9. Marine Ecosystems

9.1 Existing Environment

Within this section, the floral and faunal communities of the intertidal and shallow subtidal are described. This description is based on a series of recent surveys undertaken by both government and private sector scientists; reference to relevant data bases (e.g. EPA's WildNet Database, and the EPBC On-line database); and to the literature. The most recent survey, a partial re-survey of the study area, was undertaken in September 2002 by FRC Environmental.

9.1.1 Study Area

Floral and faunal communities of the proposed development footprint and surrounding waters and intertidal lands of Boathaven Bay are described.

Discussion of the Whitsunday region includes the area between Gloucester Island (20km east of Bowen) in the north to Cape Hillsborough (30km north-west of Mackay) in the south.

Area Directly Impacted

The area that would be directly impacted through reclamation, dredging, and the placement of structures is shown in **Figure 9-1**.

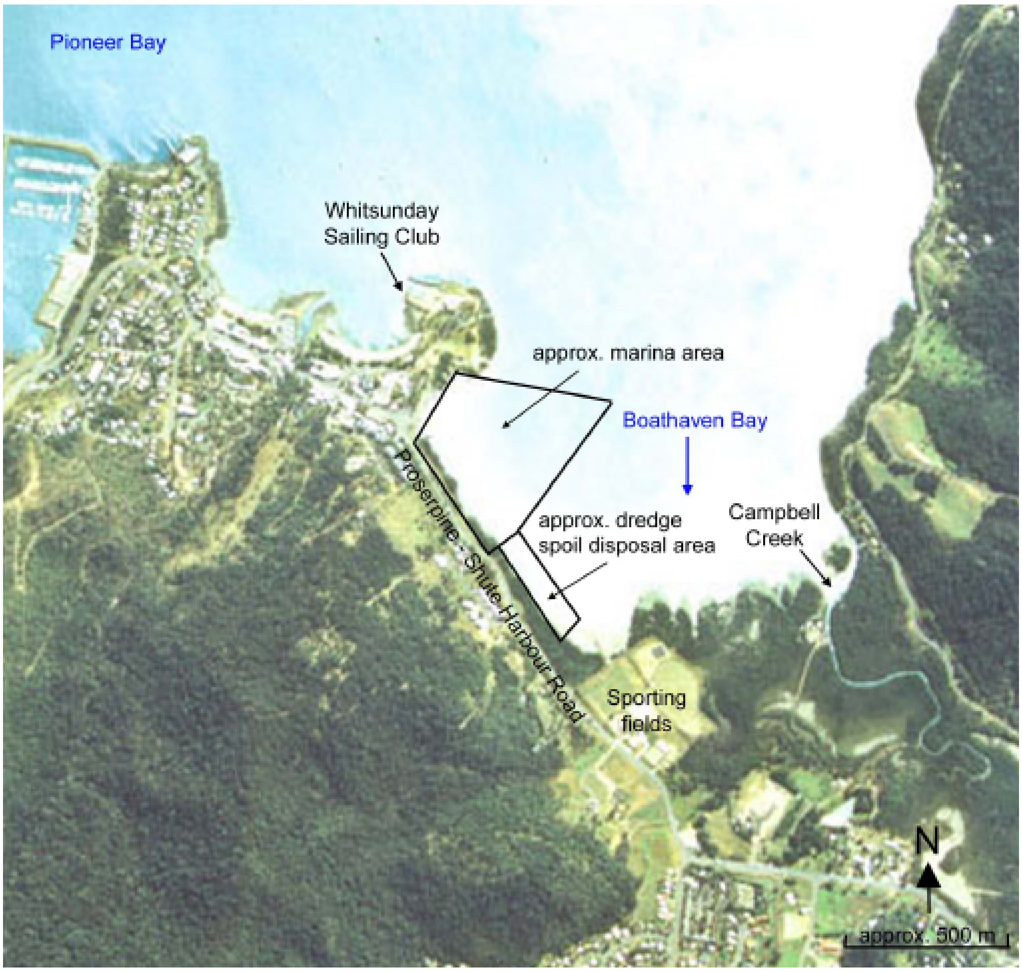
Area likely to be Indirectly Impacted

The area likely to be indirectly impacted may include other areas of Boathaven Bay. The potential for impact extending out into Pioneer Bay is considered low. Hydrodynamic modelling for the larger marina originally proposed in the 1998 EIA indicated that the turbidity dredge plume would not extend to Mandalay Point or the eastern areas of Boathaven Bay. It is likely that other impacts would also not extend beyond these areas due to the tidal action and dilution effects. However, monitoring will be conducted into Pioneer Bay to ensure that the predicted limited extent of indirect impact verified during construction activities.

9.1.2 Marine Habitats/Ecosystems

Boathaven Bay is a very shallow embayment of Pioneer Bay, much of the bay is intertidal, and sediments grade from soft silts in the bight to silty sands in the centre and offshore regions. There is a fringe of mangroves along much of the shore, whilst in the intertidal and shallow subtidal there are seagrass and macroalgal communities. There are also some sparse inshore coral communities in the vicinity of the north-western headland of Boathaven Bay and along the Mandalay peninsula to the east.

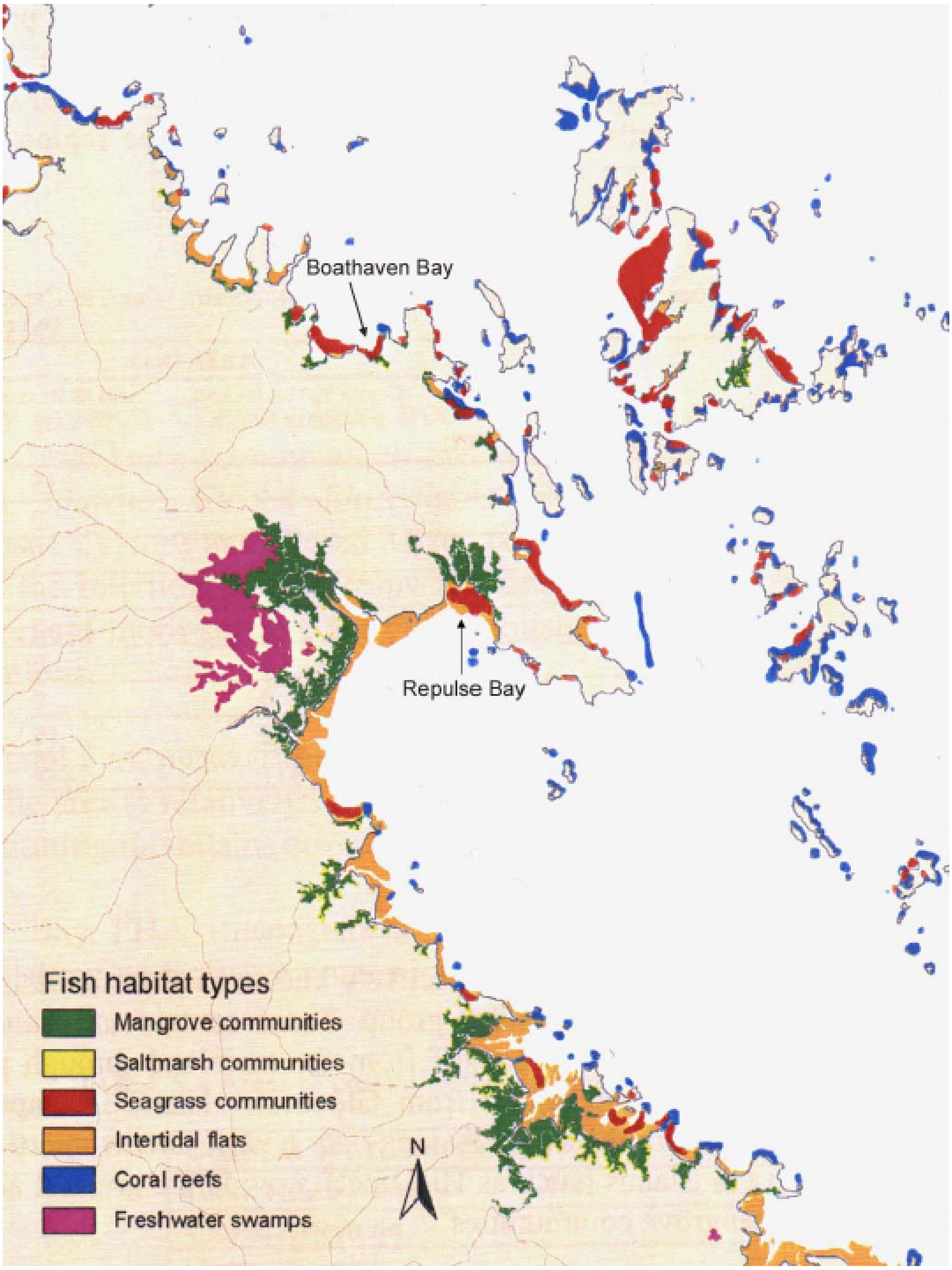
Boathaven Bay supports a number of species of conservation significance, such as marine turtles, Dugong, dolphins and sygnathids (seahorses and pipefishes).



- **Figure 9-1 The Proposed Port of Airlie Development Site**

Seagrass

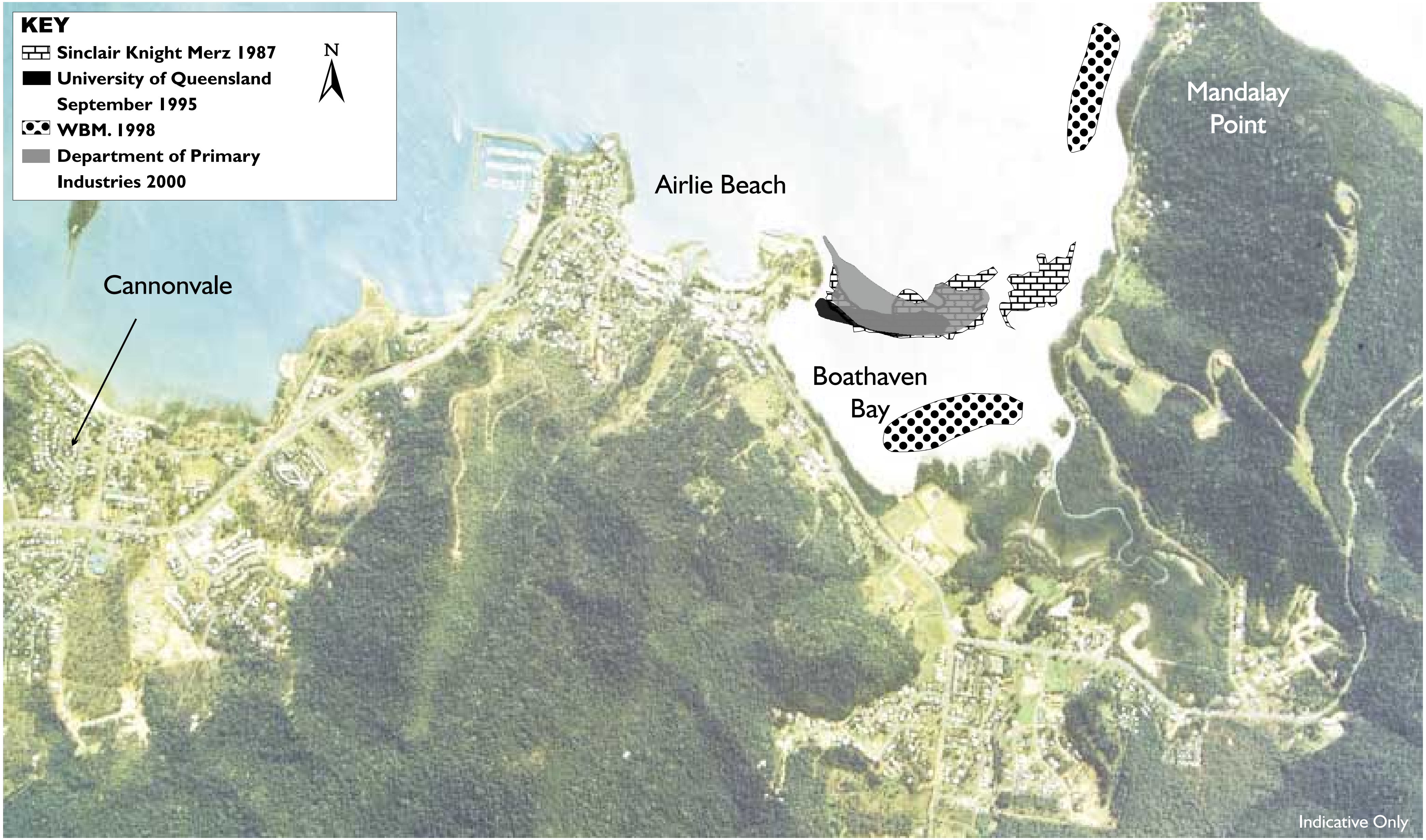
In Boathaven Bay there are extensive seagrass meadows in both the lower intertidal and shallow subtidal areas (**Figure 9-2** to **Figure 9-4**). The distribution and community composition of seagrasses within this bay (and the Whitsunday region generally) has fluctuated significantly over time (FRC Environmental 2002; 2001; 2001a; 2000; 2000a; 1999; 1999a; 1998; 1998a; Dennison *et al*. 1995). Nevertheless, since the early 1990s there has been an overall increase in the depth distribution, overall extent and density of seagrass in this bay. The dominant species is currently *Halodule uninervis*. *Halodule pinifolia, Halophila ovalis, Halophila ovata* and *Halophila spinulosa* have also been recorded from the bay (FRC Environmental 2002; WBM 1998) (**Figure 9-5**). This location and extent of seagrasses in Boathaven Bay is corroborated by seagrass mapping conducted by DPI based on surveys conducted in 1999 and 2000 in the Whitsunday Region (Map 6 of Campbell *et al*., 2002).



