities are an essential factor in providing for day usage needs. Future demand from coach companies to gain access to tour operators will place increased pressure on facilities.

The meeting of disability service obligations need to be addressed in both the design and construction stages of the facility development.

As the facility will be visible from the current mooring and swimming area, the aesthetics and landscape values will need to be carefully considered and applied to designs.

There must be consideration given to the provision of lighting at the site to allow for evening tours and early morning departures/arrivals. It may be that 24 hour lighting is not needed and an alternative is found.

There may also be demand from boat users for access to a power supply to undertake minor works on their boats rather than taking their boats to harbours at Geraldton or Carnarvon. In general, the environmental impact of extending a water and power supply to the boating facility requires further investigation.

Thank you once again for the opportunity of comment on the proposed facility at this early stage.

Yours faithfully

Stephanie Tonkin
TOURISM DEVELOPMENT MANAGER - GASCOYNE

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APPENDIX D
NATIONAL NATIVE TITLE TRIBUNAL

RECEIVED
20 OCT 1997
050 - Scoping

National Native Title Tribunal

Telephone: (08) 9268 7351
Facsimile: (08) 9325 1064
Freecall: 1800 640 501

Level 4
Commonwealth Law Courts
1 Victoria Avenue
PERTH WA 6000

GPO Box 9973
PERTH WA 6001
EMail: registrar@nntt.gov.au
Web Page: http://www.nntt.gov.au/

17 October 1997

D. A. Lord & Associates
PO Box 3172
LPO Broadway
NEDLANDS WA 6009

Att: Dr. Bruce Hegge - Project Manager

Dear Sir,

Boating facility - Coral Bay

The Tribunal is in receipt of correspondence from Mr. Cleve Flottman of the Department of Transport regarding the abovementioned proposed facility and the work your company is undertaking to examine the environmental impact of such a facility. The Tribunal is not in a position to comment on this proposal other than to offer the following information:

1. At the present time there is one Native Title Determination application registered with the Tribunal which covers, *inter alia*, the Coral Bay area. The application number is WC97/28. I enclose a Register Extract for this application which details the claimant group, the area under claim, and the claimant's representative, etc.

2. Under the Native Title Act 1993, registered native title claimants gain the right to negotiate over certain types of future act as defined under s 233 of the Act. As such, given the existence of registered native title claimants in the Coral Bay area, it may be necessary for consultations/negotiations about the proposed facility to involve this claimant group. The Crown Solicitor's Office and/or the Department of Land Administration (DOLA) may be able to provide advice about this matter.

3. The Tribunal produces publications which provide some basic information about native title, the Tribunal and it's processes. I enclose a booklet entitled 'Native Title Questions & Answers' for your information.

I trust this is of some assistance. Please don't hesitate to contact the undersigned should you require further information.

Yours sincerely

Margaret Robinson
Case Manager

c.c. Mr Alex Shaw, ALS

Encl.

A48846

National Native Title Tribunal

Telephone: 9268 7377
Facsimile: 9325 1064
Freecall: 1800 640 501

Level 4
Commonwealth Law Courts
1 Victoria Avenue
PERTH WA 6000

GPO Box 9973
PERTH WA 6001
EMail: kevint@nntt.gov.au
Web Page: http://www.nntt.gov.au/

Your Ref: 418/97

19 March 1998

Cleve Flottmann
Manager New Development
PO Box 402
FREMANTLE WA 6959

Dear Mr Flottmann

Proposed Coral Bay Boating Facility

Thank you for your letter of 11 March 1998 in relation to the above development.

I wish to advise there is only one Native Title Determination Application which has been accepted for mediation covering the area in which the development is planned.

Enclosed are copies of the register extract and attachment pertaining to the application, WC97/28(Gnulli).

Yours sincerely

Kevin Taylor
Administration Officer

National Native Title Tribunal

REGISTER OF NATIVE TITLE CLAIMS

Note: Below is the result of a search of the National Register of Native Title Claims as maintained by the National Native Title Tribunal, as at the date and time indicated and as selected by the criteria named below.

Date: 19 March 1998

Time: 9:55 AM (Perth)

Individual Application Selected: WC97/28

Note: A fee of $20 applies to search the Register of Native Title Claims or the National Native Title Register except in cases of financial hardship. The Registers can be inspected at a Tribunal Registry in each capital city or can be obtained by phoning 1800 640 501. Photocopying charges apply to all requests for copies of records maintained by the Tribunal except in cases of financial hardship.

National Native Title Tribunal

NATIVE TITLE - A SIMPLE EXPLANATION

Native title is the name Australian law gives to the traditional ownership of land and waters that have always belonged to Aboriginal people and Torres Strait Islanders according to their traditions, laws and customs. Native title may be found to exist:

- where it has not already been extinguished by an inconsistent government grant to a third party, and

- where the native title claimants have maintained their connection over the land.

Please note that this Register extract reflects only the information provided by the applicants who are seeking a native title determination. A native title determination will be made only if all the parties to the application agree. If this is not achievable, the native title application will be referred to the Federal Court for decision.

Where the Registrar of the National Native Title Tribunal 'accepts' a native title application, this does not mean that Native Title has been 'granted'. The acceptance of an application simply means that it has been accepted for mediation by the Tribunal.

Native title cannot displace existing interests in land and waters that have been validly granted. It is possible, however, for native title rights to co-exist with other interests over the land or waters.

Existing interests, such as pastoral leases other leases, licences and permits, will continue to apply even if there is a determination of native title. The Tribunal does not accept applications over present freehold land. (The exceptions to this are where the freehold is held either by the Crown or by the Aboriginal people).

Register of Native Title Claims

Registration Number: C00509

Body Application Lodged With: National Native Title Tribunal **Ref.No.:** WC97/28

Date Lodged: 14 April 1997 **Date Accepted:** 22 July 1997

Date Registered: 14 April 1997

Status: Accepted for determination **Date:** 22 July 1997

Registered Native Title Claimant: R Crowe, E Edney, R McIntosh & S Crowe, S Dale, M Franklin, L Cooyou & G Cooyou, B Roberts, S Peck, P Salmon & R Dodd

Address for Service: C/- Alex Shaw
Aboriginal Legal Service of Western Australia Inc.
Suite 44, Piccadilly Suites
Nash St
EAST PERTH WA 6004
Tel.No.: 08 9265 6666 Fax.No.: 08 9221 1767

Description of Persons Claimed to Hold Native Title:
The application is made on behalf of the applicants and the Ingarda-Teddei people, the Baiyungu and Talangi Peoples, and the Thalgari people as claimants.

Area Covered

State/s: Western Australia

ATSIC Region/s or TSRA: Yamatji Regional Council

Local Government Area/s: Shire of Ashburton, Shire of Carnarvon, Shire of Exmouth, Shire of Murchison, Shire of Shark Bay, Shire of Upper Gascoyne

Location: The area covered is within the Shires of Exmouth, West Pilbara, Carnarvon, Upper Gascoyne, Murchison & Shark Bay.

Description: The area claimed is bordered on the northeastern side by the western and southern boundary of the Thalangyi claim WC96/82, on the eastern side by a line drawn from Mt Clement on that southern boundary of the Thalangyi claim WC96/82 east then southsoutheast to Doolgarrie Creek then southeast to Minnierra Range and directly south to Cardibar Peak and thence to Wanna Hill on the northwestern boundary of the Burringurrah Wadjari claim WC96/23, and thence follows the western boundary of the Burringurrah Wadjari claim WC96/23 to Edithana Pool on the Lyons River and thence to a point directly east of Yinnetharra homestead and directly north of Dalgety Downs homestead, and thence to Dalgety Downs Homestead, and thence to Yalbra Outcamp on Glenburgh Station, and thence directly east to a point at approximate Australian map Grid co-ordinates 437500E, 7170500N, and thence in a south-south-easterly direction to the east of Yalbra Hill and Innouendy Outcamp to the Mullewa-Gascoyne Junction road and following that road to a point on Curbur station at approximate Australian map Grid co-ordinates 399500E, 7085000N, on the southern side by a line drawn from that point in a west-nor-westerly direction to the boundary with Byro station, and thence to Yalardy homestead and thence to the coast at Gladstone and thence directly west into Shark Bay to the midpoint between the coast at Gladstone and Faure island, on the southwestern side by a line drawn from that point in an approximate nor-nor-westerly direction to the midpoint between Cape Ronsard on Bernier Island and the coast at Point Quobba, and thence directly out to sea, and
on the northwestern and northern side by the limit of the waters to which the Commonwealth of Australia asserts sovereign rights under the 'Seas and Submerged lands Act 1973 (Cth)'.

3

The application includes all land and waters within the boundary of the application excluding any land in respect to which freehold title has been granted.
Amended: 11 December 1997
Amended: 09 February 1998

Size:

Land and/or Waters: Land and Waters

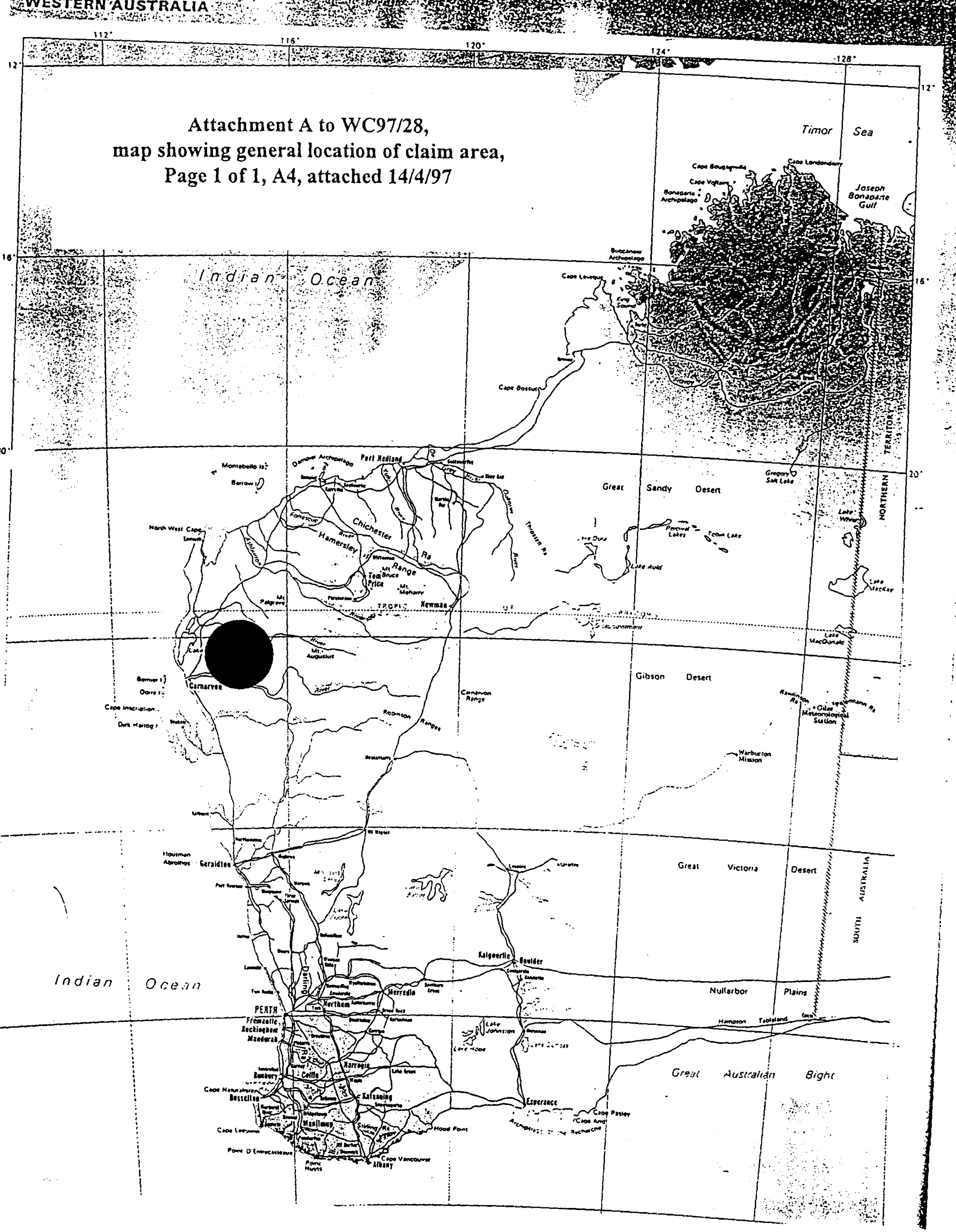
Details of Native Title Rights and Interests Possessed Under Traditional Laws and Customs:
The applicants claim all the native title rights and interests possessed by them under their traditional laws and customs in relation to the area covered by this application, subject only to the extent to which the following rights may exist at law from time to time:
a) valid rights acquired prior to 31 October 1975,
b) rights pursuant to past acts validated by the Native Title Act 1993,
c) rights pursuant to past acts validated by a State law authorised by and in accordance with the Native Title Act 1993, and
d) rights pursuant to future acts now or in the future validated by the Native Title Act 1993,
and subject also to the operation of any law of the State of Western Australia that is capable of operating concurrently with the Native Title Act 1993.

Draft Determination Sought:
The area covered by the application is the traditional country of the Ingarda-Teddei, Baiyungu & Talangi, and Thalgari peoples. The Ingarda-Teddei, Baiyungu & Talangi, and Thalgari peoples hold native title to the area covered by the application as against the whole world, subject only to the extent to which the following rights may exist at law from time to time:
a) valid rights acquired prior to 31 October 1975,
b) rights pursuant to past acts validated by the Native Title Act 1993,
c) rights pursuant to past acts validated by a State law authorised by and in accordance with the Native Title Act 1993, and
d) rights pursuant to future acts now or in the future validated by the Native Title Act 1993,
and subject also to the operation of any law of the State of Western Australia that is capable of operating concurrently with the Native Title Act 1993.

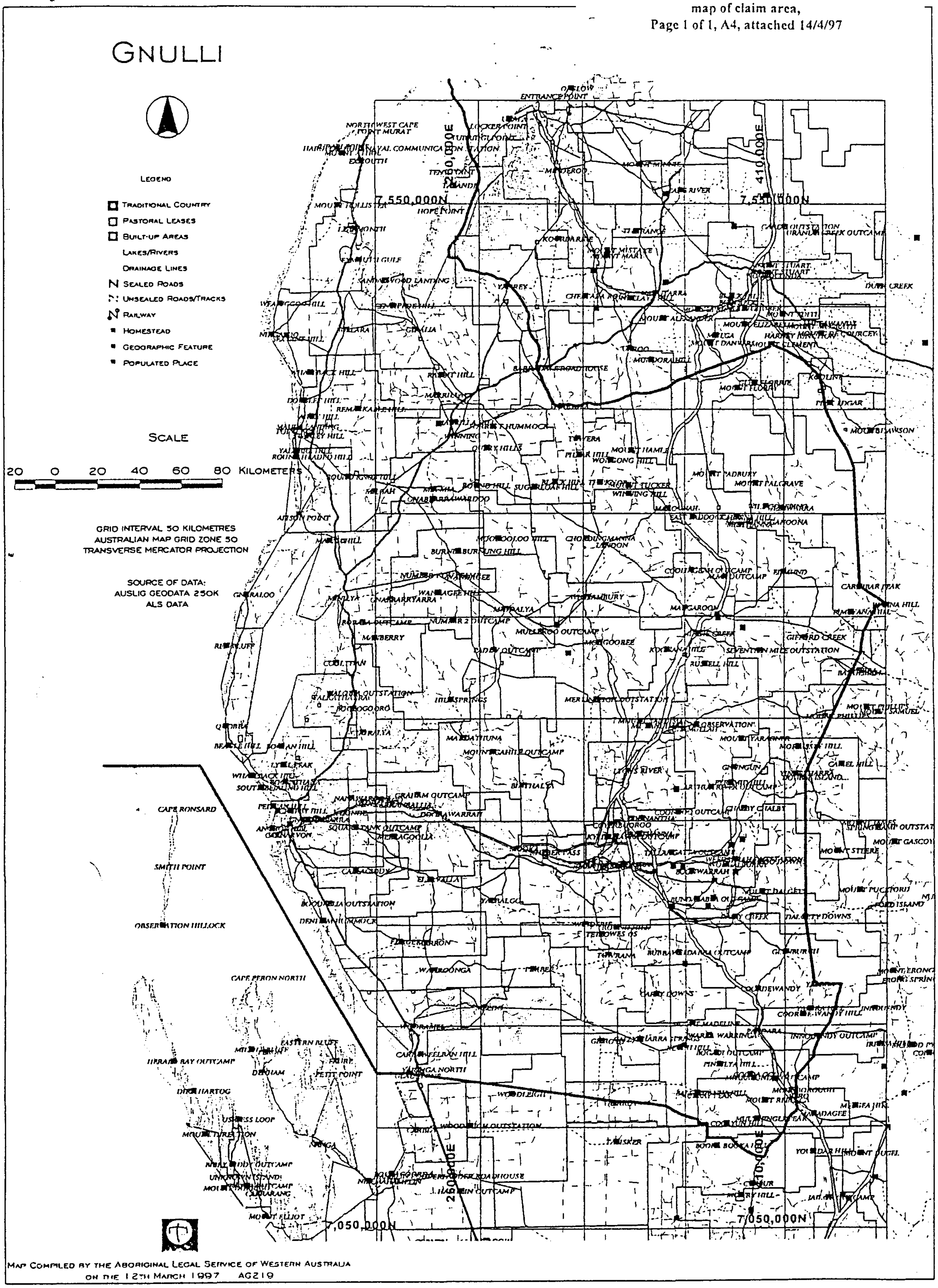
Attachments:
Attachment A, Map showing general location of claim area, page 1 of 1, A4, attached 14/4/97.
Attachment B, Map of claim area, page 1 of 1, A4, attached 14/4/97.
(If not attached these are available at NNTT Registries in each Capital City or by phoning 1800 640 501)

End of Entry for WC97/28

Attachment A to WC97/28,
map showing general location of claim area,
Page 1 of 1, A4, attached 14/4/97



Attachment B to WC97/28,
map of claim area,
Page 1 of 1, A4, attached 14/4/97



APPENDIX E
FISHERIES DEPARTMENT OF WESTERN AUSTRALIA

FISHERIES DEPARTMENT
OF WESTERN AUSTRALIA

RECEIVED
3 NOV 1997
050

Your Ref : 92/37
Our Ref : 735/73 VOL 23
Enquiries: SPO-FHP J.SHAW 9336 4535

Dr Bruce Hegge
D.A. Lord & Associates
PO Box 3172
LPO Broadway
NEDLANDS WA 6009

Dear Dr Hegge

RE: PROPOSED CORAL BAY BOATING FACILITY

Thank you for the opportunity to comment on the boating facility proposed for Coral Bay.

The Fisheries Department is interested in any development which may result in the degradation or loss of fish habitat, or impact on the recreational or commercial fishing values of the area.

The development of any small scale boating facility in the vicinity of Coral Bay is likely to result in a significant increase in recreational boating and fishing in the surrounding waters. It is unlikely however, that many commercial fishing vessels would use this facility. While the Fisheries Department would be mindful of the increased compliance issues, recreational fishers would benefit from a more convenient and safer launching facility. Managed boat access would also reduce dune damage from beach access points along the coast.

The proposed development is in a Marine Park Sanctuary Zone where commercial and recreational fishing are prohibited. There are also specific rules governing fishing within the Marine Park. These relate to fishing methods, bag limits, fishing areas and fish processing and storage.

While the Department, in consultation with other agencies and the community has developed these fishing regulations to protect fish stocks in the area, any significant increase in boating in this sanctuary zone may negatively impact on the benthic fauna and fish habitat. I would refer you to the Marine Branch, Department of Conservation and Land Management for more information on the coral communities in this area.

The Marine Park Sanctuary Zone, has been established, among other things to; serve as a special viewing area where flora and fauna may be observed without interference. Increased boat traffic and the construction of a boating facility in this zone is likely to be a safety hazard and may also result in the degradation or loss of fish habitat.

The Fisheries Department would recommend relocating the facility to a more appropriate area.

Yours faithfully

Jenny Shaw

Jenny Shaw
Senior Policy Officer
Fish and Habitat Protection
20.10.97

APPENDIX F
OFFICE OF WATER REGULATION

OFFICE OF WATER REGULATION

Our ref: WSV.10-05
Your ref: 92/37
Enquiries: Tim Rigden

RECEIVED
7 NOV 1997
OSO

Dr Bruce Hegge
DA Lord & Associates Pty Ltd
PO Box 3172
LPO Broadway
NEDLANDS Western Australia 6005

Dear Dr Hegge

PROPOSED CORAL BAY BOATING FACILITY

I have just received a letter from the Manager New Development at the Department of Transport requesting input from this office into the environmental review of the above proposal.