- **Figure 9-2 Distribution of key coastal fish habitat types (mangrove, saltmarsh, seagrass, intertidal flats, coral reefs and freshwater swamps) in the Whitsunday region (Bruinsma & Danaher 2001)**

- **Figure 9-3 Seagrass beds in the intertidal regions of Boathaven Bay**

- **Figure 9-4 Seagrass and coral reef distribution in the vicinity of the proposed development site, September 2002**



SINCLAIR KNIGHT MERZ

PORT OF AIRLIE MARINA

Temporal Seagrass Distribution

Figure 9-5

At the upper extent of seagrass distribution (from approx. 0.54 m LAT to approx. -0.4 m LAT[1]), the meadows are dominated by fine morphology *Halodule uninervis* with a minor component of small morphology *Halophila ovalis*. The meadow is nearly continuous across the bay, with cover ranging from less than 5% to over 90%. Change in percent cover is characteristically gradual. Cover is highest, and the meadow most intact, towards the centre of the bay. Within this *Halodule*-dominated meadow (below approx. 0.35 m LAT) there are discrete patches of medium morphology *Zostera capricorni*. Cover within these monospecific patches is typically 70 – 90%; and the patches themselves are typically in the order of 10 – 30 m^2. Currently, this meadow extends over an area of more than 15 ha across the bay. Seagrasses may extend to the north-east along the shore of the Mandalay peninsula.

As depths increase, the distribution of seagrass becomes increasingly patchy. Both *Halodule uninervis* and *Halophila ovalis* remain the dominant species, although both species below approx. –1.2 m LAT are predominantly present in their large morphologies. There are also patches of *Halophila spinulosa* below approximately -1.3 m LAT. Seagrasses are very sparse below approx. -1.7 m LAT (FRC Environmental 2002). Whilst accurate estimation of cover at depth is made difficult by limited visibility, recent surveys (FRC Environmental 2002; 2001; 2001a; 2000; 2000a; 1999; 1999a; 1998; 1998a) indicate overall seagrass cover below approximately -0.6 m LAT is about 10 – 20%; and below approximately -1.3 m LAT is about < 5%.

Table 9-1 summarises the seagrass species recorded in Boathaven Bay.

■ Table 9-1 Seagrass species of the region and of Boathaven Bay

Species	Common Name	Recorded in Region	Recorded in Bay
Cymodocea serrulata		✓	
Halodule pinifolia		✓	✓
Halodule uninervis		✓	✓
Halophila ovalis	Paddle weed	✓	✓
Halophila ovata		✓	✓
Halophila spinulosa		✓	✓
Zostera capricorni	Eel grass	✓	✓

Each of the species recorded in the region is common within shallow, sheltered, inshore environments of Australia's tropical east coast.

Seasonality of Distribution and Abundance

In the Whitsunday region, seagrass distribution and abundance is commonly greatest during early Spring, and least at the end of Summer (FRC Environmental 2002). This is due to increased desiccation intertidally, and increased turbidity subtidally, during the warmer months. This pattern is common in North Queensland seagrass communities (Mellors *et al.* 1993; McKenzie 1994; Lanyon and Marsh 1995). However, the seagrasses of the Pioneer Bay region do not always reflect this pattern of expansion and contraction, suggesting that on occasion seasonal influences are tempered by other factors (FRC Environmental 2002).

[1] Minor patches of seagrass are also found occasionally in depressions amongst the rocky outcrops of the foreshore.

Seagrasses in the Region

From 1987 to 1999-2000 a 40% increase in meadow area compared with surveys in 1987 (3355 ha) was measured by DPI (Campbell *et al.*, 2002). The distribution of seagrasses in the region is shown in **Figure 9-5**. Whilst this map was published by the Department of Primary Industries in 2001, it is based on seagrass surveys undertaken in 1987. The general distribution of seagrasses in the region has not changed significantly according to regional scale mapping by DPI (map 2 in Campbell *et al.*, 2002).

In contrast, there has been a reduction in the extent of seagrasses in Pioneer Bay region since 1987, from 519 ha to 134 ha but this is primarily due to a contraction of up to 1.3 km in the seaward extent of the meadow mapped in 1987. Th inshore meadow (in Boathaven Bay) seems relatively unchanged (Campbell *et al*., 2002). The seagrasses of Pioneer Bay comprise a significant percentage of inshore seagrasses of the region (perhaps 15%); and those of Boathaven Bay comprise approx. 30% of the seagrasses within Pioneer Bay. More extensive seagrass meadows are associated with the islands of the Whitsunday group.

Intertidal Mudflats

The intertidal flats of Boathaven Bay grade from soft sandy silts to silty sands with rubble inclusions (WBM 1998) (**Figure 9-6** and **Figure 9-7**). Close to the bight of the bay (adjacent to Shute Harbour Road and in the vicinity of Campbell Creek) and in a subtidal area to the south-east of the Whitsunday Sailing Club sediments are predominantly soft sandy silts. Firmer silty sands are found in patches along northern and western shores of the bay, along the southern shore, and across the broad intertidal flats of the bay.

■ **Figure 9-6 Sediments close to the bight of Boathaven Bay and south-east of the Whitsunday Sailing Club are soft sandy silts**

■ **Figure 9-7 Silty sands with rubble inclusions on the south-western shore**

Subtidal Rocky Shore and Coral Reef Communities

Along the rocky shores of the Whitsunday coast there is a discontinuous fringe of coral communities. Sparse coral communities are associated with the rocky headland at the north-western extent of the bay, and along the Mandalay promontory to the north east (FRC Environmental 1998; WBM 1998).

In Boathaven Bay macroalgae and turf algae compete with hard and soft corals for available substratum. Currently, macroalgae and turf algae contribute to limit the recruitment of hard and soft corals, and are occasionally seen overgrowing hard corals. At a community level this apparent algal 'competition' is moderate and is characteristic of many of Queensland's fringing reef areas. Macroalgae are able to encroach upon hard and soft corals either when environmental conditions change to favour algae (for example an increase in available nutrients) or when conditions change to the detriment of hard and soft corals (for example severe fluctuations in salinity and / or temperature, and increased turbidity).

9.1.3 Marine Fauna and Fisheries

Benthic Fauna

Benthic Fauna of the Region

The Whitsundays region includes a number of embayments dominated by soft sediments (ranging from rubbles through sands to fine silts), commonly fringed by mangroves, supporting seagrass, and with some rocky outcrops. Given the planktonic larval stages characterising each of the benthic fauna recorded from Boathaven Bay, it is reasonable to conclude that each species is likely to be widely distributed and common within the region.

The distribution of soft sediment intertidal flats is shown in **Figure 9-2**. Whilst the extent of intertidal flats within Boathaven and Pioneer Bay is probably under-represented in the figure, clearly, this habitat type is well represented within the region.

Hard and soft corals are found throughout the region, associated with subtidal rocky outcrops (FRC Environmental 2002). The dominant species (e.g. *Turbinaria* spp, *Favia* spp. and *Goniopora* spp.) are tolerant of unstable conditions, particularly elevated turbidity.

The distribution of coral reef patches in Boathaven Bay is shown in **Figure 9-4**. There are patches of coral adjacent to Mandalay Point and the Whitsunday Sailing Club and are part of the combined mangrove, mudflat and seagrass ecosystems of Pioneer Bay.

The subtidal hard bottom communities of Boathaven Bay are similar to those of other embayments of the region (FRC Environmental 2002; WBM 1998). Studies by WBM (1998) found in particular that:

- consistent with other areas, coral cover was highly variable within and among sites. Mean hard and soft coral percentage cover values were not unusually high within the study area,
- among the hard corals, the numerical dominance of *Goniastrea* spp., *Turbinaria* spp., massive *Favites* and *Acropora* spp. is typical of turbid, near-shore environments; and
- the high cover of the brown algae *Sargassum* is a typical feature of shallow near-shore reefs.

Benthic Infauna

The macroinvertebrate infauna communities of Boathaven Bay are characterised by a diverse and moderately abundant fauna, characteristic of intertidal communities in the Whitsunday region (WBM 1998). The two most abundant infaunal taxa are lucinid bivalves and capitellid polychaetes. Lucinid bivalves are commonly found in estuarine mudflats and capitellid polychaetes are one of the most abundant polychaete families in estuarine areas, particularly in habitats containing high organic matter (WBM 1998).

Subtidally anemones and sea pens are common and there are abundant mantis shrimp burrows (pers. obs.).

Benthic Epifauna

Currently small whelks (*Cerithium* sp.) are extremely abundant (densities exceeding 100 m^2) in the mid-intertidal, other grazing gastropods and carnivorous gastropods (including *Polinices* sp.) are also common. *Cerithium* sp. were also highly abundant in epifaunal sampling in Boathaven Bay and the mangrove communities of Campbell Creek (WBM 1998). Small solitary ascidians and brittlestars were also abundant. The gastropods *Nerita balteata*, *Littoraria scabra*, *Cerithidea reida* and *Astralia squariferum* were common in the bay's fringing mangrove forests (WBM 1998), and the mud creeper *Telescopium telescopium* common on muddy substrata both within and adjacent to fringing mangroves (pers. obs.; WBM 1998) (**Figure 9-8**).

■ **Figure 9-8 The mud creeper *Telescopium telescopium* is common on muddy substrata both within and adjacent to fringing mangroves**

Intertidal rocky shores supported abundant epifaunal communities. *Nodilittorina pyramidalis* was present in the supralittoral zone of the rocky outcrop on the eastern tip of the bay. *Patella* spp. and the carnivorous gastropod *Morula* sp. were common further seaward, as were barnacles and bivalves (*Chama pacifica)* (WBM 1998).

Shore crabs (Grapsidae and Ocypodidae) are common throughout the bay's fringing mangrove forests (pers. obs.; WBM 1998), and most abundant in mangrove communities fringing Campbell Creek (WBM 1998). Hermit crabs and snapping shrimps are common lower on the shore (WBM 1998).

In nearby Shute Bay a range of mobile macrobenthos including: *Calappa* sp. and *Camposcia* sp. crabs; estuary shrimp (*Palaemonetes* sp.); bay prawns (*Metapenaeus* sp.); brown tiger prawns (*Penaeus esculentus*); and squat lobsters (Galatheidae) were collected in a recent beam trawl survey (FRC Environmental 1999b). These species are also likely to be present in Boathaven Bay.

Common coral species in the vicinity of the north–western headland include *Turbinaria mesenterina, T. reniformis, T. peltata, Porites* spp., *Goniastrea retiformis* and *Favia* sp. Occasional softcorals of the genera *Xenia* and *Sarcophyton* were also recorded. There are large areas of bare bedrock covered with a thin layer of turf algae and silt in these coral communities (WBM 1998). Other parts of the headland, for example on the northern face of the Whitsunday Sailing Club rock wall, have *Sargassum* (algae) dominated rocky shore communities.