The Office of Water Regulation is currently considering proposals for development of a water supply and sewerage scheme for Coral Bay.

Our interest with respect to the proposed boat launching facility is to ensure that should any water services be required in connection with the facility that the rights and interests of any licensed water service provider are recognised.

Decisions as to whether any facilities associated with the boat launching ramps are connected to water/or sewerage will need to be taken by appropriate agencies (eg Shire, DEP) in consultation with the licensed service provider.

Thank you for the opportunity to comment on the proposal.

Yours faithfully,

Brian Martin

Brian Martin
COORDINATOR OF WATER SERVICES

4 November, 1997

cc *Cleve Flottmann*
Manager New Development
Transport

THE HYATT CENTRE 87 ADELAIDE TERRACE EAST PERTH WA 6004
PO BOX 6740 HAY STREET EAST PERTH WA 6892 TEL (08) 9278 0500 FAX (08) 9278 0501

Our ref: IND/1/70/6-02
Your ref: 050
Enquiries: Gary Casey

RECEIVED
23 MAR 1998
050

Dr Bruce Hegge
Principal Earth Scientist
D.A. Lord & Associates Pty Ltd
PO Box 3172 LPO Broadway
NEDLANDS WA 6009

Dear Dr Hegge

PROPOSED CORAL BAY BOATING FACILITY

I refer to the letter from Mr Cleve Flottmann of the Department of Transport dated 11 March 1998, which details proposals for the a boating facility at Coral Bay. In response to his request for comments on the proposed Coral Bay Boating facility the following comments are provided.

Although the Office of Water Regulation has no specific interest in the location of the proposed boating facility, the Office is mindful that the location of the boating facility may impact on further residential/tourist/commercial developments that will require sewerage and water services. Furthermore, if the proposed boating facility was to provide ablution facilities and commercial premises then the Office has an interest in who is to provide for water and sewerage treatment services for these facilities and by what means these services would be provided.

The Office has now signalled its intent to issue Kaiser Engineers Pty Ltd with an operating licence to provide sewerage services at Coral Bay. The location of the proposed sites for the sewerage treatment plant and water treatment plant are provided on the attached map. These sites are currently undergoing land clearances processes under section 116 of the *Lands Act, Native Title Act 1993 and the Land Acquisition and Public Works Act 1902.*

If you wish to discuss any of these matters then please contact Gary Casey of this Office on 9213 0103.

Yours faithfully

Brian Martin

Brian Martin
COORDINATOR OF WATER SERVICES

19 March, 1998

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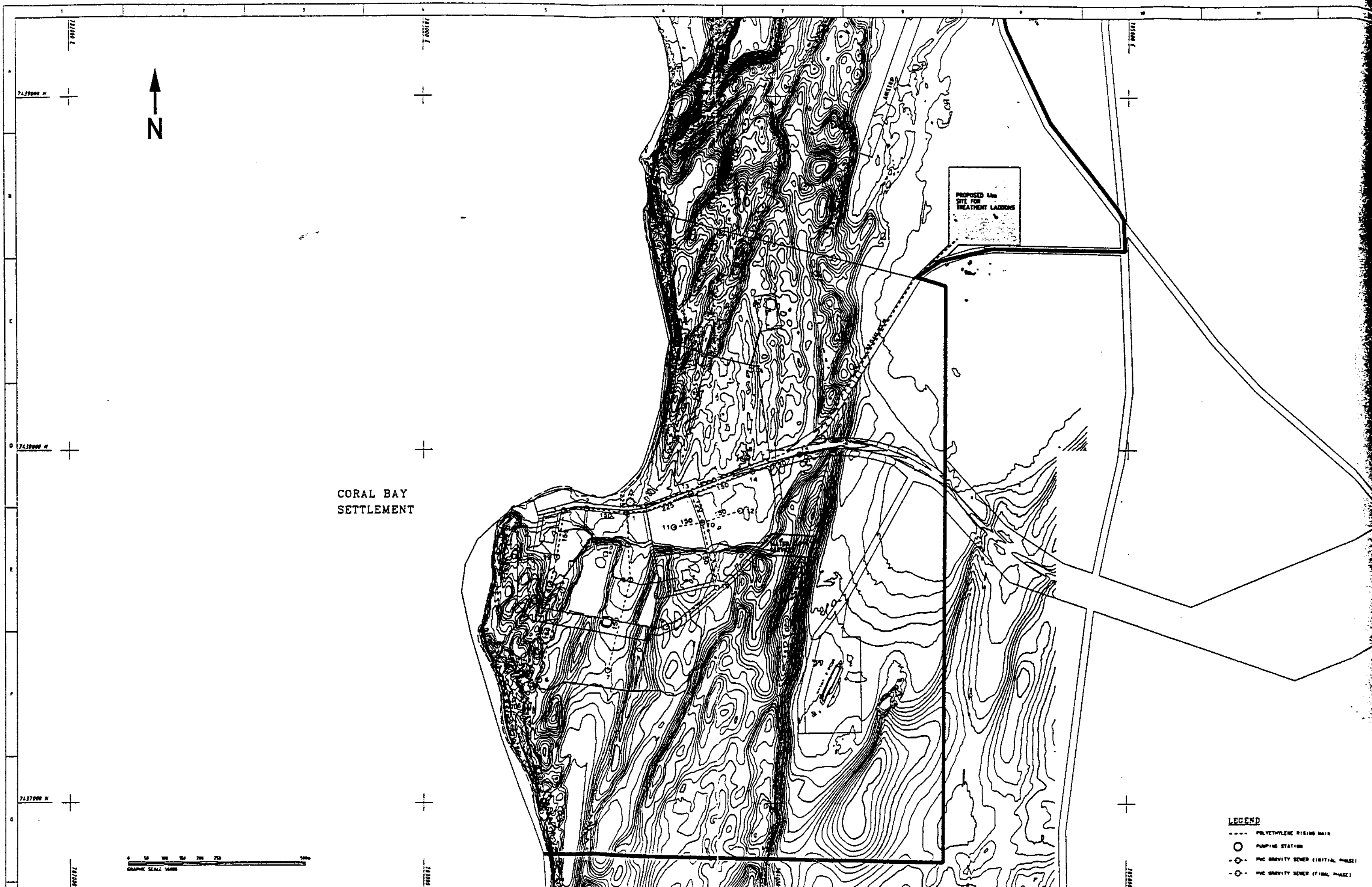

No.	DATE	REVISION	BY
B	13.01.98	ISSUED FOR APPROVAL	CRC
A	5.12.97	ISSUED FOR REVIEW	CRC

SCALE 1:5000 — DRAWN CRC — DATE 4.12.97

THIS MATERIAL IS CONFIDENTIAL

DO NOT SCALE
DIMENSIONS IN MILLIMETRES

FOR DEPARTMENT OF LAND ADMINISTRATION

DESIGNED BY KAISER ENGINEERS PTY. LIMITED
PERTH WESTERN AUSTRALIA

PROJECT CORAL BAY SEWERAGE SCHEME

TITLE CORAL BAY SEWERAGE
RESERVES AND SERVICES
RETICULATION

JOB NUMBER 58741

DRAWING NUMBER CB-SK-0001

SHEET SIZE A1

APPENDIX G
DEPARTMENT OF ENVIRONMENTAL PROTECTION

97 MON 13:53 FAX 61 8 9239 2314 DEPT. of TRANSPORT 002

418/97 C.FLOTTMAN

41.

Department of Environmental Protection

Head Office:
Westralia Square
141 St Georges Terrace
Perth, Western Australia 6000
Tel (08) 9222 7000 Fax (08) 9322 1598
http://www.environ.wa.gov.au

Postal Address:
PO Box K822
Perth, Western Australia 6842

A46983

Manager New Development
Department of Transport
PO Box 402
FREMANTLE, WA 6959

Your Ref	92/37
Our Ref	438/97
Enquiries	Greg Davis

ATTENTION: CLEVE FLOTTMANN

SMALL SCALE BOATING FACILITY, CORAL BAY

Thank you for your letter dated September 26, 1997 regarding the above matter. I apologise for the delay in responding.

The advice contained in this letter is from the Department of Environmental Protection (DEP) and in no way should be taken as the position of the Environmental Protection Authority.

The DEP is aware that a number of sites have been investigated to determine their suitability as a boat launching area. The Department appreciates the need for a boat launching area due to the recreational conflict and damage to coral that occurs at the existing site.

Although the North Bills Bay area would be an improvement on the existing situation the DEP is concerned that the site is within a sanctuary zone. Construction of groynes, breakwaters or similar structures is inconsistent with the purpose of this zone.

DEP officers are of the opinion that the Mauds Landing site would be the most environmentally acceptable.

If you have any enquiries regarding this matter, please contact Greg Davis on 92227036.

K J Taylor
DIRECTOR
EVALUATION DIVISION

18/11/97

RECEIVED
2 NOV 1997
DEPT OF TRANSPORT

APPENDIX H
NATIONAL PARKS AND NATURE CONSERVATION AUTHORITY

RECEIVED
21 NOV 1997
050

National Parks and
Nature Conservation Authority

Dr Bruce Hegge
Project Manager: Coral Bay Boating Facility
D.A. Lord & Associates Pty Ltd
PO Box 3172
LPO Broadway
NEDLANDS WA 6009

PROPOSED CORAL BAY BOATING FACILITY

I refer to the letter from the Department of Transport dated 23 October 1997 inviting comments on the proposed Coral Bay boating facility.

The National Parks and Nature Conservation Authority (NPNCA) supports the relocation of current boating activity away from the southern end of Bills Bay. While the Authority acknowledges that north Bills Bay would be preferable to the existing situation, it has a number of concerns relating to this proposal.

A major consideration of the current proposal is that North Bills Bay is situated within the Maud Sanctuary Zone. Section 15.4 of the Ningaloo Marine Park Management Plan 1989-1999 excludes the construction of groynes, breakwaters or similar constructions in the Marine Park's sanctuary zones. An amendment to the management plan would be required in accordance with the Conservation and Land Management Act 1984 (CALM Act) for this to occur.

Other relevant factors regarding north Bills Bay are:

- The proposed location is in close proximity to roosting sea birds on Point Maud. There is high potential for disturbance of these birds from close passing vessels. Australia has international obligations associated with the protection and conservation of migratory sea birds.
- The proposed location has the potential to trap sediment on the southern side of any groyne built. Sedimentation and other factors associated with substantial increases in boating activity, may damage sensitive coral formations known to exist in the immediate area and may also be to the detriment of Skeleton Bay, an area where small reef sharks are known to congregate periodically.
- Road access to the North Bills Bay site is technically feasible, but is difficult due to the location and configuration of high sand dunes in the area.
- Point Maud is an accreting sandy headland. Such headlands are often unstable in the long term (eg Becher Point, Rockingham) making them unviable for the establishment of long term infrastructure.

The availability of Maud's Landing as a potential development site is unclear, however it may be preferable if it were available for the following reasons.

- This is a less sensitive marine environment than north Bills Bay.
- Facing Bateman Bay, a boat launching facility would have ready access to a large water body suitable for a range of activities. One of the problems with the current site for boating activities is the limited range of activities that can be safely carried out at the southern end of Bills Bay. Many business ventures are currently precluded because of this (eg. wind surfers, catamarans, parasailing, jet skis). North Bills Bay will face similar problems.
- The Mauds Landing site would be more easily serviced by road than the North Bills Bay site. It would also remove the risk of building in an unstable landscape.

Thank you for the opportunity to provide comments on this proposal.

Yours sincerely

Tom Day
CHAIRMAN

19 November 1997

U:\NPNCA\LETTERS\OTHER\coralba2.doc

cc. Chairman, Marine Parks and Reserves Authority

RECEIVED
20 APR 1998
050

National Parks and
Nature Conservation Authority

Dr Bruce Hegge
Project Manager: Coral Bay Boating Facility
D.A. Lord & Associates Pty Ltd
PO Box 3172
LPO Broadway
NEDLANDS WA 6009

PROPOSED CORAL BAY BOATING FACILITY

I refer to the letter from the Department of Transport dated 11 March 1998, advising that the Environmental Protection Authority has set the level of assessment for the proposed Coral Bay boating facility and seeking any further comments that the National Parks and Nature Conservation Authority (NPNCA) may have.

On behalf of the Authority I would like to thank representatives from D.A. Lord and Associates, Shire of Carnarvon and Department of Transport for briefing the NPNCA on the proposal at its recent meeting held 13 March 1998.

The Authority would like to reiterate its previous comments made on the proposal recognising that the reserve impacted by the proposal is now vested in the Marine Parks and Reserves Authority. The NPNCA supports the relocation of current boating activity away from the southern end of Bills Bay. While the Authority acknowledges that a number of alternatives are being looked at there are a number of major considerations in relation to the northern Bills Bay option including:

- The northern Bills Bay site is located within the Mauds Sanctuary zone. An amendment to the management plan would be required for this development to occur.
- The proposed location is in close proximity to roosting sea birds on Point Maud.
- The proposed location has the potential to trap sediment on the southern side of any groyne built, which may damage sensitive coral formations known to exist in the immediate area.
- Road access to the North Bills Bay site is technically feasible, but is difficult due to the location and configuration of high sand dunes in the area.
- Point Maud is an accreting sandy headland. Such headlands are often unstable in the long term (eg Becher Point, Rockingham) making them unviable for the establishment of long term infrastructure.

The Authority looks forward to the opportunity to provide further comment during the Public Environmental Review process.

Yours sincerely

Tom Day
CHAIRMAN

17 April 1998

cc. Chairman. Marine Parks and Reserves Authority

APPENDIX I
DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

HEAD OFFICE
HACKETT DRIVE CRAWLEY
WESTERN AUSTRALIA
Phone (08) 9442 0300
Facsimile (08) 9386 1578

STATE OPERATIONS HEADQUARTERS
50 HAYMAN ROAD COMO
WESTERN AUSTRALIA
Phone (08) 9334 0333
Facsimile (08) 9334 0466
Teletype (08) 9334 0546

Please address all correspondence to Executive Director, Locked Bag 104, Bentley Delivery Centre W.A. 6983

Your Ref:
Our Ref: AJW:SB
Enquiries: Jim Williamson
Phone: 9334 0403

D A Lord and Associates Pty Ltd
PO Box 3172 LPO Broadway
NEDLANDS WA 6009

Attention: Dr Bruce Hegge

Dear Dr Hegge

PROPOSED CORAL BAY BOATING FACILITY

Thank you for the invitation to comment on this proposed boating facility.

The Department of Conservation and Land Management (CALM) is very much aware of the need to relocate the current boating activity at the southern end of Bills Bay. The danger to swimmers and to the nearby corals because of boating activity in the area are factors that are important to resolve as soon as possible.

A number of potential boat launching sites in the Coral Bay area have been considered by various Government agencies, including CALM. In December 1996 the Coral Bay Task Force considered, amongst other things, the following four alternative sites for a boat launching facility to service Coral Bay - Mauds Landing; North Bills Bay; Moncks Head; North Moncks Head.

Their preferred site was North Bills Bay as indicated in recommendation 17 of their report which was subsequently endorsed by Cabinet.

The main environmental issues to be considered when appraising North Bills Bay as a suitable site for a boating facility are:

- The proximity and potential regular disturbance of roosting sea birds at Point Maud. Access to this area by vehicle was stopped several years ago for this reason. It will be difficult to prevent vessels from passing close to the point and disturbing the birds. Apart from normal concerns about disturbance of wildlife in a declared marine protected area, Australia has international obligations associated with the protection and conservation of migratory sea birds.

- The potential trapping of sediment on the southern side of a groyne that would be built for protection of the boat launching facility. Substantial trapping of sand may have a detrimental effect on Skeleton Bay nearby which is an area where small reef sharks are known to congregate at certain times of the year.

- Sedimentation and other factors associated with substantial increases in boating activity may damage valuable and sensitive coral formations that are known to exist in the immediate surrounds of the North Bills Bay site.

- A boating facility at North Bills Bay, although probably costing less than the one at Mauds Landing initially, runs the very serious risk of being more costly in the long term by causing environmental damage that would spoil its attraction for tourism and be costly to repair.

Another basic issue is that the North Bills Bay site is within the Maud Sanctuary Zone, which was approved by the Minister for the Environment in 1989 as part of the management plan for Ningaloo Marine Park. On page 55 of the plan (copy attached) it is expressly stated that "groynes, breakwaters or similar structures not be constructed in Sanctuary Zones." This was clearly placed in the plan to ensure protection of the environment within the Sanctuary Zone. Establishment of the boat landing facility at the North Bills Bay site would require a significant change to the Ningaloo Marine Park Management Plan. This in turn, under the CALM Act, would require a public comment period of at least two months.

One of the pressures that CALM is under at Coral Bay is frequent requests from prospective businesses to run activities and equipment such as jet skis, wind surfers, catamarans, parasailing and similar activities. These are unable to be accommodated at Coral Bay because of safety and environmental reasons. The North Bills Bay site, if adopted, would also be unable to meet all of these requests because of the threat to the environment as indicated by its occurrence in a Sanctuary Zone.

Road access to the North Bills Bay site is feasible but difficult due to the configuration of the high sand dunes there. Department of Transport officers acknowledge that a road through the area would require careful planning and sensitive construction techniques.

If Mauds Landing was available as a launching site it would have some advantages. Mauds Landing is free of corals and other environmentally sensitive areas, is sheltered from south westerly winds and has no management plan restrictions - it is not in a Sanctuary Zone. The cost of road access to Mauds Landing would be less than to the North Bills Bay site and also to the other two sites considered. There would be no long term problems associated with establishing a road through large sand dunes. Mauds Landing faces a large body of open water that would provide the safe opportunity for a wide range of aquatic activities such as catamarans, windsurfers, and parasailing. It also offers direct access to the only all weather boat passage through Ningaloo Reef in the Coral Bay area.

Yours sincerely

Syd Shea
EXECUTIVE DIRECTOR

21 November 1997

Att

JRS\LETTERS\HEGGE

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

HEAD OFFICE
HACKETT DRIVE CRAWLEY
WESTERN AUSTRALIA
Phone (08) 9442 0300
Facsimile (08) 9386 1578

STATE OPERATIONS HEADQUARTERS
50 HAYMAN ROAD COMO
WESTERN AUSTRALIA
Phone (08) 9334 0333
Facsimile (08) 9334 0466
Teletype (08) 9334 0546

Please address all correspondence to Executive Director, Locked Bag 104, Bentley Delivery Centre W.A. 6983

Your Ref:
Our Ref:
Enquiries:
Phone:

RECEIVED
9 DEC 1997
050

Dr Bruce Hegge
Project Manager
D.A. Lord & Associates Pty Ltd
PO Box 3172
LPO Broadway
NEDLANDS WA 6009

PROPOSED CORAL BAY BOATING FACILITY

I refer to the letter from the Department of Transport dated 29 October 1997 inviting comments on the proposed Coral Bay boating facility.

The Marine Parks and Reserves Authority (MPRA) is aware that the National Parks and Nature Conservation Authority (NPNCA) has provided detailed comments on the proposal. The MPRA supports the comments made by the NPNCA.

As indicated in the NPNCA submission one of the major considerations of the current proposal is that North Bills Bay is situated in the Maud Sanctuary Zone as classified in the Ningaloo Marine Park Management Plan 1989-1999. Development of this proposal would require an amendment to the management plan in accordance with the Conservation and Land Management Act 1984 (CALM Act). Section 61 of the CALM Act provides for the amendment or revocation of a management plan, and a new plan substituted for it, subject to compliance with the same public review process applied to draft management plans. After the review period the NPNCA and/or MPRA would then consider the public comments and submit a recommendation, as to whether or not there should be an amendment made to the management plan, to the Minister for the Environment for approval.

Thank you for the opportunity to comment on this proposal.

Yours sincerely

Dr Barry Wilson
CHAIR
MARINE PARKS AND RESERVES AUTHORITY

5 December 1997

cc. Chairman, National Parks and Nature Conservation Authority

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FAXED

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

HEAD OFFICE
HACKETT DRIVE CRAWLEY
WESTERN AUSTRALIA
Phone (08) 9442 0300
Facsimile (08) 9386 1578

STATE OPERATIONS HEADQUARTERS
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Phone (08) 9334 0333
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Teletype (08) 9334 0546

Please address all correspondence to Executive Director, Locked Bag 104, Bentley Delivery Centre W.A. 6983

Your Ref:
Our Ref: AJW:SB
Enquiries: Mr J Williamson
Phone: 9334 0403

Dr Bruce Hegge
D A Lord and Associates Pty Ltd
P O Box 3172
NEDLANDS WA 6009

Dear Dr Hegge

NORTH BILLS BAY SITE ENVIRONMENTAL ISSUES

The main environmental issues to be considered when appraising North Bills Bay as a suitable site for a boating facility are:

- The proximity and potential regular disturbance of roosting sea birds at Point Maud. Access to this area by vehicle was stopped several years ago for this reason. It will be difficult to prevent vessels from passing close to the point and disturbing the birds. Apart from normal concerns about disturbance of wildlife in a declared marine protected area, Australia has international obligations associated with the protection and conservation of migratory sea birds.