The eastern side of Boathaven Bay approaching Mandalay Point supports coral outcrops along a subtidal fringe. Hard coral cover is patchy, common species include *Goniastrea retiformis, Turbinaria reniformis, T. mesenterina* and *Acropora* spp. Common soft corals include *Xenia* sp,, *Sarcophyton* sp., *Sinularia* sp. and *Dendronephthya* sp.

Fish

Seagrass beds and associated bare substrate support fishes such as blennies, gobies, and mudskippers (EMG 1988). Other common fish species of the bay are likely to include whiting (*Sillago* spp.), silverbiddies (*Gerres argyreus)* and flat-tailed mullet (*Liza dussumieri*) (EMG 1988). Sub-adult prawns of three species (king, banana and tiger) have been recorded on bare substrates adjacent to seagrass (SKM 1988).

Mangroves in the region support trevallies (*Caranx* spp.), cod (*Epinephelus* spp.), mangrove jack (*Lutjanus argentimaculatus*) and mud crab (*Scylla serrata),* among others (EMG 1988).

Gill netting in Boathaven Bay (WBM in Burchill1998) resulted in the capture of 23 species from 16 families. Major findings of this sampling include:

- the most specious families were mullet (Mugilidae), trevally (Carangidae) and herrings (Clupeidae);
- 16 out of 23 species caught were of direct commercial fisheries value;
- all species captured, except sea mullet (a catadromous species) were primary estuarine/saltwater species; and
- the most abundant species caught were snub–nose garfish, threadfin salmon, herring, grunter bream and tiger mullet. All of these species are of direct commercial value.

It is likely that sampling using a greater variety of gears and mesh sizes would have resulted in an ever greater diversity of species being recorded. The fish assemblages of Boathaven Bay are characteristically associated with shallow, soft-sediment and mangrove fringed embayments of the region and beyond. All fish species recorded are widespread and common in the region (WBM in Burchill 1998).

Whilst no quantitative data is available, the size of the bay together with the variety of habitat present suggest that Boathaven Bay supports a diverse and highly productive finfish community. The bay’s mangrove and seagrass habitats are likely to provide important nursery habitat to a variety of commercially and recreationally important species.

More extensive surveys have been conducted by DPI Queensland Fisheries Service off the Laguna Quays Resort in nearby Repulse Bay which is about 20km to the south between 1991 to 1994. Unpublished data from this survey is provided in **Appendix T**. The survey was of four habitats similar to those found in Boathaven Bay including: mangrove foreshore; a small tidal creek; intertidal flat; and offshore. The survey recorded 251 species of fish from 69 families. The vast majority of these fish, however, were from the offshore habitat which is probably more similar to Pioneer Bay in the study area rather than the shallower inshore area of Boathaven Bay.

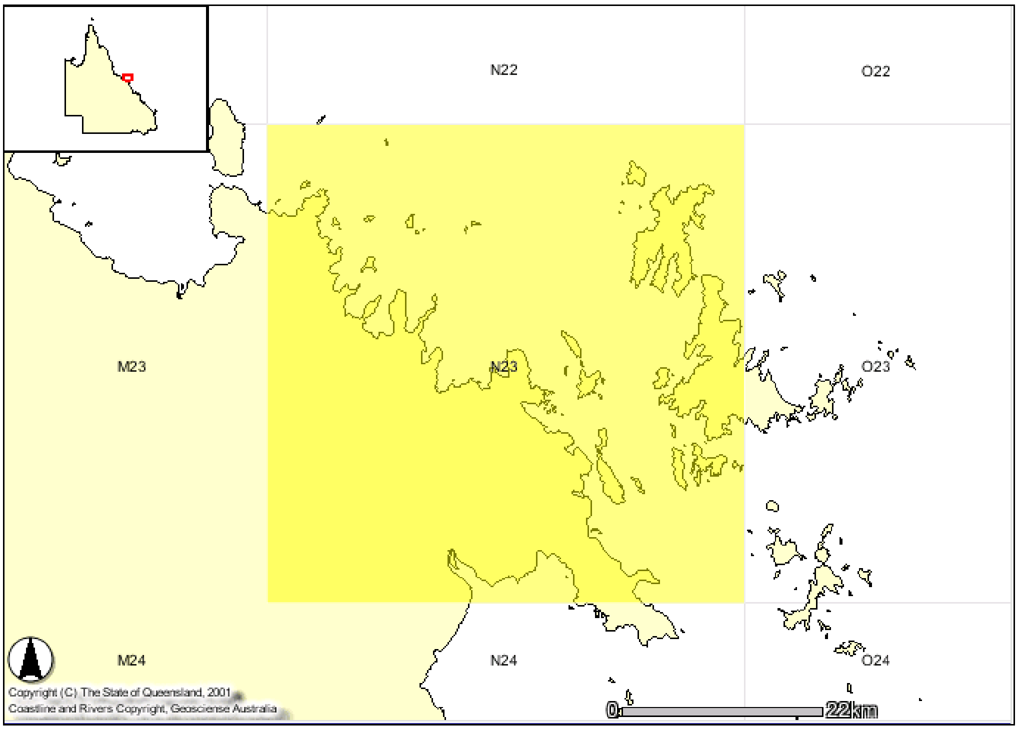
Fisheries

Boathaven Bay supports a variety of habitat widely recognised to contribute to fisheries productivity (Blaber 1997; Halliday & Young 1996; Laegdsgaard & Johnson 1995; West & King 1996; Laegdsgaard and Johnson 1995; Connolly 1994; Coles & Lee Long 1985; **Figure 9-4**). The ecological values of mangroves, seagrasses and soft sediment benthic communities are discussed in **Appendix I**.

Commercial fishing

The only recognised fishery in Boathaven Bay is opportunistic crabbing within Campbell Creek and foreshore mangroves of the bay by individuals for personal use. The low usage of the bay by commercial fishers is said to be due to the recognition of the values of this type of area as a nursery. The current lack of commercial shore facilities and navigational difficulties is also likely to be a significant factor. Proximity to residential areas is also a factor, with the potential conflict between commercial operators and the public a concern (WBM 1998).

Commercial fishing summary data for the Whitsunday region (DPI Chrisweb grid N23; **Figure 9-9**) for 2001 are provided in **Table 9-2**.



■ **Figure 9-9 Whitsunday region commercial fishing reference grid N23 (from DPI Chrisweb database)**

Table 9-2 Whitsunday region commercial catch data summary for 2001 (from DPI Chrisweb database)

Grid	Fishery	Species	Tonnes	Boats	Days	GVP (AUS $)
N23	Trawl - Otter	All Species	24.7	28	225	$375,712.00
N23	Pot - Crab	All Species	8.87	14	466	$93,011.00
N23	Net	All Species	52.2	21	486	$253,996.00
N23	Line	All Species	3.91	7	94	$23,963.00
N23	All	All Species	90.09	54	1208	$750,328.00

GVP = Gross Value of Production

Recreational fishing

Boathaven Bay is a low–use recreational fishing area, when compared to other areas in the region (WBM 1998; SunFish, pers. comm.).

9.2 Protected Flora and Fauna

The Whitsunday region is recognised as supporting a variety of floral and faunal species and communities that are protected under either or both State and Commonwealth legislation.

9.2.1 Marine Flora

All marine plants, including mangroves, seagrass and saltmarsh plants that grow on intertidal and subtidal lands are fully protected under Section 123 of the *Fisheries Act 1994*. It is an offence to unlawfully remove, damage or destroy a marine plant. A marine plant is defined as a plant that usually grows on, or adjacent to tidal lands and includes seagrasses, macro-algae, mangroves and saltmarshes. A permit (issued under s51) to undertake these activities may be obtained on successful application to the chief executive of the Department of Primary Industries Queensland Fisheries Service.

9.2.2 Marine Fauna

Turtles

Two species of sea turtle have been observed in Boathaven Bay, the green turtle *(Chelonia mydas)* and the flatback turtle *(Natator depressa)*. Both of these species are listed as ‘vulnerable’ under schedule 3 of the *Nature Conservation Act 1992, Nature Conservation (Wildlife) Regulation 1994;* and the Commonwealth’s *Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act).* Additionally, the loggerhead turtle *(Caretta caretta)*, leathery turtle (*Dermochelys coriacea)* and the hawksbill turtle *(Eretmochelys imbricata)* are known from the Whitsunday region, although they have not been recorded from Boathaven Bay. Under Schedule 3 of the *Nature Conservation Act 1992 (NCA), Nature Conservation (Wildlife) Regulation 1994*, loggerhead and leathery turtles are listed as ‘endangered’, and the hawksbill turtle is listed as ‘vulnerable’ (WBM 1998). Under the *EPBC Act* the hawksbill and leathery turtle are listed as ‘vulnerable’, and the loggerhead turtle is listed as ‘endangered’. All sea turtles are protected under the ‘marine’ and ‘migratory’ provisions of the *EPBC Act.*

The dominant seagrasses of Boathaven Bay, *Halophila* and *Halodule* species are the preferred foraging species for green turtle feeds. Green turtles also feed on the propagules of the mangrove *Avicennia marina*, which are likely to be seasonally common in the bay. Given the range of reef and intertidal habitats, Boathaven Bay also provides suitable feeding areas for flatback, hawksbill, leathery and loggerhead turtles. Boathaven Bay is not known to support turtle nesting, and is unlikely to do so for any turtle species (Mather & Bennett 1993 cited in WBM 1998).

On the basis of available information, Boathaven Bay is likely to have moderate conservation value for sea turtles at regional and national scales.

Crocodiles

Discussions with local residents indicate that saltwater crocodiles (*Crocodylus porosus*) have occasionally been recorded in Campbell Creek, but can be considered as uncommon overall.

Saltwater crocodiles are declared 'vulnerable' under the *NCA*, and protected under the 'marine' and 'migratory' provisions of the *EPBC Act.*

Dugong

Australian coastal waters, particularly in Queensland, are considered to have the highest Dugong population densities in the world. Dugong are listed as 'vulnerable' under schedule 3 of the Queensland *Nature Conservation Act 1992, Nature Conservation (Wildlife) Regulation 1994*. Dugong are also protected under the *EPBC Act*, under the 'migratory' and 'marine' provisions. Dugong populations in the southern Great Barrier Reef (GBR) region are listed as 'critically endangered' by the IUCN (Marsh *et al.* 1996, cited in WBM 1998).

Dugong feed almost exclusively on the seagrass species *Halophila ovalis, Halophila spinulosa* and *Halodule uninervis* (Lanyon & Morrice 1997; Preen *et al*. 1995; Preen 1992). Dugong feeding trails have been observed within Boathaven Bay (pers. obs.) According to local residents Dugong sightings are rare in Boathaven Bay, but are common in bays to the north (WBM 1998).

Dugong numbers in the Whitsunday region are generally low and numbers have dramatically declined in the past 2 to 3 decades (Marsh *et al*. 1996, cited in WBM 1998). This is consistent with other regions where this species occurs (Marsh *et al*. 1996, cited in WBM 1998). Possible causes for this decline in Dugong numbers include loss of seagrass beds due to coastal development, indigenous hunting, and incidental catches by fishing operations (Marsh *et al.* 1996, cited in WBM 1998). Dugong sanctuaries are established within Edgecumbe Bay approx. 80 km to the north and Repulse Bay approx. 120 km to the south: Boathaven Bay: there are no such sanctuaries in Boathaven or Pioneer Bays.

Dolphins

Common dolphins (*Delphinus delphis)* and bottlenose dolphin (*Tursiops truncatus)* inhabit Boathaven Bay. The Indo-Pacific hump-backed dolphin (*Sousa chinensis*), classified as 'rare' under the *NCA* is also likely to use the area. These dolphins are coastal and are rarely seen more than 20 km out to sea, preferring areas in which there are lagoons, estuaries or mangrove swamps (Bryden *et al.* 1998). Humpback dolphins eat fish, particularly those associated with estuarine habitats. The usual social unit is a group of 2 – 20 with an average of 8.

Several other species of dolphin have a range that potentially includes Boathaven Bay (Bryden *et. al* 1998). These include the Irrawaddy River dolphin (*Orcaella brevirostris*, listed as 'rare' under the *NCA)*, Risso's dolphin (*Grampus griseus)*, the pantropical spotted dolphin (*Stenella attenuata)* and the spinner dolphin (*Stenella longirostris)*. It is unlikely that Boathaven Bay would provide significant habitat for any of these species.

All delphinids are protected under the 'cetacean' provisions of the *EPBC Act.*

Fish

Whilst whale sharks (*Rhincodon typus*) and great white sharks (*Carcharodon carcharias)* have a range that includes the Whitsunday coast, and are both listed as 'vulnerable' under the *EPBC Act* (and whale sharks are also protected under the 'migratory' provisions of the Act), it is unlikely that these species would frequently enter Boathaven Bay.

A number of syngnathid (sea horse, sea dragon and pipefish) species, and solenostomid (ghost pipefish) species are likely to inhabit the area. Species in these families are protected marine species under the *EPBC Act*. Many syngnathid (and solenostomid) species such as the double-ended pipefish, and the flat-faced seahorse are associated with bays and estuaries, and are often found in seagrass beds (EMGrant 1987).

9.2.3 Conservation Estate

The conservation value of Boathaven Bay and the region; of ecosystems; and of particular taxa are ascribed by a variety of Commonwealth and State legislation. The relevant legislation is discussed below. In each instance, this legislation has been enacted to provide protection to the whole state / country.

Commonwealth Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)

This Act commenced on the 16th July 2000. This Act provides that certain actions, in particular actions that are likely to have a significant impact on a matter of national environmental significance, are subject to a rigorous assessment and approval process. The Commonwealth may delegate to the States the responsibility for conducting assessments and, in limited circumstances, the responsibility for deciding whether to grant approval.

Matters of national significance identified in the Act as triggers for the Commonwealth assessment and approval regime are:

- World Heritage properties
- Ramsar wetlands
- Nationally threatened species and ecological communities
- Migratory species
- Commonwealth marine areas
- Nuclear Actions (including uranium mining).

The *EPBC Act* is of significance to the proposed development in the context of World Heritage properties (GBRWHA), nationally threatened species, and migratory species.

Nature Conservation Act 1992 and the *Nature Conservation (Wildlife) Regulation 1994*

This Act and the regulations are administered by the (Queensland) Environmental Protection Agency and provides generally for the protection and management of protected areas, native wildlife and wildlife habitats throughout Queensland. Wildlife is classified and listed in the Regulations as presumed extinct; endangered; vulnerable; rare or common. Under the Act, conservation plans may be prepared for any native wildlife, habitat or area that contains natural resources of significant nature conservation value. Final conservation plans take effect as subordinate legislation, and local governments must not give approval to a proposal that is inconsistent with a conservation plan.

Species listed in Environmental Protection and Biodiversity Conservation Act 1999 and *Nature Conservation Act 1992 Provisions*

There are a number of species of conservation significance noted or likely to occur in the study area (as listed in the EPA's Wildnet database, and the EPBC online database). These are listed **Table 9-3** to **Table 9-5**. Relevant species are discussed in **Section 9.2**.

- **Table 9-3 Listed marine species recorded from the Whitsunday's Region (EPA Wildnet Database)**

	Species	Common name	NCA	EPBC Act
Chondrichthyes	*Carcharodon carcharias*	Great White Shark	-	Vulnerable
Chondrichthyes	*Rhincodon typus*	Whale Shark		Vulnerable
Mammalia	*Megaptera novaeangliae*	Humpback Whale	Vulnerable	Vulnerable
Reptilia	*Caretta caretta*	Loggerhead Turtle	Endangered	Endangered
Reptilia	*Chelonia mydas*	Green Turtle	Vulnerable	Vulnerable
Reptilia	*Dermochelys coriacea*	Leathery Turtle	Endangered	Vulnerable
Reptilia	*Eretmochelys imbricata*	Hawksbill Turtle	Vulnerable	Vulnerable
Reptilia	*Natator depressus*	Flatback Turtle	Vulnerable	Vulnerable

Of these species, only the green and loggerhead turtles are commonly seen within Boathaven Bay.

- **Table 9-4 Marine species covered by 'migratory' provisions of the *EPBC Act***

	Scientific Name	Common Name	NCA	EPBC
Chondrichthyes	*Rhincodon typus*	Whale Shark	-	Vulnerable
Mammalia	*Dugong dugon*	Dugong	Vulnerable	-
Mammalia	*Megaptera novaeangliae*	Humpback Whale	Vulnerable	Vulnerable
Reptilia	*Caretta caretta*	Loggerhead Turtle	Endangered	Endangered
Reptilia	*Chelonia mydas*	Green Turtle	Vulnerable	Vulnerable
Reptilia	*Crocodylus porosus*	Estuarine or Salt-Water Crocodile	Vulnerable	-
Reptilia	*Dermochelys coriacea*	Leathery Turtle	Endangered	Vulnerable
Reptilia	*Eretmochelys imbricata*	Hawksbill Turtle	Vulnerable	Vulnerable
Reptilia	*Natator depressus*	Flatback Turtle	Vulnerable	Vulnerable

Table 9-5 Marine species covered by 'marine' provisions of the *EPBC Act*

	Scientific Name	Common Name	NCA	EPBC
Mammalia	*Dugong dugon*	Dugong	Vulnerable	-
Osteichthyes	*Acentronura tentaculata*	Pipehorse	-	-
Osteichthyes	*Campichthys tryoni*	Tryon's Pipefish	-	-
Osteichthyes	*Choeroichthys brachysoma*	Short-bodied Pipefish	-	-
Osteichthyes	*Choeroichthys suillus*	Pig-snouted Pipefish	-	-
Osteichthyes	*Corythoichthys amplexus*	Brown-banded Pipefish, Fijian Pipefish	-	-
Osteichthyes	*Corythoichthys flavofasciatus*	Network Pipefish, Yellow-banded Pipefish	-	-
Osteichthyes	*Corythoichthys intestinalis*	Banded Pipefish, Australian Messmate Pipefish	-	-
Osteichthyes	*Corythoichthys ocellatus*	Ocellated Pipefish, Orange-spotted Pipefish	-	-
Osteichthyes	*Corythoichthys paxtoni*	Paxton's Pipefish	-	-
Osteichthyes	*Corythoichthys schultzi*	Schultz's Pipefish	-	-
Osteichthyes	*Cosmocampus darrosanus*	D'Arros Pipefish	-	-
Osteichthyes	*Doryrhamphus excisus*	Bluestripe Pipefish	-	-
Osteichthyes	*Festucalex cinctus*	Girdled Pipefish	-	-
Osteichthyes	*Halicampus dunckeri*	Duncker's Pipefish	-	-
Osteichthyes	*Halicampus grayi*	Gray's Pipefish, Mud Pipefish	-	-
Osteichthyes	*Halicampus nitidus*	Glittering Pipefish	-	-
Osteichthyes	*Halicampus spinirostris*	Spiny-snout Pipefish	-	-
Osteichthyes	*Hippichthys cyanospilos*	Blue-spotted Pipefish, Blue-speckled Pipefish	-	-
Osteichthyes	*Hippichthys heptagonus*	Reticulated Freshwater Pipefish, Madura Pipefish	-	-
Osteichthyes	*Hippichthys penicillus*	Steep-nosed Pipefish, Beady Pipefish	-	-
Osteichthyes	*Hippocampus bargibanti*	Pygmy Seahorse	-	
Osteichthyes	*Hippocampus kuda*	Spotted Seahorse, Yellow Seahorse	-	-
Osteichthyes	*Hippocampus planifrons*	Flat-face Seahorse	-	-
Osteichthyes	*Hippocampus zebra*	Zebra Seahorse	-	-
Osteichthyes	*Micrognathus andersonii*	Shortnose Pipefish, Anderson's Pipefish	-	-
Osteichthyes	*Micrognathus brevirostris*	-	-	-
Osteichthyes	*Nannocampus pictus*	Reef Pipefish, Painted Pipefish	-	-
Osteichthyes	*Solegnathus hardwickii*	Pipehorse	-	-
Osteichthyes	*Solenostomus cyanopterus*	Blue-finned Ghost Pipefish, Robust Ghost Pipefish	-	-
Osteichthyes	*Solenostomus paradoxus*	Harlequin Ghost Pipefish, Ornate Ghost Pipefish	-	-
Osteichthyes	*Syngnathoides biaculeatus*	Alligator Pipefish, Double-ended Pipehorse	-	-
Osteichthyes	*Trachyrhamphus bicoarctatus*	Short-tailed Pipefish, Bend Stick-pipefish	-	-
Osteichthyes	*Trachyrhamphus longirostris*	Long-nosed Pipefish, Straight Stick-pipefish	-	-
Reptilia	*Acalyptophis peronii*	Horned Seasnake	-	-
Reptilia	*Aipysurus duboisii*	Dubois' Seasnake	-	-
Reptilia	*Aipysurus eydouxii*	Spine-tailed Seasnake	-	-
Reptilia	*Aipysurus laevis*	Olive Seasnake	-	-
Reptilia	*Astrotia stokesii*	Stokes' Seasnake	-	-
Reptilia	*Caretta caretta*	Loggerhead Turtle	Endangered	Endangered
Reptilia	*Chelonia mydas*	Green Turtle	Vulnerable	Vulnerable
Reptilia	*Crocodylus porosus*	Estuarine or Salt-Water Crocodile	Vulnerable	-
Reptilia	*Dermochelys coriacea*	Leathery Turtle	Endangered	Vulnerable
Reptilia	*Disteira kingii*	Spectacled Seasnake	-	-

	Scientific Name	Common Name	NCA	EPBC
Reptilia	*Disteira major*	Olive-headed Seasnake	-	-
Reptilia	*Enhydrina schistosa*	Beaked Seasnake	-	-
Reptilia	*Eretmochelys imbricata*	Hawksbill Turtle	Vulnerable	Vulnerable
Reptilia	*Hydrophis elegans*	Elegant Seasnake	-	
Reptilia	*Hydrophis mcdowelli*		-	-
Reptilia	*Hydrophis ornatus*	a seasnake	-	-
Reptilia	*Lapemis hardwickii*	Spine-bellied Seasnake	-	-
Reptilia	*Laticauda colubrina*	a sea krait	-	-
Reptilia	*Laticauda laticaudata*	a sea krait	-	-
Reptilia	*Natator depressus*	Flatback Turtle	Vulnerable	Vulnerable
Reptilia	*Pelamis platurus*	Yellow-bellied Seasnake	-	-

The Great Barrier Reef World Heritage Area (GBRWHA)

The Great Barrier Reef (GBR) was included on the World Heritage List in 1981, as it represents, contains or provides:

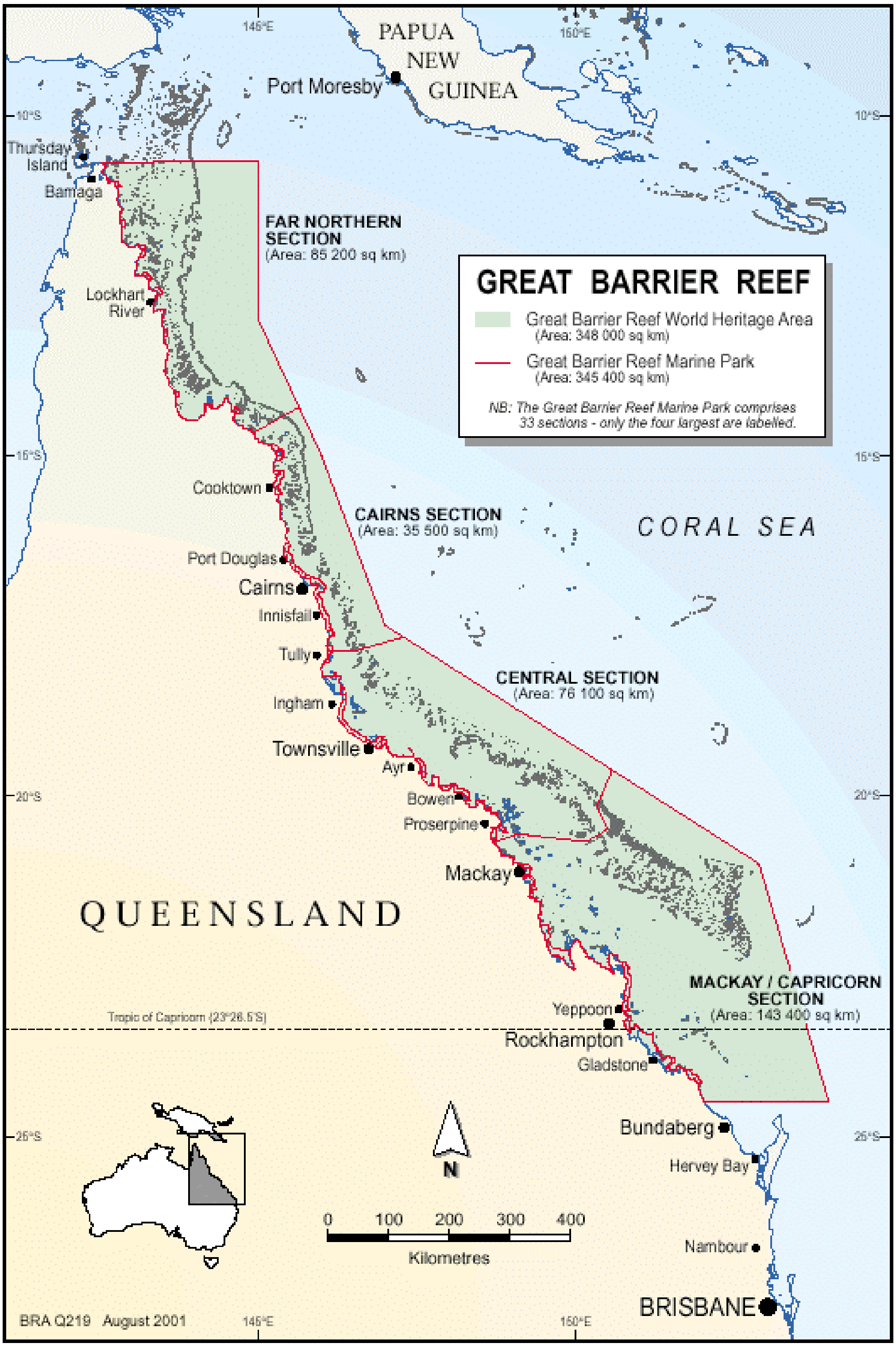
- an outstanding example representing a major state of the Earth's evolutionary history;
- an outstanding example representing significant ongoing geological processes, biological evolution and man's interaction with his natural environment;
- unique rare and superlative natural phenomena, formations and features and areas of exceptional natural beauty; and
- habitats where populations of rare and endangered species of plants and animals still survive.

Properties that have been inscribed on the World Heritage list are automatically 'declared World Heritage Properties' and are therefore protected under the *EPBC Act*.

Any portion of the proposed development below 'low water' would lie within the GBRWHA (Paul Davies, GBRMPA pers. comm. 2002; **Figure 9-10**).

The Great Barrier Reef Marine Park

The Great Barrier Reef Marine Park (GBRMP) was established in 1975 to protect the values of the Reef and to manage activities within the Marine Park area. The GBRMP is managed by the Great Barrier Reef Marine Park Authority in conjunction with the Queensland Environmental Protection Agency and Queensland DPI.



■ **Figure 9-10 The GBRMP and GBRWHA**

The Great Barrier Reef Marine Park Authority (GBRMPA) is the principal adviser to the Commonwealth Government on the care and development of the Great Barrier Reef Marine Park. GBRMPA's statutory responsibility is to manage the Marine Park with the goal of "providing protection, wise use, understanding and enjoyment" of the resources of the GBRMP Region in perpetuity. It requires the following to be taken into account in managing the GBRMP:

- the conservation of the GBR;
- the regulation of the use of the Marine Park so as to protect the GBR while allowing reasonable use of the GBR Region;
- the regulation of activities that exploit the resources of the GBR Region so as to minimise the effect of these activities on the GBR;
- the reservation of some of these areas of the GBR for the appreciation and enjoyment of the public; and
- the preservation of some parts of the GBR in its natural state, undisturbed by humans except for the purposes of scientific research.

Various management zoning plans have been gazetted under the *Great Barrier Reef Marine Park Act 1975*, in order to provide for right of activities, prohibited activities, and activities that can be undertaken with consent.

The Fisheries Act 1994 and Fisheries Regulations 1995

The *Fisheries Act 1994* and subordinate *Fisheries Regulation 1995* provide for the regulation of both commercial and recreational fisheries and for the protection of endangered species and habitat critical to sustaining fish stocks.

All marine plants, including mangroves, seagrass and saltmarsh plants that grow on intertidal and subtidal lands are fully protected under Section 123 of the *Fisheries Act 1994*. It is an offence to unlawfully remove, damage or destroy a marine plant, being a plant that usually grows on, or adjacent to tidal lands. A permit (issued under s51 of the *Regulation*) to undertake these activities may be obtained on application to the chief executive of the Department of Primary Industries, Fisheries Division.

A number of species are also protected under the *Fisheries Act* and *Regulation* and cannot be taken: Helmet, trumpet and clam shells are totally protected. Initially the trumpet or triton shell was protected as the only known natural predator of the crown-of-thorns starfish. The helmet shell was later also thought to eat crown-of-thorns. Further research showed this not to be the case, but the protection has remained. Clams are protected due to their vulnerability, especially to collection as a food for the South-East Asian market. Some species of giant clams are now cultured for this market, and smaller species are cultured for the aquarium trade.

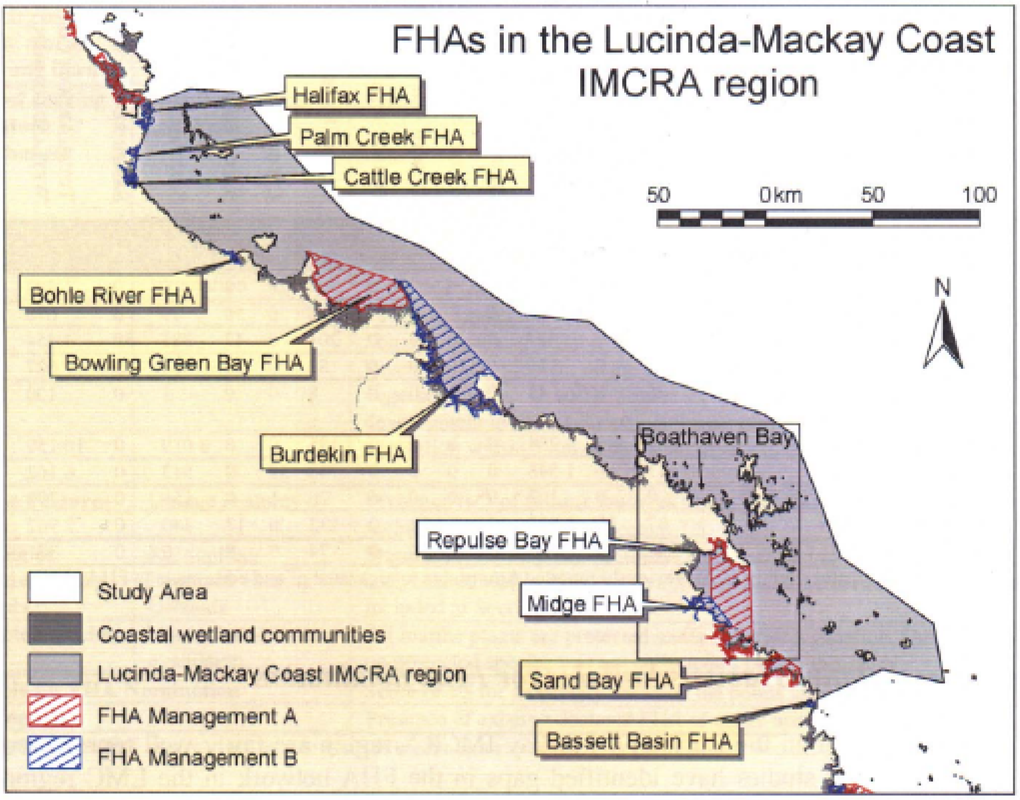
Female mud crabs and blue swimmer crabs are totally protected. The mud crab (*Scylla serrata*) and blue swimmer (*Portunus pelagicus)* fisheries are of major commercial and recreational importance. Protecting the females allows them to breed and replenish the populations. Since sexually mature males are able to mate with many more than one female during the breeding season, they are able to be harvested. However, males have a minimum legal size limit of 15 cm across the carapace to allow them to reach sexual maturity and contribute at least once to the breeding population.

Female crabs and bugs carry their eggs as a mass beneath their tail flaps, protecting them until they hatch. For this reason, berried (egg-bearing) female spanner crabs, sea bugs and slipper lobsters are protected to allow fertilised eggs to reach hatching stage.

In line with all other Australian States and with world-wide recognition of their vulnerability, the grey nurse and great white sharks are totally protected in Queensland under the *Fisheries Act 1994* and Regulations.

Fish Habitat Areas

No 'Fish Habitat Areas' have been declared under the provisions of the *Fisheries Act 1994* within Boathaven Bay (**Figure 9-11**).



- **Figure 9-11 Fish Habitat Areas in the Whitsunday Region (Bruinsma & Danaher 2001)**

9.3 Potential Impacts

Potential impacts of the proposed development may be associated with the development of the site, or with the consequent use of the developed facilities. Impacts may be direct (e.g. removal of habitat) or indirect (e.g. through influences on water quality).

The potential impacts of development are clearly related to the sensitivities of floral and faunal communities within the area influenced by the proposed development. **Appendix J** provides a discussion of the various environmental factors influencing the distribution and abundance of key floral and faunal communities.

Whilst the proposed development will inevitably result in some detrimental impacts, it will also provide some ecological benefits.

9.3.1 Construction

9.3.1.1 Direct Impacts of Construction

Loss of Habitat

Development of the proposed marina-complex will result in the direct loss of approximately 1.2 ha of fringing mangrove forest; approximately 8 ha of intertidal and shallow subtidal seagrass meadows; and approximately 6.5 ha of unvegetated soft sediment intertidal and shallow subtidal lands. Placement of the dredge and excavation spoil will result in the loss of a further 2 ha (approximately) of unvegetated soft sediment intertidal lands.

Dredging of the access channel will result in the loss of approximately a further 2 ha of sparse seagrass and unvegetated soft sediment substrate.

Less than 0.1% of the intertidal and subtidal, unvegetated soft sediment in the region would be lost. The loss of these habitats is likely to have a minor local impact on associated flora and fauna; and cannot be considered to be significant in a regional context.

Approximately 40% of the current distribution of seagrass in Boathaven Bay would be lost, which equates to 15% of the seagrass meadows of greater Pioneer Bay; 2% of the seagrass meadows in the Whitsunday coastal region and 1% of total Whitsunday Region (Bruinsma & Danaher 2001). It must be acknowledged that any loss of habitat may be significant and may impact on associated flora and fauna at a regional scale. Species impacted would include commercially and recreationally important fish species and species of conservation significance including turtle and Dugong. As for the majority of seagrass meadows in the region a range of pressures associated with urbanisation currently impact these meadows.

However, it should be noted that the calculated loss of seagrass resulting from the marina development is likely to represent a maxima. Over the past decade, and in other seasons, there has been considerably less seagrass in Boathaven Bay than there is currently (September 2002) (FRC Environmental 2002). It is likely that as weather patterns change over the next decade and into the future, the seagrass distribution within Boathaven Bay will fluctuate markedly.

Seagrass meadows provide important nursery habitat, for a range of commercially important crustacean and finfish species (West and King 1996; Gray *et al*. 1996; Laegdsgaard and Johnson 1995; Connolly 1994; McNeill *et al*. 1992; Ramm 1986; Scott *et al*. 1986; Staples *et al*. 1985; Coles and Lee Long 1985; Middleton *et al*. 1984; Young 1978). For example, the species in Queensland's east coast commercial prawn fishery are dependent upon seagrass meadows as nursery areas. Juveniles shelter and feed in these areas before recruiting to deepwater fishing grounds (Zeller 1998). Seagrass leaves provide physical cover for the young prawns and a substrate for epiphytic algae and minute grazing animals, which form a major component of the prawns' diet. Some seagrasses including the common eelgrass (*Zostera capricorni*) are themselves eaten by juvenile tiger prawns (O'Brien 1995). This fishery (extending from Moreton Bay to the Cape) is valued at more than $50,000,000 (Williams 1997).