- The potential trapping of sediment on the southern side of a groyne that would be built for protection of the boat launching facility. Substantial trapping of sand may have a detrimental effect on Skeleton Bay nearby which is an area where small reef sharks are known to congregate at certain times of the year.

- Sedimentation and other factors associated with substantial increases in boating activity may damage valuable and sensitive coral formations that are known to exist in the immediate surrounds of the North Bills Bay site.

- North Bills Bay site is within the Maud Sanctuary Zone, which was approved by the Minister for the Environment in 1989 as part of the management plan for Ningaloo Marine Park. On page 55 of the plan it is expressly stated that "groynes, breakwaters or similar structures not be constructed in Sanctuary Zones." This was clearly placed in the plan to ensure protection of the environment within the Sanctuary Zone. Establishment of a boat landing facility at the North Bills Bay site would require a significant change to the Ningaloo Marine Park Management Plan. This in turn, under the CALM Act, would require a public comment period of at least two months and there is no guarantee that the Marine Parks and Reserves Authority, in whom the marine park is vested, would recommend the change.

- Road access to the North Bills Bay site is feasible but difficult and costly due to the configuration of the high sand dunes. Department of Transport officers acknowledge that a road through the area would require careful planning and sensitive construction techniques.

Yours sincerely

Syd Shea
EXECUTIVE DIRECTOR

29 April 1998

JRS\LETTERS\HEGGE4

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

HEAD OFFICE
HACKETT DRIVE CRAWLEY
WESTERN AUSTRALIA
Phone (08) 9442 0300
Facsimile (08) 9386 1578

STATE OPERATIONS HEADQUARTERS
50 HAYMAN ROAD COMO
WESTERN AUSTRALIA
Phone (08) 9334 0333
Facsimile (08) 9334 0466
Teletype (08) 9334 0546

Please address all correspondence to Executive Director, Locked Bag 104, Bentley Delivery Centre W.A. 6983

Your Ref: AJW:SB
Our Ref: Jim Williamson
Enquiries: 9334 0403
Phone:

Dr Bruce Hegge
D A Lord & Associates Pty Ltd
P O Box 3172
NEDLANDS WA 6009

RECEIVED
MAY
050

Dear Dr Hegge

PROPOSED BOATING FACILITY AT CORAL BAY

Thank you for the invitation to comment on this proposed boating facility in relation to the preparation of a Public Environmental Review.

The Department of Conservation and Land Management (CALM) is aware of the need to relocate the current boating activity at the southern end of Bills Bay. The danger to swimmers and to the nearby corals because of boating activity in the area are factors that are important to resolve as soon as possible.

The proposed facility should not cause an unacceptable impact on either the land environment or the sea environment.

There are two major kinds of existing and potential demands for boating facilities at Coral Bay. One is for larger cruisers, charter boats and tour boats, the other is for small dinghies.

Of the three sites being considered, Mauds, North Bills Bay and North Moncks Head, only Mauds appears to be able to cater for large cruisers, charter boats and tour boats. Mauds is not in a Sanctuary Zone, so there is no management plan restriction on developing a boat launching facility including a ramp and associated protective groynes there. It is free of corals and other environmentally sensitive areas and is sheltered from the south westerly winds. There are no apparent problems associated with establishing road access to the site at Mauds. It faces a large body of open water that would provide the safe opportunity for a wide range of aquatic activities and is suitable for large cruisers, charter boats and tour boats. It also offers direct access to the only all weather boat passage through Ningaloo Reef in the Coral Bay area.

Mauds, however does not appear to be so suitable for small dinghies. The journey to the corals in Coral Bay is time consuming for a small boat and exposes boats to bad weather. One of the other two sites closer to the corals of Coral Bay, and in more sheltered sites, may be more desirable. The reasons why one of those sites, North Bills Bay, may not be as environmentally suitable is that it has issues with the land environment (proximity to a sea bird roosting site at Point Maud, difficult road access) and issues relating to the marine environment, (potential damage to reef shark habitat, potential boating damage to corals, and it is within the Maud Sanctuary Zone that specifically disallows groynes, breakwaters and similar structures).

The site at North Moncks Head appears to be able to accommodate a small ramp for small boats without causing unacceptable impacts on either the land or the sea environments. There is an existing track to the site that would require only minimal upgrading for small boat trailer traffic. The corals will be only minimally at risk as long as the size of boat that is allowed to be launched from the small ramp is restricted to boats about 14 feet long (4.3 metres). This will ensure that the corals close by, that provide one of the most interesting near shore dives in the world, are not harmed as they would be by large boats. The site is located within an excision from the Maud Sanctuary Zone. Although not completely weather proof without breakwater protection, it would be suitable for the launch and retrieval of small dinghies. Channels for dinghy traffic may need to be marked to prevent any damage to the corals.

It is apparent that a single boating facility may not be able to satisfy the combination of environmental and boating needs at Coral Bay.

Yours sincerely

Syd Shea
EXECUTIVE DIRECTOR

29 April 1998

JRS\LETTERS\HEGGE3

Please address all enquiries to:

418/97
M BAIRD

A86478

Your Ref:
Our Ref:
Enquiries: Dr Chris Simpson
(08) 8432 5100 Fax (08) 9430 5408

Marine Conservation Branch
47 Henry Street
FREMANTLE WA 6160

Martin Baird
Coastal Facilities Management
Department of Transport
PO Box 402
FREMANTLE WA 6959

RECEIVE
12 APR 2000
DEPT OF TRANS

Dear Martin

Comments on *Coral Bay Boat Launching Facility: Fuel Spill Environmental Risk Assessment* (report by D A Lord and Associates Pty Ltd, September 1999).

Thank you for your briefing on this issue at CALM's Fremantle office on 2 March 2000. As requested, we are pleased to provide you with this written advice further to our discussions with you on the above report on circulation and transport and potential for environmental impacts from fuel spills at the three proposed boat launching sites. Nick D'Adamo, Oceanographer, Marine Conservation Branch has reviewed the D A Lord report and the following assessment is based on his review.

The analysis of the transport and dispersion of any spills from the three respective sites appears to be technically sound, notwithstanding the limited field data that was available to conduct the analysis at the time. Our assessment of the hydrodynamics of the area concurs with that of your consultants, in that we believe that flushing of the north and southern Bills Bay sites would be slower than the Monck head site. CALM has some limited data on salinity-temperature fields of the area between Point Maud and Monck Head which suggest that the northern and southern Bills Bay areas are likely to be relatively poorly flushed compared to the less bathymetrically constrained region around Monck Head. These same data were provided to your consultants for their analyses.

Thank you again for the opportunity to comment on this issue.

If you would like to discuss technical aspects of CALM's review of the report then please feel free to contact Nick D'Adamo on Ph 94325104 or myself on 94325101.

Yours sincerely

Dr Chris Simpson
MANAGER
MARINE CONSERVATION BRANCH

7 April, 2000

cc: Doug Myers, Manager, CALM Exmouth District
cc Jim Williamson, Manager, CALM Planning and Visitor Services Branch

FFICE
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EY
Australia

9442 0300
9386 1578

PERATIONS
UARTERS
Perry Avenue
Precinct
gy Park
GTON WA

9334 0333
9334 0466
08) 9334 0546

dress:
ag 104
elivery Centre

-99

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

41 8/97
Martin Baird.

Your Ref:
Our Ref: CBI:KA
Enquiries: Mr J Sharp
Phone; Fax: (t) 9442 0304 (f) 9386 1286
Email: jims@calm.wa.gov.au

RECEIVED
16 OCT 2000
DEPT OF TRANSPORT

A98851

Mr Martin Baird
Department of Transport
P O Box 402
FREMANTLE WA 6959

Dear Martin

I refer to the Department of Transport's letter of 22 September 2000 requesting details on the process for amending a management plan.

The steps required to be undertaken to amend a management plan are set out in Sections 57-60 of the Conservation and Land Management Act as outlined in Section 61. The CALM Act has recently been amended and is awaiting the Governor's assent. I have included a copy of the amendments to this section.

Prior to initiating any process under the CALM Act to amend a plan, CALM would need to seek the support of the Marine Parks and Reserves Authority (MPRA) for an amendment. There would be little point in proceeding with an amendment process unless the controlling body was agreeable in principle to the proposed change(s).

In summary the process involves:

- Public notification of the proposed amendment to the plan, including a description of the proposed changes and outlining any implications of the change.
- The receipt of public submissions for a period of no less than two months.
- The referral of the proposed amendment to other bodies or organisations, including the Minister for Fisheries, Minister for Mines, and the Western Australian Tourism Commission and the affected local government authority(s).
- Analysis of submissions.
- Referral to the MPRA.
- Submit proposed amendment to plan or modified amendment to the Minister for the Environment for approval.
- The Minister can approve the proposed amendment or approve it with modifications.
- If approved the amendment must be published in the "Gazette".

The timeframe for amendments will vary depending on the complexity of the issue and the level of support for the proposal.

A recent amendment to the Matilda Bay Reserve Plan took six months to complete.

If you require any further assistance please feel free to contact me.

Yours sincerely

Jim Sharp
DIRECTOR OF PARKS

10 October 2000

Att

APPENDIX J
MARINE PARKS AND RESERVES AUTHORITY

MPRA

MARINE PARKS &
RESERVES AUTHORITY

Dr Bruce Hegge
Project Manager
D.A. Lord & Associates Pty Ltd
PO Box 3172
LPO Broadway
NEDLANDS WA 6009

RECEIVED
1 MAY 1998
050

PROPOSED CORAL BAY BOATING FACILITY

I refer to the letter from the Department of Transport dated 11 March 1998, advising that the Environmental Protection Authority has set the level of assessment for the proposed Coral Bay boating facility and seeking any further comments that the Marine Parks and Reserves Authority (MPRA) may have.

On behalf of the Authority I would like to thank representatives from D.A. Lord and Associates, Shire of Carnarvon and Department of Transport for briefing the MPRA on the proposal at its recent meeting held 2 April 1998.

The MPRA supports the relocation of current boating activity away from the southern end of Bills Bay where congestion and safety are major issues. Although the Authority is not yet in a position to make a decision on which option it supports, at this stage the MPRA has a preference for the Mauds Landing site.

Regardless of which option is put forward it is crucial that the values of the Gazetted sanctuary area in the Ningaloo Marine Park are maintained and the potential impacts of any proposal that affects those areas must be fully assessed.