Seagrass meadows are very important for species of conservation significance such as Dugong and green turtle as it is the major component of their diet. Whilst there is insufficient data to accurately quantify the effect of the loss of seagrass on Dugong and turtle populations, it is generally accepted that Dugong numbers are strongly influenced by the availability of seagrass. Currently, the seagrass meadows of Boathaven Bay and the Pioneer Bay region do not appear to be 'over-grazed'. However Dugong numbers along the southern barrier reef coast are generally accepted as being at around 50% of pre 1995 numbers: the hope for recovery may increase grazing pressure within the region (CRC Reef 1998). From time to time, seagrasses of the region may also come under increased grazing pressure, when for example significant meadows elsewhere decline.

Seagrass meadows are also closely associated with the distribution of many syngnathid species, which are also conservationally significant.

Gain of Habitat

Construction of the proposed development will also result in the creation of other valuable habitats associated with the rock breakwaters (almost a kilometre), piles and other intertidal and subtidal structures. These hard surfaces will be designed to maximise the substrate available for algae, hard and soft corals, and a variety of other invertebrate fauna. In turn, this hard-substrate benthic community will provide shelter and food for a variety of fishes and other fauna (*vis*. nearby Able Point Marina).

The waters of the marina basin are likely to have a relatively low ecological value: similar waters are characteristically dominated by fishes of little direct commercial or recreational value (Morton 1989). Whilst the productivity supported by the structures of the proposed marina is likely to be significant, there is insufficient understanding to be able to accurately compare the net loss / gain. Simple consideration of the relative extent of habitat to be lost / gained suggests a likely net loss. The ecological value of habitat types is discussed in detail in **Appendix I.**

Blasting

Concussion effects from blasting in marine environments can cause death or harm to fish and other marine animals. Should blasting of shore rock be required for the installation of the sheet piles around the marina area, this can be carried out at low tide (ie when the rock areas are fully exposed) to avoid concussion effects. Once the sheet pile walls are in place, any blasting required will take place within this enclosure and there will be no risk of transmission of harmful shock waves through water.

9.3.1.2 Indirect Impacts of Construction

Overview

Construction activities likely to impact the marine environment include dredging, spoil consolidation, pile driving and similar activities. These construction activities may result in:

- increased suspended sediment levels and consequent sediment deposition within the bay and adjoining waters;
- potential impacts on seagrass communities through reduced light due to turbidity and smothering by suspended solids;

- potential changes in hydrodynamics in the Boathaven Bay;
- a release of nutrients from the disturbed sediments;
- spills of hydrocarbons and other contaminants;
- increased human activity, including changes in light and noise levels.

Note however, that the sediments of the site are not considered to contain contaminant levels of concern (refer to **Section 6.1.4** and **6.2.1**).

The marina basin will be excavated in dry conditions behind sheet piling. There will consequently be little impact on sedimentation or turbidity of adjoining waters during excavation. When the area is re-inundated there may be increases in turbidity due to the suspension of the newly exposed sediment.

The access channel will be dredged using a cutter-suction dredge, with the spoil pumped to the nominated spoil disposal area (refer **Figure 9-1**). It is anticipated that capital dredging will be completed within 2 months. Maintenance dredging is expected to take place every 10-15 years and will take approximately 1 month (refer to **Section 2.8.2**). Dredging activities will be scheduled in winter (May to September) where possible so that they are outside seagrass flowering and fish migration times. This timing will also be in the low rainfall season which will assist with management of tailwater within the maintenance dredging spoil disposal area.

The principal indirect impacts of construction activities are summarised below. Further discussion on water quality impacts is also provided in **Section 7**.

9.3.1.3 Increased Suspended Solids Concentration and Sediment Deposition

The effects of increased suspended solids and sedimentation resulting from dredging and dredge and excavation spoil disposal are highly variable. The likelihood of increases in suspended sediments and of smothering are closely related to the characteristics of the sediment. Coarse sediments settle from the water column quickly and are unlikely to move away from the dredge site. Fine sediments, such as those in the vicinity of the development are more easily suspended; remain suspended longer; may be carried further before settling, and consequently are more likely to smother marine organisms.

Enclosing the marina basin, excavating it in dry conditions and minimising the duration of construction and maintenance dredging will minimise the potential impacts of increased turbidity and sediment deposition. As discussed in **Section 7**, the overall increase in turbidity is expected to be confined to Boathaven Bay in the vicinity of the works and is not expected to result in significant impacts on habitat.

Similarly, management of sediment levels in waters discharged from the spoil disposal site will also minimise impacts on marine ecosystems.

Effects on Seagrass and Macroalgae

The increase in turbidity associated with dredging and dredge and excavation spoil disposal may decrease the penetration of light through the water column. Light availability, or specifically the duration of light intensity exceeding the photosynthetic light saturation point controls the depth distribution of seagrasses (Dennison and Alberte 1985; Dennison 1987; Abal & Dennison 1996). For example, on average 30% of surface light; a light attenuation co-efficient of less than $1.4m^{-1}$ and total suspended solids of less than 10 mg L^{-1} are required for the survival of *Zostera capricorni*

(Longstaff *et al*. 1998; Abal & Dennison 1996). *Halophila ovalis* another common species in the area, has a particularly low tolerance to light deprivation caused by pulsed turbidity such as floods and dredging (Longstaff *et al*. 1998). However, *Halophila ovalis* can quickly recolonise areas due to its high growth rate and high seed production.

Availability of light also affects the productivity of seagrasses. Seagrass exposed to higher light intensity is more productive than seagrass in less intense light (Grice *et al*. 1996). Consequently, impacts associated with dredging may result in at least a temporary decrease in seagrasses productivity. Light also controls the population dynamics of macroalgae (Lukatelich and McComb 1986a; cited in Lavery and McComb 1991).

Increases in turbidity are likely to be most pronounced during the dredging activities. However, impacts due to increases in turbidity due to dredging are likely to be short lived as construction dredging will only take approximately two months; and maintenance dredging will only occur every 10-15 years and will take approximately one month. Limiting dredging, at least initially, to the entrance channel will also decrease the impact. Turbidity generated from dredging works is less likely to have an impact on water quality and the marine flora and fauna of Boathaven Bay when background levels are high, as the proportional increase is not as great. Highest background levels typically occur in the wet season from about December to March, so dredging during these times are likely to have least impact, but is dependent on sea conditions. Impact to seagrasses will also be minimised by conducting dredging activities outside the primary seagrass flowering and fruiting times of September to December where possible.

Once dredging is complete, there may be some chronic increases in turbidity due to resuspension of the exposed sediment through boating and tidal movements. Suspended sediment from the construction activities may be deposited on surrounding seagrass beds, negatively impacting their growth.

Management of turbidity levels from dredging activities and the spoil disposal area will minimise potential impacts on seagrass and macroalgae. It is expected that if there are any impacts on the seagrass and macroalgae communities due to minor short term increases in turbidity, that once turbidities return to normal, these communities will recover.

Effects on Soft Sediment Benthos

The fauna associated with soft sediment habitats is typically determined by the character of the sediment: its grain size and stability and with the presence or absence of seagrass. Grain size influences the ability of organisms to burrow, and the stability of ‘permanent’ burrows. Unstable sediments support less diverse benthic communities than those that are relatively stable. Resuspension of fine sediments can interfere with the feeding and respiration of benthic fauna.

Increases in the concentration of suspended solids may impact the respiration and feeding of a variety of taxa reducing abundance, species diversity and productivity. The deposition of fine sediment over existing substrate is likely to influence the community structure in favour of those species most able to cope with fine sediment substrate to the disadvantage of those less able. Filter feeding and gilled fauna are most likely to be affected. Whilst it is not possible to accurately predict the broadscale ecological consequences of these changes on the available information, these consequences will be minimised by minimising the period of dredging and the amount of material dredged.

Effects on Corals and other Benthic Invertebrates

No coral communities are to be removed as a result of the excavation of the marina basin or dredging of the navigation channel.

The effects on coral reefs of increased sedimentation and light attenuation from sediment plumes can range from mild coral stress to subtle changes in community structure, to outright coral mortality and ecological collapse of the community.

The impacts of increases in sediment deposition on coral communities can include reduced algal and coral diversity and reductions in epifaunal densities (Hatcher *et al*. 1989). The varied biota found associated with coral communities, living or feeding in the crevices and crannies within and around corals are likely to suffer as these spaces are filled by deposited sediments (Johannes 1975). Coral communities are generally better developed, are more diverse, and with greater coral cover and rates of coral growth the lower the sediment load is in overlying waters (Rogers 1990). There is little quantitative information on the sub-lethal effects of chronic elevated turbidity and sedimentation.

Coral communities of the Whitsunday coast are influenced at a broad-scale by the discharges of the Proserpine and O'Connell Rivers. The coral communities of the Pioneer Bay area are dominated by abundant favids, encrusting *Montipora*, *Goniastrea*, *Porites*, *Goniopora* and *Turbinaria* species, and are typical of inshore river dominated communities. As such, they are highly influenced by both elevated suspended solids and nutrients and are habituated to existing in these environments. Corals found in coastal habitats are also generally more efficient at sediment clearance than those species typically found on offshore reefs (Salvat 1987), and can consequently withstand deposition of sediment better than offshore species.

Prolonged phases of elevated suspended sediment levels are likely to detrimentally impact this community. It is expected that given that construction dredging will only take approximately 2 months and that maintenance dredging will only occur every 10-15 years (refer to **Section 2.7.1.2**), high levels of suspended sediment will be similarly short-lived.

Estimates of dredging plumes made through hydrodynamic modelling in the 1998 IAS, show that it is unlikely that there will be any significant increases in turbidity levels in the vicinity of Mandalay Point where patchy coral communities has been recorded (see also **Section 7**). Any impacts on the patchy coral community near the Whitsunday Sailing Club would be cumulative on impacts in the region resulting from similar developments (Abel Point Marina and Vision Airlie Lagoon).

Effects on Marine Vertebrates

To minimise the potential for turtle or Dugong capture by the cutter-suction dredge, a "turtle exclusion" devise will be specified for the dredge suction head. If a turtle or Dugong is noticed in the immediate vicinity (100m) of the dredge head, the dredging will cease until it has moved on. If a turtle or Dugong is injured during dredging works then assistance will be sought for the injured animal. Any injury to a threatened species will be reported to the relevant State and Commonwealth agencies (EPA and Environment Australia).

Marine vertebrates (mammals, reptiles and fish) are likely to be most affected by secondary impacts of dredging such as the decline of seagrass beds. Whilst some marine vertebrates may avoid areas of high turbidity, areas of high turbidity may also be attractive to a range of fishes, particularly juveniles, as it confers a greater degree of protection from predators (Blaber and Blaber 1980).

9.3.1.4 Nutrient Enrichment

Nutrients released from disturbed sediments may alter the community composition of floral and consequently faunal communities. Increased nutrient loads may to lead to an increase in phytoplankton densities, and consequently a reduction in water clarity and seagrass depth distribution (Dennison *et al*. 1993).

Moderate amounts of additional nutrients in the water column can increase seagrass growth (McRoy and Helfferich 1980). However, as macroalgae are more efficient at absorbing nutrients from the water column than seagrasses and coral, higher levels of nutrient enrichment can lead to an increase in macroalgal growth at the expense of seagrass and coral (Wheeler and Weidner 1983; Zimmerman and Kremer 1986). Consequently, benthic macroalgae may overgrow and displace seagrass, whilst drift and epiphytic algae may physically shade seagrass and coral, reducing their growth and distribution (Twilley *et al.* 1985; Silberstein *et al*. 1986; Maier and Pregnall 1990; Tomasko and Lapointe 1991). Epiphytic algae may also reduce diffusive exchange of dissolved nutrients and gases at leaf surfaces (Twilley et al. 1985; Neckles *et al*. 1993).

Nutrient enrichment is also likely to alter the community composition (habit and species composition) and distribution of the mangrove and saltmarsh communities (Adam 1990, Adam 1995). In the short to medium term the production of mangroves and to a lesser extent the more shallow rooted saltmarsh flora may increase, however in the longer term this may lead to degeneration of these communities as nutrient saturation levels are reached, and as species composition changes.