The Authority looks forward to the opportunity to provide further comment during the Public Environmental Review process.

Yours sincerely

Dr B. R. Wilson FTSE
CHAIR

30 April 1998

cc. Chairman, National Parks and Nature Conservation Authority

U:\MPRA\LETTERS\OTHER\CORALBA3.DOC

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MPRA

MARINE PARKS & RESERVES AUTHORITY

A78862

TRANSPORT 31 AUG 1999 RECEIVED

41 8/97
M BAIRD

Mr Dennis Forte
A/Executive Director
Department of Transport
PO Box 402
FREMANTLE WA 6959

Attention: Mr Martin Baird

Dear Mr Forte

PROPOSED CORAL BAY BOATING FACILITY

The Marine Parks and Reserves Authority (MPRA) considered at its meeting held on 19 August 1999 the Department of Transport's July 1999 version of the draft Public Environmental Review (PER) document for the proposed Coral Bay boating facility.

The MPRA would like to reiterate its previous comments made on this proposal.

The Authority acknowledges that there is serious congestion at the present launching and mooring sites in Bills Bay next to the Coral Bay townsite and that activities conducted there such as fueling are a threat to the coral communities in the bay which are the prime attraction of the area. The Authority also believes there is a safety problem as a result of the congestion.

The Authority is opposed to the construction of any facility at North Bills Bay for the reasons previously given. Although a solution to the congestion in the bay is urgently needed, a facility within the present sanctuary zone is considered by the MPRA to be an inappropriate option.

A small boat landing facility at Moncks Head, just south of the sanctuary zone boundary would relieve the problem on the beach in Bills Bay and would be acceptable to the Authority on environmental grounds.

Accommodation of the needs of larger charter and fishing boats in the vicinity of Mauds Landing would also be acceptable. Any proposal would need to demonstrate that a system of management could be established for the proposal to maintain the ecological integrity of Ningaloo Marine Park.

It is understood that the Department of Transport is considering the release of the current version of the PER document seeking public comments on the several options. The MPRA believes this strategy is likely to foster controversy rather than resolve it. Nevertheless, if the Department does release the document in its present form, the Authority wishes to be kept fully informed and involved in the process and outcomes.

Yours sincerely

Dr B. R. Wilson FTSE
CHAIR

26 August 1999

Hackett Drive, Crawley, Western Australia 6009 Telephone (08) 9442 0300
All correspondence to be addressed to Department of Conservation and Land Management,
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983

APPENDIX K
DEPARTMENT OF LAND ADMINISTRATION

DOLA
Department of LAND ADMINISTRATION

MIDLAND SQUARE, MIDLAND
WESTERN AUSTRALIA
Postal Address: PO Box 2222
Midland, Western Australia 6936

Your Ref: 418/97
Our Ref: 687/990V4 (Job No 951471) WR:CB
Enquiries: Win Rose
Telephone: (08) 9273 7233
Facsimile: (08) 9273 7052

Cleve Flottmann
Manager New Development
Department of Transport
PO Box 402
FREMANTLE WA 6959

Dear Sir

PROPOSED CORAL BAY BOATING FACILITY

Thank you for the opportunity to comment on the environmental aspects of proposals for development of a small scale boat launching facility at Coral Bay.

You will of course be aware of proposals by Coral Coast Marina for development of a Resort facility at Mauds Landing, the subject of a Heads of Agreement with Government and contingent upon granting of planning and environmental approvals.

Provided proposals for establishment of a small boat facility are not in conflict with the abovementioned development, DOLA has no objection, subject to compliance with requirements under the Native Title Act.

Yours faithfully

W Rose

WIN ROSE
MANAGER
REGIONAL OPERATIONS
LAND ADMINISTRATION SERVICES BRANCH

1 April 1998

1471CB01.DOC

APPENDIX L
MINISTRY FOR PLANNING

403/00
MBAIRD

PLANNING
WESTERN AUSTRALIA
MINISTRY FOR PLANNING
HEAD OFFICE

Enquiries: Mersina Robinson
Our Ref: 555/10/2/2V6
Your Ref:

Department of Transport
PO Box 7272
Cloisters Square
PERTH WA 6850

A90788

RECEIVED
15 JUN 2000
DEPT OF TRANSPORT

Attention: Martin Baird

Dear Martin

PUBLIC ENVIRONMENTAL REVIEW FOR CORAL BAY BOATING FACILITY

I refer to the Public Environmental Review (PER) for Coral Bay Boating Facility May 2000 (Report NO 97/050/X).

I wish to advise that the consideration of the environmental impact of a boating facility at North Bills Bay as opposed to Moncks Head or Mauds Landing is consistent with the recommendations of the *"Coral Bay Task Force Report on Infrastructure Requirements for Coral Bay December 1996."*

It is suggested that the following matters be addressed in the PER document.

The following comments from the *"Coral Bay Task Force Report on Infrastructure Requirements for Coral Bay December 1996"* be included in paragraph 2 of the Executive Summary of the PER.

"From a planing point of view the North Bills Bay option is highly attractive in that it would provide another focal point for activity around Bills Bay. It would separate most of the boating use from the prime swimming beach at the south end of Bills Bay and would also lead to people moving along the beach towards the boat launching area. Separation of these uses would improve the visitor experience, lead to safer boating facilities and swimming and would enhance the spread of usage around the bay

From a boating point of view it is a sheltered area which has good access to the outer Ningaloo Reef and is backed by an area which has adequate parking for cars and boat trailers. The nearshore area is shallow and would require a long boat launching ramp and would be backed by a service jetty and groyne. In this respect the site offers a safe, all weather mooring place for charter vessels and other boats."

More detail is required in relation to the comment in the second paragraph about the management constraints at the North Bills Bay site. Later in the document should address how these management constraints could be overcome.

The Executive Summary outlines two development options that were considered for the North Bills Bay site namely a wave screen and a boat harbour option. There is a list of points about the advantages of the boat harbour option, but no detail about the advantages or disadvantages of the wave screen option. Strong justification is needed if we are to opt for a breakwater.

The third last paragraph of the Executive Summary and the third paragraph of the Recommendations, do not pick up on many of the positive aspects of the North Bills Bay site, particularly:

- There is a very strong argument in terms of safety. The North Bills Bay site is a much safer site due to its proximity to the Cardabia Passage as opposed to the Yalobia (south) Passage which is noted on the Coral Bay navigation chart (DMH, 1991) as being unsafe for navigation during various combinations of wind, swell and tide. The statistics should be referred to in the document i.e. some nine persons have died over the last 30 years through use of the Yalobia Passage.
- Reflection of the points quoted from the *"Coral Bay Task Force Report on Infrastructure Requirements for Coral Bay December 1996"* above.
- The strong support by the Coral Bay community for a boat launching facility at North Bills Bay, and the valid arguments that have been raised by the community in this regard, as a result of practical experience.

Further detail is required under Marine Facilities page 12 regarding the wave screen option and boat harbour option.

Page 26 -Response from Government Agencies, the comments of the Ministry for Planning and Gascoyne Development Commission are not included.

Clause 6.5 should reflect that a boat ramp is classified as a "Special" use or activity within the *"Ningaloo Marine Park Management Plan 1989-1999"* Sanctuary zone. This means it would only be allowable under a particular set of conditions or extenuating circumstances such as safety. The issue of safety must be given due weight in the PER.

Sections 7, 8 and 9 of the PER relating to environmental impacts and their management could be expanded to provide more detail on the extent of the potential impact from the proposal and how this impact will be managed. These sections are the most important in the PER and do not clearly outline the scope of impact or proposed managed. Section 7 should link clearly with Section 4 on the existing environment to provide a context for the level of potential impact

Should you wish to discuss the above please contact Mersina Robinson by phone (08) 9264 7741, fax (08) 9264 7566 or email: mersina.robinson@planning.wa.gov.au.

Yours faithfully

PAUL FREWER
EXECUTIVE DIRECTOR
STRATEGIC PLANNING

9 June 2000

APPENDIX M
BAYVIEW CORAL BAY REPRESENTING THE INTERESTS OF CORAL BAY LODGE; HOLIDAY VILLAGE; CARAVAN PARK; ARCADE AND BACKPACKERS

BAYVIEW CORAL BAY

LODGE
HOLIDAY VILLAGE
CARAVAN PARK
ARCADE
AND BACKPACKERS

Warrago Pty. Ltd.
ACN 057 591 152
as trustee for the
BACCA Unit Trust
P.O. Box 411
WEMBLEY WA 6014
Ph. (08) 9385 7411
Fax. (08) 9385 7413

Submission to D.A.Lord & Associates re Proposed Coral Bay Boating Facility

Attention: Dr. B. Hegge

W F Brogan
Curriculum Vitae

Research Background :

Various projects in the field of the etiology epidemiology and clinical treatment of Craniomaxillo Facial Congenital Abnormalities; funded by N.H. & M.R.C. and Princess Margaret Hospital research fund grants, have resulted in the publication of 30 papers in refereed journals.

Marine experience :

Hookah and Scuba Diving 1948 to date.

Extensive amateur boating and fishing experience.

Have owned and operated cray boats, wet line fishing and charter boats. Commercial Master Class V Ticket 1977. Member W.A. Underwater Photography Society. Have dived all over the southwest and central Pacific. Specialised in wreck diving.

Currently involved in producing a book, "Marine Biology of the Ningaloo Reef" co-authors Sue Morrison, W.A. Museum, Ann Storrie, W.A.U.P.S., Editor Carolyn Thompson, C.A.L.M. To be published by C.A.L.M. July 1998.

Coral Bay Experience :

Have owned and operated glass bottom boats and charter fishing, diving and whale-watching boats 1973 to date.

Developed Bayview Coral Bay holiday village 1978 to date.

General Considerations

In discussion with Dr. Bruce Hegge, I raised the question of the economic viability of the various options. He commented that was not an issue at this stage. I would respectfully suggest that if you put forward an option that the government is not prepared to fund, you are effectively voting for the "do nothing option", which has been declared unacceptable by the various task forces which have examined the Coral Bay situation over the last four years. At present the boat channel runs through the main snorkelling and swimming area. It is essential to get the boats away from this area before there is a serious accident.

I believe that any site selected must be economically viable and also acceptable to commercial and amateur boat owners. No seaman will accept a mooring area he considers unsafe either from an anchorage or security viewpoint.

The other general point to be considered is accessibility to the North and South Passages. Any boat ramp or mooring area selected should give easy access to and encourage the use of the North Passage which is safe to use in all conditions in which pleasure boats are likely to go to sea. The South Passage is dangerous, once the swell gets above 2 metres, and there have been many accidents and some fatalities in this area.

With regard to the specific sites :

Southern option - Moncks Head :

Road access: Will require construction through sand dunes, access to beach might require blasting through low cliffs. The beach is submerged at high tide.

Holding ground: Shallow with a limestone bottom. Permanent moorings would require blasting to secure. Probably not suitable for large or commercial vessels.

Marine considerations : Located in area of good corals frequently visited by divers and snorkelers. Prevailing winds, currents and tides would flow any oil or fuel spillage into main coral areas in Bills Bay.

Security : Poor anchorage, not visible from Coral Bay beach or accommodation.

Protection from wind and weather : adequate.

Access to North Passage : poor.

Aboriginal connection : none known.

Northern option - Bills Bay

Road Access : Good at first along edge of salt flat by airstrip. Would require some construction through sand dune area. Some beach available even at high tides.

Holding ground and ramp : Good, sand bottom, well sheltered by main block of corals in Bills Bay. This is the traditional anchorage area for large commercial vessels and cruising yachts making passage along the coast. There is a limestone ridge to the surface about 100 metres off shore which would afford good protection to the boat ramp.

Marine Considerations : Located in area of poor corals. Wind, currents and tides tend to bring coral spawn which deoxygenates the water and kills corals (Simpson, Carey & Masini, Destruction of Corals and Other Reef Animals by Coral Spawn Slicks on Ningaloo Reef W.A. Coral Reefs 12:185-191.) into this area. It probably happens on a small scale most years. Any oil/diesel spillage would tend to be washed out to Mauds Bay. The area is not used by divers or swimmers.

Security : Good anchorage, visible from Coral Bay beach and accommodation.

Protection from wind and weather : adequate.

Access to North Passage : Good. Dinghy access to Southern Lagoon fishing. Adequate and safe.

Aboriginal Connection : none known

Mauds Landing

Road access : Good along existing tracks but farthest area from Coral Bay. Beach sand is wide, soft and steep. Will be difficult to keep beach approach to boat ramp clear of drift sand.

Ramp & anchorage This is a surf beach open to the prevailing winds, with considerable erosion potential. Boat ramp would need to be protected by extensive groyne built to resist cyclonic surge. Nearest known rock quarry 140 kms distant. Anchorage good on sand bottom, but very exposed. Dinghy access to boats difficult.

Marine Considerations : Not a coral viewing area, little use by swimmers. Traditional area for catching large (4 metre plus) Tiger and Bronze Whaler Sharks. Well swept by tide, wind and currents.

Security : Poor, not visible from Coral Bay, farthest distance from Coral Bay. Very exposed to weather conditions.

Protection from wind and weather : Poor.

Access to North Passage : Good. Dinghy access to Southern Lagoon fishing poor and dangerous in windy conditions.

Aboriginal connection: Aborigines from the Giralia-Windarra area known to have come down to this area and to Bruboodjoo Point in the summer. Small freshwater soak in sand dunes. (Comments on aboriginal use of the area based on recent discussion with Mr. J. Robinson and Mrs. Norma French whose families have been involved with Ningaloo and Cardabia Stations from 1893 to 1997.)

I believe the facts I have given above are accurate and easily verified. On the basis of this information the Northern Bills Bay option is the only one viable on marine, economic and security grounds. It also meets the criteria of easy and safe access to the North Passage and the Southern Lagoon fishing and diving areas. The Mauds Landing option is non viable on cost grounds and would also have a significant annual maintenance cost.

John Farne, my Manager in Coral Bay and John Ashton, Skipper of M.V. Ningaloo, will be happy to take you on a tour of the area in the Ningaloo and to give any other assistance you may require.

I would appreciate the opportunity to discuss matters further on your return to Perth.

With kind regards.

Yours sincerely,

W.F. Brogan

W.F. Brogan
D.D.O, R.F.P.S., F.R.A.C.D.S.

c.c. G. Enston, D.O.T.
J. Farne, Bayview Coral Bay

BAYVIEW
CORAL BAY

LODGE
HOLIDAY VILLAGE
CARAVAN PARK
ARCADE
AND BACKPACKERS

Warrago Pty. Ltd.
ACN 057 591 152
as trustee for the
BACCA Unit Trust
P.O. Box 411
WEMBLEY WA 6014
Ph. (08) 9385 7411
Fax. (08) 9385 7413

7th May 1998

RECEIVED
11 MAY 1998
050

D.A. Lord & Associates
P.O. Box 3172
LPO Broadway
NEDLANDS WA 6009

Dear Dr. Lord,

Thank you for the opportunity to meet with you and your associates on Tuesday 28th April to discuss the location of the Coral Bay boat ramp. I am writing to present my impression of the salient points of our discussion. If I have misunderstood or misinterpreted any points please let me know.

1. You did not appear to be aware of the Chief Executive Officer's committee recommendation to limit the tourist population of Coral Bay to a maximum of 3,000 people per day in peak season. I accept your reservation that this can be achieved but I believe it is possible by limiting accommodation in Coral Bay and by the CALM and Shire rangers controlling illegal camping outside the Bay area. Council recommended at its April meeting to investigate the feasibility to station a full time council officer in Coral Bay.

I believe Coral Bay can and should be controlled on the Rottnest model lines.

This implies that we are looking at a boat ramp for tourists and a maximum of 6 charter tourist boats. This is not a marina development.

2. The Northern Guardian of 6th May 1998 states the Premier has allocated $1,250,000 to the construction. Any conclusion should take into account the amount of funds available.

With regard to your Provisional Site Selection Matrix, I would make the following comments :

(i) Near shore substrata. Dregibility, difficult. This conflicts with your suggestion that it would be possible to dredge the area near Skeleton Bay which would be the ideal area for the boat ramp.

(ii) Animal Communities Marine. Seabird refuge on Point Maud. I believe we agreed the birds did not appear to be disturbed by passing boats. Reef shark breeding area, small school sharks and rays are seen in this area. There is no evidence to show they breed there. The coral reef has been a relatively dead area to my knowledge since 1973. It has not changed significantly in that time. The 1989 disaster had a much greater effect on the vital areas of the Bay, the north west area was already devitalised. This is where all the pollutants collect from whatever source. There is constant regrowth as there is in all corals which are not in completely sterile areas.

(iii) Proximity to Coral Bay by road. This could be significantly reduced by surveying the best route through the dunes from the airport, or reduced even more if the direct road behind the primary foredune is selected.

(iv) Viewpoints from scoping. You appeared to place great stress on the mind set of various departments. I do not consider this is a valid environmental argument. I would suggest that the views expressed by the local community with their long term local knowledge should be given more weight.

Finally, observation this week has confirmed my view shared by other local residents, that the southern ramp area is being increasingly used as a beach snorkeling area. It is the natural overflow area for tourists when Bills Bay is crowded, i.e. once numbers rise above 2,000 people in Coral Bay.

Yours sincerely,

per W.F. Brogan
CHAIRMAN

APPENDIX N
GLASS BOTTOMED BOATS

GLASS BOTTOM BOATS
ECOLOGY CRUISES
A.C.N. 008 825 027

Bayview Park, Coral Bay, W.A. 6701 Phone (099) 425 885 Fax (099) 425 883

12th April 1998

Dr B. Hegge
Principal Earth Scientist
Project Manager: Coral Bay Boating Facility.

Dear Bruce

In response to your letter re the proposed Coral Bay boating facility I submit the following observations and suggestions.

With regard to Monck Head, whilst this site would be quite suitable from the boat owners point of view, allowing relatively convenient access to both Yalobia (South) Passage and the Cardabia (North) Passage, there is one major drawback which in my view totally eliminates the area as a potential boat ramp with associated facilities.

The tide flows in over the back (outer) reef from about Alison Point to the south and out through North Passage, which is, in fact, a gap in the reef of some 5 kilometeres in length rather than a relatively small passage.

This tidal movement is consistant so that in this area the current created invariably flows in a northerly direction within the confines mentioned above. Therefore anything, be it man made polutants, fish offal or refuse of any kind which finds its way into the water around Monck Head will definitely turn up in southern Bill's Bay where it can remain for a considerable time, depending on the weather and tidal conditions.

A classic illustration of this situation occurred during the annual coral spawning in 1989. In this case north westerly winds sprung up just at the critical time of a major release of spawn, these winds pushed vast quantities of spawn into the small area from Fletchers Hill in the south to around Skeleton Bay in the north. Then the winds died and, as corals choose to release their spawn during a neap tide there was insufficient tidal current to clear the spawn from the area quickly. The eggs of corals require substantial quantities of oxygen, so that in the amazingly short time of less than two hours the available oxygen in the water was depleted, resulting in the death by suffocation of several hectares of coral along with more than one million fish, plus thousands of other creatures including squid, octopus, eels, crayfish, marine worms, other crustacia, moluscs, shells, etc.

Whilst this was an act of nature, it was a particularly dramatic event due to the coincidence of all the "right" conditions combining exactly with a very major release of eggs and sperm not only by the corals but also by various other marine creatures. However the potential does remain for the situation to be repeated given similar conditions and the presence of polutants, albeit on a much smaller scale and without the influence of coral spawn.

With respect to northern Bill's Bay this site would be quite satisfactory, being reasonably sheltered during cyclone conditions and quite accessable. However any boats wishing to go south inside the back (outer) reef must first proceed in a westerly direction almost to the back reef before turning south, therefore necessitating adequate markers and signs to direct them. It may also be necessary to "sell" to the public, etc. the need for some relatively minor dredging to create a suitable chanel and approval for this may prove to be a stumbling block of major proportions.

Lastly, Mauds Landing. This sight is by far the least likely to be the cause of any serious damage to our National treasure, the corals of the Ningaloo Reef. However this area is exposed to the worst type of weather conditions that we experience here, i.e. north easterly, north, north westerly or westerly winds, any of which when strong enough can create very difficult, if not dangerous, boating conditions due to the wave action associated with these types of conditions and compounded by the lack of protection from the back reef due to the 5 kilometre gap which is the North Passage.

To summarise, it is my view that Monck Head should not be considered at all. Northern Bill's Bay would be quite satisfactory and far less expensive providing all potential obstacles can be overcome. Mauds Landing is the best site from the point of view of minimal damage to the environment but would be slightly less accessable, far more costly to construct and in general would provide a rather less comfortable situation from the point of view of boat owners and would be quite exposed to any cyclone which may approach the vicinity of Coral Bay. In any case I feel that one facility catering for both private (leisure) craft and professional (commercial) craft is all that is necessary and providing two separate facilities should never be contemplated.