Increases in nutrient levels may also negatively impact coral communities such as those at Mandalay Point. Changes are most evident in eutrophic conditions, however small increases in nutrient levels can also have an impact. Recent research indicates that increases in nutrients can have sub-lethal impacts on hard corals. In particular elevated nitrogen levels can stunt coral growth and decrease larval settlement (Koop *et al* 2001). In areas of high nutrient enrichment corals may be replaced by macroalgae (Lapointe 1997), particularly if this is accompanied by a significant reduction in herbivores ((e.g. Hughes *et al*. 1999; McCook 1999). By reducing growth and larval settlement, elevated nutrients may effectively prevent the recovery of corals that have suffered some form of acute stress (e.g. a bleaching event, flood or cyclone damage).

The trophic structure of benthic invertebrate communities often changes with increased nutrient levels, becoming dominated by small opportunistic deposit feeders. In eutrophic estuaries deposit feeding spionid and capetellid polychaete worms often tend to dominate benthic communities.

Within the region, nutrient enrichment from sewage effluent discharge has contributed to an increase in epiphytic algae (FRC Environmental 2002). However, monitoring has not detected any clear nutrient-related changes in coral community structure. It is likely that the dominant corals of the region are well adapted to waters characterised by elevated nutrient concentrations. Whilst some nutrients may be released from the sediments during construction and maintenance dredging, the planned upgrading / decommissioning of the Jubilee pocket sewage treatment plant (refer to **Section 2.6.2** and **7.1.2**) is likely to result in a net reduction in nutrient loadings discharged to this bay (refer to **Section 7.1.2**).

Similarly, the provision of sewage pump out facilities in the marina will reduce sewage discharges from boats, including live aboard boats moored in the mouth of Boathaven Bay. Overall, nutrient levels in Boathaven Bay can be expected to improve within the next 5 to 10 years as a result from development of this marina.

9.3.1.5 Spills of Hydrocarbons and other Contaminants

Different organisms and different life-stages of particular organisms react to petroleum hydrocarbon pollution in different ways. The damage to marine biota by petroleum hydrocarbons is determined more by the degree of persistence of the oil than its absolute toxicity when fresh (van Gelder-Ottway 1976). As such, contamination arguably poses a greater risk during operation of the proposed development than during the construction phase, the potential impacts of hydrocarbon contamination are discussed in the section discussing the impacts of operation. In any case, most construction activities will be taking place within a fully enclosed area and as such, the risk of release of a spill of hydrocarbons to the marine environment is very low.

9.3.1.6 Disturbance of Acid Sulphate or Potential Acid Sulphate Sediments

In the event that acid sulphate soils (ASS) are generated during excavation, these will be managed through the implementation of an Acid Sulphate Soils Management Plan (ASSMP) such that there will be no change in the pH of receiving waters. Hence, impacts on flora and fauna species, including turtles and Dugong resulting from acid sulphate soils are not expected.

Without management measures as indicated in **Section 6**, the release of acidic water may impact on seagrasses in Boathaven Bay, potentially resulting in a localised loss of food for a range of turtle species and Dugong.

Discussion of acid sulphate soils is provided in **Section 6**. Preliminary testing of sediments indicates that small quantities of ASS are present. A detailed ASS Management Plan has been prepared for the project and is included in **Appendix E**. Any potential impacts from ASS can be avoided through appropriate management and mitigation strategies of acid sulphate soils/sediments.

9.3.1.7 Human Activity

Increased human activity during construction, including changes in light and noise levels, may influence the behaviour of fauna. As use of Boathaven Bay by turtles and Dugong is limited, this impact should not be significant.

Construction activities themselves may also directly impact fauna. For example, in 1999, two marine turtles were killed in Queensland ports during dredging (Haines *et al*. 2000). Dredging activities will need to minimise the likelihood of this through visual monitoring of the dredge area for turtles and Dugong and the use of turtle exclusion devices on the cutter suction dredge head.

Noise impacts are discussed in **Section 11**. Light impact are not expected to be significant during the construction of the marina as construction activities will largely not occur at night. Operational light impacts are discussed in **Section 9.3.2.6**.

9.3.1.8 Disturbance of Contaminated Sediments

Dredging activities may alter other aspects of water quality. For example, disturbance of sediments in a reducing environment can lead to a significant elevation in biological and chemical oxygen demand, depleting enclosed waters of dissolved oxygen. Increases in bacterial concentration are typically associated with turbid waters surrounding dredging operations (Salvat 1987). Bacteria are known to adhere to suspended solids. Toxicants may also be released from the sediment. Depending upon the nature and extent of this release, impacts could range from morbidity and the reduction of reproductive capacity of some species, through to outright mortality of plants and animals.

Boat users have historically used a portion of the area to be developed as an ad hoc hardstand area. It is likely that the stripping and application of antifoulants containing copper and tributyl tin has been a regular occurrence and consequently the sediments in this area may be contaminated. Results of sediment testing show low levels of TBT in a few areas but otherwise no contaminants of concern (refer to **Section 6.1.4**).

Re-suspension of contaminants from sediment is not considered likely to result in any adverse impacts on marine ecosystems.

9.3.1.9 Impact on Fisheries

The reduction of seagrass, intertidal and mangrove habitat resulting from the construction of the marina is likely to have a small but positive, direct and cumulative effect on recreational and commercial fisheries through the loss of locally recognised nursery areas. This has been discussed in **Section 9.3.1.1**.

9.3.2 Operation

Impacts potentially associated with the operation of the marina-complex are likely to be principally linked to human activity. Use of the marina will result in an increase in human activity and specifically in boat traffic within Boathaven Bay, and an increase in, for example, refuelling operations. There is likely to be an increase in recreational fishing in the bay, and any ‘charismatic megafauna’ (e.g. turtles and Dugong) are likely to attract increased attention. There will be an increase in the quantity of litter finding its way into the bay, including non-biodegradable items that may directly harm fauna. The characteristics of these potential impacts are discussed in detail in the following sections. No quantitative data has been made available to enable an accurate prediction of the geographic extent or severity of these impacts.

9.3.2.1 Altered Hydrodynamics

The construction of a marina-complex has the potential to alter the hydrodynamics of Boathaven Bay, potentially altering wave climates and patterns of erosion and sediment deposition. It is likely that any change to the hydrodynamics to the bay would be limited to the western portion in the vicinity of the marina. Hydrodynamics of other areas of Boathaven Bay, including mangrove systems on Campbells Creek are unlikely to be significantly affected.

9.3.2.2 Boat Traffic and Boat Strike

Boat traffic can have a significant detrimental impact on nearby intertidal and shallow subtidal seagrass through the excavation, erosion and increased turbidity (FRC Environmental 2001). Use of the marina and access channel by vessels operating in accordance with Queensland Transport regulations is not likely to produce wake or wash of a magnitude to threaten the nearby intertidal flats or fringing mangroves. Nor is vessel traffic likely to cause the suspension of significant quantities of bottom sediments.

Boat strike is a significant cause of death and stranding of marine turtles in Queensland. Over 40% of recorded turtle deaths and strandings are due to fractures from boat strikes and propellers (Haines *et al*. 2000).

Turtles are particularly vulnerable to boat strike as they feed on the intertidal flats at high and mid tides, and drop into the deeper water of the navigation channels at low tide (Dr C. Limpus pers com 2001), where they can be struck by passing traffic. In general the shallower the area and the larger the boat, the greater the risk posed to turtles (Dr. C. Limpus pers comm. 2001). Boat strike of the endangered loggerhead turtles is of particular concern as the breeding population on the east coast of Australia is critically low. The loss of a few adults may have a major impact on the breeding and survival of this species in this area (Dr. C. Limpus pers comm. 2001).

Boat strike appears to be less common among marine mammals than among reptiles, with fewer deaths recorded as a direct result of boats. However, as Dugong have low breeding rates and are slow to reach maturity, any Dugong deaths may contribute to a population decline.

Boat traffic may also be detrimental, altering the behaviour patterns of marine reptiles and mammals. Changes in behaviour because of noise may include cessation of feeding, resting, and social interactions; or avoidance (Richardson & Würsig 1995). Dugong move out of the way of approaching boats, however they are slow to move which makes them vulnerable to vessels moving at fast speeds. If vessels are too frequent, the Dugong leave the area and go elsewhere to feed. The longer the boat stays in the area (e.g. manoeuvring or 'hanging around') the more strongly the Dugongs react, and more likely they are to leave (A. Hodgson pers comm. 2001).

There is evidence to indicate that dolphins (perhaps contrary to popular belief) generally avoid approaching boats, but few changes in behaviour have been documented in response to passing vessels (Acevedo 1991 and Janik and Thompson 1996 cited in Neil 1998).

The risk of boat strike will be managed through:

- A marina and channel speed limit, to be enforced by Queensland Transport and, informally, by marina operators
- Signs at the marina and boat ramp warning boaters to keep watch for turtles and Dugong.

Hydrocarbon Contamination

Concentrations of dissolved oil fractions below 0.01 ppm have not been shown to have adverse effects on any marine organism either in the short or long term, at any stage of development or at a cellular or sub-cellular level. Between 0.01 ppm and 0.1 ppm, some adult animals show sub-lethal behaviour and physiological disturbance, while developmental stages may show retarded growth or increased abnormalities. In general, the developmental stages of a species are far more susceptible than are adults, frequently by one or two orders of magnitude (Brown 1985). However, changes in behaviour in response to sub-lethal doses of pollutant may have far-reaching ecological effects (Dicks 1976).

Chronic hydrocarbon pollution can result from the synergistic effects of small, yet frequent spills. Such a pattern of spillage may be commonly associated with the refuelling of smaller crafts at marinas, other purpose built and ad hoc refuelling facilities and boat ramps (refer Cullen Grummitt and Roe 2000; GBRMPA 1998). Marinas that support considerable marine activity, including pleasure boat marinas, boat repair facilities and commercial fishing operations have significantly higher levels of both aromatic and aliphatic hydrocarbons than estuaries seldom used by boats (Voudrias and Smith 1986). The small-scale spills commonly associated with small-scale refuelling operations are rarely reported or treated: the petrol, diesel or oils are left to disperse under essentially natural conditions.

In contrast to the comprehensive consideration given to the effects of large scale or ‘industrial’ fuel and oil spills, the effects of small-scale fuel spills have been very poorly documented.

However, it is clear that the chronic presence of hydrocarbons has the potential to cause locally significant impacts. Low levels of petroleum hydrocarbons in the aquatic environment are adsorbed onto, or incorporated into, the sediments, where they may persist for years (Pelletier *et al*. 1991; Voudrias and Smith 1986). A large number of small-scale oil spills may lead to a significant increase in hydrocarbons over time, in effect resulting in a ‘permanent’ impact (refer **Sections 7.3.2**). Mangrove sediments in particular may serve as long-term reservoirs for chronic contamination holding hydrocarbons for periods in excess of 5 years (Burns *et al*. 1994). Clearly, in determining the potential for chronic contamination at a particular site, characteristics of flushing and sediment stability need to be considered.

Whilst acute (or at least a ‘one off”) contamination may result in severe ecological consequences, recovery is in most cases inevitable. In contrast, chronic contamination can result in the ‘permanent’ (or at least for the duration of contamination) morbidity or localised extinction of flora and fauna. Floral communities and sessile faunal communities (such as the many groups of invertebrates that develop attached to the substrate) are clearly most at risk from chronic hydrocarbon pollution (Kirby *et al*. 1998). As these communities often form a critical component of ‘habitat’ (providing structural complexity, shelter and often food), a 'permanent' impact to these communities may have a consequentially widespread impact on the mobile components of the original faunal community including the fishes and crustacea.

Whilst 'one off' spills of great volume have the potential to severely impact a large area, recovery is likely; chronic small spills, though probably influencing a lesser area, effectively prevent recovery and lead to cumulative impacts. Frequent spills from a diffuse number of locations within a waterway can in concert result in an enduring impact over a very wide area.

The potential for hydrocarbon spills to impact on the marine habitat will be minimised by undertaking fuel storage and handling activities in accordance with AS1940 (Storage and Handling of Flammable and Combustible Liquids). This will encompass spill containment and response. Fuel storage and dispensing facilities will be licensed through Whitsunday Shire Council and Environmental Protection Agency. Measures to manage the risk of spills from this facility are discussed in **Section 2.5.2**.