Further, whichever sight is eventually chosen it will be absolutely essential to provide adequate markers and signs for the direction of marine traffic along with considerable education of the boating public because of the large areas of very shallow coral which at certain times cannot even be navigated in small dingies.

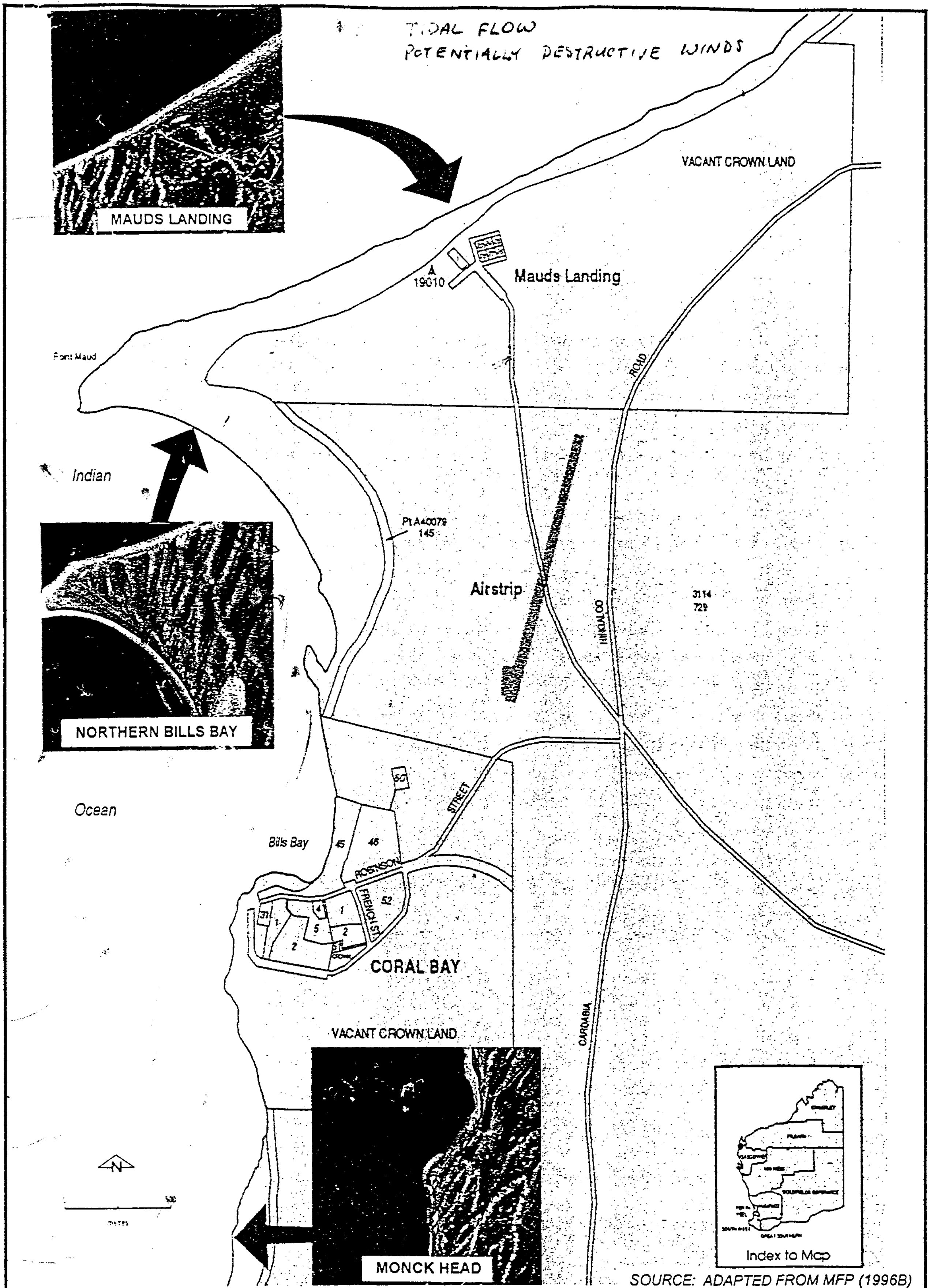
And finally I suggest that provision for the parking of boats and trailers up to a number of seventy five to eighty units would be required to see the project through for the next 20-30 years or so.

I assume that fueling facilities would be provided as a matter of course. Naturally it goes without saying that the provision of an alternative sight to the existing boat launching area is absolutely essential and rapidly becoming critical.

Trusting that my comments and views are of some use to you and always ready to be of any assistance should you require.

Regards

Ken Bailye



Department of Transport
CORAL BAY BOATING FACILITY

ALTERNATIVE LOCATIONS FOR CORAL BAY BOATING FACILITY

FIGURE
1

Auth: GWB Date: 11/97

APPENDIX O
NINGALOO REEF RESORT

Phone: 099 425934
Fax: 099 425953
ACN 009 125 099

Ningaloo Reef Resort
AUSTRALIA
CORAL BAY HOTEL

Deligo Pty Ltd
Postal:
Maud Landing
Coral Bay WA 6701

cc: George Begg ✓

23 APR 1998
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PHONE: (08) 99425934
FAX: (08) 99425953

ATT: DR. BRUCE HEGG

DEAR SIR
IN RESPONE TO YOUR LETTER REF:418-97, WE TAKE THIS OPPORTUNITY TO PUT OUR THOUGHTS FORWARD.
WE HERE AT THE NINGALOO REEF RESORT, ARE ONE OF ONLY THREE RATE PAYERS IN CORAL BAY, AND AS SUCH TAKE A VERY KEEN INITEREST IN THE DEVELOPMENT OF CORAL BAY.
DURING OUR THREE YEARS HERE WE HAVE BEEN AMAZED THE MIXTURE OF SWIMMERS AND BOATS, HASN'T RESULTED IN AN ACCIDENT.
BOTH THE NUMBER OF SWIMMERS AND BOATS HAVE MORE THAN DOUBLED SINCE OUR ARRIVAL IN CORAL BAY.
WE WOULD LIKE TO COMMENT ON THE THREE SITES YOU HAVE LISTED AND SUGGEST ANOTHER OPTION.
FIRSTLY OPTION: MONKS HEAD IS EXTREMELY POPULAR WITH SWIMMERS AND SNORKLERS, AS THERE ARE GOOD CORAL FORMATIONS AND A CURRENT WHICH RUNS NORTHWARD ALL YEAR ROUND, MAKING THESE ACTIVITIES EASIER.
WE FEEL THAT THIS CURRENT WOULD MAKE THE LAUNCHING SOMEWHAT HAZARDOUS AND ALSO WOULD PROVE VERY DETRIMENTAL SHOULD AND OIL OR FUEL SPILLAGE OCCUR, ALSO TO CONSIDER, IS THE FACT THAT TO GET OUTSIDE THE REEF, BOATS HAVE TO GO THROUGH EITHER THE NORTH OR SOUTH PASSAGE. SOUTH PASSAGE CAN BE VERY DANGEROUS IF ONE IS NOT AN EXPERIENCED SEA PERSON. WE PREFER TO SEND PEOPLE OUT THE NORTH PASSAGE , BECAUSE IT IS SAFER. BUT TO GET THERE THEY MUST FIRST GO SOUTH APPROX. ONE KILOMETRE, TURN STARBOARD OUT TO THE REEF, THEN TRAVEL NORTH ON THE INSIDE OF THE REEF UNTIL PAST POINT MAUD.
SECOND OPTION MAUDS LANDING: WHILST THIS MAY BE THE EASIEST SITE, IT IS SUBJECT TO VERY LARGE SWELLS, THAT AT TIMES ERODE THE BEACH TO A STAGE THAT MAKES IT IMPASSABLE TO FOUR WHEEL DRIVES. WE SEE THIS AS BEING VERY DANGEROUS FOR THE LAUNCHING OF VESSELS AND AS WE HAVE SEEN ON MANY OCCASSIONS A LOT OF

BOAT OWNERS DO NOT SECURE THEIR BOATS VERY WELL, WHICH MAY LEAD TO DISASTER. YOU MENTION A BREAK WATER THAT WAS CONSTRUCTED AT EMU POINT IN ALBANY, THAT CAUSED MASSIVE ERROSION ON THE BEACH AROUND IT. WE ALSO ASK YOU TO CONSIDER THE MANY AND VARIED WAVE PATTERNS ALONG THE BEACH AT MAUDS LANDING. WE CAN ASSURE YOU THAT A FLIGHT OVER THIS AREA WILL CONFIRM THIS FACT.

THE THIRD OPTION IS NORTHERN BILLS BAY: WHILST THIS IS POSSIBLY THE BEST OF THE THREE OPTIONS WE SUGGEST TO YOU A FOURTH SITE. SKELETON BAY IS SITUATED HALF WAY BETWEEN BILS BAY AND NORTHERN BILLS BAY. THE ACCESS TO SKELETON BAY COULD BE THROUGH THE MASSIVE SAND BLOW OUT, SO DAMAGE TO THE FRAGILE ENVIRONMENT WOULD BE MINIMAL, COMPARED TO NORTHERN BILLS BAY. THE WINDS IN CORAL BAY COME MOSTLY FROM THE SOUTH WEST, SO IT WOULD BE BLOWING ON SHORE, MAKING LAUNCHIUNG EASIER, AND SHOULD AN OIL OR FUEL SPILLAGE OCCUR, THE WIND AND CURRENT DIRECTION WOULD TAKE THE SPILLAGE TO THE BEACH. OBVIOUSLY THERE WILL BE CONSIDERABLE DREDGING WITH ANY SITE SELECTED, BUT THE LARGE SAND BLOW OUT, WOULD MAKE AN IDEAL DUMPING GROUND. WE THINK THE SAFETY ASPECT, WIND AND TIDE DIRECTION AND THE MINIMAL DAMGE TO THE COASTAL VEGETATION, MAKE SKELETON BAY THE OPTION.

ONE AREA WE HAVN'T SPOKEN ABOUT, IS A CLEARLY MARKED CHANNEL ON THE INSIDE OF THE REEF, BUT GEORGE BEGG SPOKE BRIEFLY TO US AND SAID THIS WOULD HAPPEN, AND WE COMMEND YOU ON THIS.

WE ARE WILLING TO DISCUSS THIS LETTER WITH YOU, OVER THE PHONE IF YOU WISH AND THANK YOU FOR THE OPPORTUNITY TO COMMENT.

YOURS SINCERELY

WD GIBBINGS.