9.3.2.3 Heavy Metal Contamination

The absorption of heavy metals from solution occurs in plants and animals by passive diffusion across gradients created by adsorption at the surface, and by binding by constituents of the surface cells, body fluids, etc. An alternative pathway for animals is when metals are adsorbed onto or are present in food, and by the collection of particulate or colloidal metal by food gathering mechanisms, such as the bivalve gill.

There is considerable variation in the extent to which plants and animals can regulate the concentration of metals in their body: plants and bivalve molluscs are poor regulators of heavy metals; crustacea and fish are generally able to regulate essential metals such as zinc, copper and iron (Clark 1992).

Metal concentrations in organisms are usually a function of environmental concentrations and bio-accumulation; however, there are a variety of factors that can modify bio-availability and metal toxicity, all of which act synergistically. In general, metals are more toxic at high temperatures and low salinities. Redox potential also affects toxicity, with higher metal concentrations in anoxic conditions. The availability of metals may also increase with low pH. In addition, there are synergistic/antagonistic interactions between the metals themselves (Langston 1988).

The effect of chronic heavy metal pollution is still largely unresolved, and effects depend on the interrelationships of many physical and chemical factors. Threshold concentrations of toxicants to ensure the protection of aquatic ecosystems have been developed by the Australian and New Zealand Environment and Conservation Council (ANZECC / ARMCANZ 2002).

Where the marina is managed in accordance with current best practice / expected EPA licence conditions, it is reasonable to expect that effective management of contaminants will be achieved. This is discussed further in **Section 7.2.2**.

9.3.2.4 Maintenance Dredging

Maintenance dredging will be required every 10 – 15 years (refer to **Section 2.7.2**) with the same suite of impacts associated with capital dredging (discussed above).

9.3.2.5 Removal of Swing Moorings

Development of the proposed marina and access channel will mean some swing-moorings are lost. These moorings currently impact on the seabed through chronic physical disturbance as the vessel responds to changing winds and tides. The removal (or decommissioning) of swing moorings will enable a more stable and productive benthic community to develop. The provision of marina berths will also provide the opportunity for Queensland Transport to remove many of the swing moorings in Pioneer Bay. If this occurs, consideration should be given to removing moorings in areas more likely to be colonised by abundant seagrasses.

9.3.2.6 Artificial Lighting

Lighting from the marina has the potential to affect nesting females and hatchlings by disorienting them. Light in the 300-500nm wavelength is the most disruptive to turtles and studies have shown fluorescent and mercury vapour lamps are the most disruptive to turtles (studies reported in URS, 2000). Sodium vapour lamps are dominated by wavelengths above 600nm. Consequently, to mitigate the effects of lighting on turtles, lighting of the marina will use sodium vapour lamps where possible. Where this lighting is not practical for safety reasons, lights will be shielded and directed so as not to affect turtles.

9.3.2.7 Removal of Casual Maintenance Opportunities

Development of the proposed marina will preclude the use of that part of Boathaven Bay for casual vessel maintenance and 'hard stand'. Currently a number of vessels are moored on the beach here, many undergoing repairs or maintenance without any form of formal environmental safeguards. Some of these vessels have been in place for many years and are currently be used as 'residences'. It is likely that these activities are contributing a range of contaminants to the waters and sediments of the bay.

Provision of a controlled boat repair facility at the marina will assist in controlling impacts from these activities.

9.3.3 Impacts on World Heritage Values

The potential impacts of the proposed development on World Heritage Values are summarised in **Table 9-6**.

The proposal is likely to slightly increase boat numbers to the GBRMP and GBRWHA. However, it is expected that many of the boats using the marina and boat ramp are existing in the area. This conclusion is based on:

- Very high level of usage of existing boat ramps at Abel Point Marina and Shute Harbour, which indicates that an additional boat ramp is needed to meet current use requirements
- The large number of inquiries received for private and commercial berths at the marina from boat owners and operators already in the immediate area.

Regulation of the numbers of boats and passengers in the marine park is a matter for GBRMPA and the Authority has policies to guide the granting of permits for commercial boats as well as restrictions on access for commercial and private boats to certain areas.

Table 9-6 Potential impacts of World Heritage values of the GBRWHA.

GBRWHA World Heritage Value	Response
Geological and geomorphological evolution of the reef structure, morphological diversity of the reef	The project will have no effect on geological, geomorphological or morphological features of the reef. Possible indirect effects from sedimentation during dredging will be managed by a dredge management program including monitoring of suspended sediment levels and ameliorative actions in the event that adverse effects are identified.
Diversity of life forms (400 species of coral, foraminifera, echinoderms, crustaceans, polychaete worms, ascidians, over 400 species of molluscs, 1500 species of fishes, 6 species of sea turtles, whales and dolphins, sea birds with breeding colonies, land birds, fleshy algae)	Coral, foraminifera, echinoderms, crustaceans, polychaetes, ascidians, crustaceans, molluscs, fishes, sea turtles, dolphins and Dugongs are all likely to be impacted, either by reduction in area of feeding grounds (as is the case for sea turtles and Dugongs), habitat (as may be the case for fishes and invertebrates) or may be indirectly affected such as by a loss of habitat for target prey species (this may affect species such as dolphins which prey on fishes). No impacts are expected on the biodiversity of the GBRWHA, as species present within Boathaven Bay are known or likely to be represented elsewhere in the area.
Endemic Species	No endemic (that is geographically restricted) species identified.
Diverse ecosystems (coral communities, seagrass beds, mangrove communities, low wooded islands, sand cays)	Direct loss of 8.5 ha of intertidal mudflat habitat. Direct loss of 8 ha of seagrass habitat and 1.2 ha of mangroves. Secondary impacts from construction and maintenance of the development (such as sedimentation and increased turbidity) may impact further on intertidal and subtidal communities, locally reducing both diversity and abundance.

9.3.4 Mitigation Measures

Current ‘best practice’ assessment and engineering practice offers significant opportunities to minimise the impacts associated with both construction and operation of the proposed development.

The Department of Primary Industries has a policy of “No nett loss of marine fish habitat” (Dixon & Beumer, 2002). Areas of disturbance to vegetated and unvegetated tidal land of greater than 500 m^2 (0.05 ha) are deemed to be large areas and require a combination of mitigation (on-site) and compensation (off-site) options to be used to achieve the no nett loss requirement for authorisation of marine fish habitat loss.

Mitigating or compensating actions can include:

- Avoidance of fish habitat loss through avoidance or redesign;
- Best practice methodologies;
- Timing of activities to minimise disturbance to fish reproduction activities;
- Habitat productivity enhancement;
- Restoration or replacement of fish habitat;
- Fisheries resource research and education support;
- The payment of bonds (held towards ensuring that impacts are minimal);
- Fish habitat creation;
- Fish habitat acquisition/ exchange (relinquishment of private tenure); or
- Fisheries stock enhancement.

The overall objective of the mitigation and compensation actions is to maintain habitat diversity and the overall biodiversity of habitats.

Removal of most of the mangrove fringe along Shute Harbour Road has been avoided by placing the marina facilities area and spoil disposal area on unvegetated intertidal mud flats. While it is acknowledged that the unvegetated intertidal mudflats have habitat value too, the retention of mangroves is considered more significant as these provide habitat, visual screening of parts of the project and will also enhance stormwater runoff quality. Other matters to be taken into consideration during detailed design include:

- Selection of lighting types and placement so as to minimise impacts on turtles;
- Design of armour rock structures to maximise value as fish habitat;
- Design of stormwater systems to minimise release of gross pollutants into Boathaven Bay;
- Design of stormwater and waste containment within the marina facilities area to control discharges of oil, suspended solids and other contaminants to Boathaven Bay;
- Design of fuel storage and refuelling facilities to minimise risk of spills to Boathaven Bay; and
- Installation of a sewage pump out facility to provide an alternative to direct discharge of sewage to Boathaven Bay and Pioneer Bay.

Best practice management and mitigation measures during construction will include:

- Use of cutter suction dredging for the access channel;
-
- Preparation of a Dredging and Disposal Management Plan to include monitoring, trigger levels and corrective action for dredging activities;
- Inclusion of visual monitoring and appropriate “scaring” tactics for turtles and dugong during dredging activities;
- Excavation of the marina basin and reclamation of land behind sheet piling to prevent release of suspended solids to the adjoining waters of Boathaven Bay;
- Use of silt curtains during beach construction;
- Tailwater management system that allows settlement of suspended solids to required standards prior to release;
- Management of acid sulphate soils such that pH of receiving waters is not affected (see also **Section 6**);
- Conduct of dredging activities during winter to avoid seagrass flowering and fish migration times; and
- Environmental monitoring program including monitoring of discharges and ambient water quality and ecosystem health monitoring in the vicinity of the project (see also **Section 21.5.1**).

In addition, the proponent will comply with any conditions placed on permits and approvals issued to the project during the construction and operation phase.

Operation phase environmental management requirements include:

- Protection of water quality as outlined in **Section 7**
- Imposition of speed limits to significantly reduce the risk of boat strike to Dugong and turtle

- Interpretive signs and materials to inform users of the marina, boat ramp and ferry terminal of best practice for visitors to the GBRMP as well as providing background information aimed at enhancing awareness and understanding of the natural values of the area and the benefits of preserving these values.

Guidelines set out in the GBRMPA's *Environmental Guidelines for Marinas in the Great Barrier Reef Marine Park* (1994) will be used as a basis for best practice environmental management wherever appropriate and practicable.

At this stage of the proposal, the Proponent is not aware of any appropriate compensatory habitat opportunities that exist within the Whitsunday area. Much of the area is already protected within the marine park and managed by GBRMPA. Terrestrial areas of conservation significance are also largely included in national parks. The proponent is also not aware of any fish habitat enhancement opportunities within the area.

DPI's Policy for *Mitigation and Compensation for Works or Activities Causing Fish habitat Loss* (DPI 2002), makes allowance for funding for research as a form of compensation (Policy Principle 8). The Policy notes that compensation for loss of fish habitat should be dedicated towards fisheries related projects and lists the following themes as being of research interest to the Department:

- Habitat utilisation
- Habitat status
- Habitat production
- Ecological processes
- Human impacts
- Habitat rehabilitation.

Policy Principle 3 also notes that, in addition to research compensation measures may include:

- Funding of community based initiatives
- Restoration and rehabilitation projects
- Signage or educational materials for marine fish habitat information and management.

The Proponent is prepared to negotiate a compensation agreement with DPI in relation to the areas of fish habitat to be lost as a result of this project. The Proponent also notes the interests of a range of other agencies in the outcomes of this aspect of the proposal and supports a cross government approach to identifying resource management opportunities arising from this project.

9.3.5 Summary of Likely Impacts

Development of the proposed marina-complex would involve the loss of approximately 8 ha of seagrass habitat, 1.2 ha of fringing mangrove and 6.5 ha of intertidal and shallow subtidal soft sediment lands. Dredge and excavation spoil placement will result in the further loss of 2 ha of unvegetated soft sediment intertidal lands; and dredging of the channel will result in the loss of approximately 2.5 ha of unvegetated soft sediment intertidal land. The marina-complex will contribute elements of hard-substrate habitat to the bay. The net loss of critical habitat, and in particular the seagrass will result in a commensurate loss of productivity within the bay. Consequently, it is likely that fisheries productivity of the bay, and the abundance of seagrass-dependant species (including species of conservation significance species such as Dugong and green turtle) will decline within the bay. The seagrass meadows of the bay also contribute to the productivity of the wider region: the partial loss is likely to have some impact on regional productivity and fisheries production.

The predicted loss of habitat may potentially be mitigated through the provision elsewhere of habitat having similar ecological values, through the enhancement of existing habitat elsewhere, or through other means that may include the financial sponsorship of habitat research.

Indirect impacts may include acute detrimental changes to water quality during construction and scheduled maintenance dredging, through the disturbance of sediments or introduction of contaminants. These impacts may be significantly mitigated through the application of ‘current best practice’ design, technologies and work practices. Human activity is likely to increase and may require mitigation through management and education. Chronic low level fuel and oil spillage is likely to have a localised chronic impact on the distribution and abundance of sensitive species. Analysis undertaken in **Section 7** indicates that, with appropriate management, water quality impacts can be adequately controlled.

The proposed development will significantly increase the extent of hard substrate within Boathaven Bay. It will also contribute to a reduction in nutrient levels in Boathaven Bay and provide the opportunity for some swing moorings that are damaging seagrass habitat to be removed.

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