Australia Pacific LNG Project

Volume 4: LNG Facility

Chapter 10: Marine Ecology

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10. Marine ecology

10.1 Introduction

10.1.1 Purpose

This chapter addresses potential environmental issues and impacts to the marine ecology for the Australia Pacific LNG Project (the Project), specifically those related to the construction and operation of a liquefied natural gas (LNG) facility near Laird Point on Curtis Island. This chapter describes:

- The main features of the existing environment in the region of the proposed LNG plant and assesses the impacts of a number of impacting processes on the existing environment
- Potential impacts on the marine environment from the construction and operation of the LNG facility
- Options for managing, mitigating or offsetting identified impacts.

In the preparation of the environmental impact statement (EIS) and going forward with the Project, of its 12 sustainability principles, Australia Pacific LNG will be guided by the following principles when identifying potential impacts the Project may have on the marine ecological values:

- Minimising adverse environmental impacts and enhancing environmental benefits associated with its activities, products or services; conserving, protecting, and enhancing where the opportunity exists, the biodiversity values and water resources in its operational areas
- Identifying, assessing, managing, monitoring and reviewing risks to its workforce, its property, the environment and the communities affected by its activities.

These principles have been applied to identify management options to reduce impacts from the construction and operation of the LNG facility on the marine ecology for Port Curtis.

10.1.2 Scope of work

This chapter principally addresses Section 3.3.5: Marine flora and fauna of the environmental impact statement (EIS) terms of reference for the Project.

The scope of work is as follows:

- Describe the main features of the existing marine environment in the region of the pipeline crossing
- Assess the impacts on the marine environment from the construction and operation of the gas pipeline
- Identify options for mitigation and management of these impacts
- Apply relevant sustainability principles.

10.1.3 Legislative framework

Environment Protection and Biodiversity Conservation Act

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides for the protection of matters of national environmental significance (MNES). The Act requires a proposal must be referred to the Commonwealth Department of the Environment, Water, Heritage and the Arts (DEWHA) if the project has the potential to have a significant impact on MNES. These are:

- World heritage sites
- National heritage places
- Wetlands of international importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed)
- Nationally threatened species and ecological communities
- Migratory species
- Commonwealth marine areas
- Nuclear actions.

Marine Parks Act

The *Marine Parks Act 2004* provides for the establishment and management of marine parks in Queensland coastal waters. The provisions of the Act control access to, and use of, the marine environment. The Act recognises zoning, zoning plans and management plans as the principle tools for managing marine parks.

Fisheries Act

The *Fisheries Act 1994* provides the use, conservation and enhancement of the community's fisheries resources and fish habitats. It seeks to:

- Apply and balance the principles of ecologically sustainable development
- Promote ecologically sustainable development.

Environment Protection Act

The *Environment Protection Act 1994* (EP Act) provides for sustainable resource development while protecting ecological processes. The EP Act regulates environmentally relevant activities, including petroleum activities.

The *Environmental Protection (Water) Policy 2009* aims to achieve the object of the EP Act in Queensland waters by establishing environmental values and water quality objectives.

State Coastal Management Plan

The State Coastal Management Plan (State Coastal Plan) describes how the coastal zone is to be managed. As a statutory instrument it has statutory effect under the Coastal Act and guides relevant decisions by the State and local governments and the Planning and Environment Court. While there are no enforcement penalty provisions for breach of the Plan, there are mechanisms to ensure the Plan is appropriately considered in relevant decisions. The State Coastal Plan identifies “areas of state significance (natural resources)" which includes wetlands at and adjacent to the proposed gas pipeline route.

10.1.4 Methodology

This study assessed and analysed peer-reviewed literature, augmented with field observations. Field investigations of the habitats within the proposed development footprint were undertaken during June 2009. An Outland Technology Inc. video and video recording system was used at selected sites along the proposed gas pipeline route to provide visual information on typical seabed features along the crossing of The Narrows. Intertidal areas were visually inspected.

10.2 Existing environment

10.2.1 Overall environmental values

Port Curtis is a natural deepwater embayment protected from the open ocean by Curtis and Facing Islands. Port Curtis has areas largely un-impacted by human activity as well as areas highly modified by port developments and various industries. The LNG facility is to be constructed near Laird Point which is at the start of The Narrows, the 20,903ha passage that separates Curtis Island from the mainland. It is one of only five tidal passages within Australia. The proposed location is within Gladstone Port limits, but also within the Great Barrier Reef World Heritage Area.

The Port Curtis region contains extensive wetland habitats including saltmarsh, saltpan and mangroves with extensive seagrass beds. These habitats support species of conservation significance including dugong and marine turtles, as well as fisheries production. The Port Curtis region including the proposed location of the LNG facility is within a dugong protection area. Various marine turtle species utilise seagrass and bare sedimentary habitats for foraging. The endemic flatback turtle nests on the eastern beaches of Curtis Island in the vicinity of the South End township.

10.2.2 Marine parks, wetlands and World Heritage areas

The proposed location for the LNG facility is near Laird Point on the western side of Curtis Island. It is situated within the Gladstone Port Limits, however all of the Port waters below the mean low water mark lie within the Great Barrier Reef World Heritage Area. Curtis Island itself is a continental island within the Great Barrier Reef Marine Park. The proposed LNG facility is near the southern boundary of The Narrows section of the Great Barrier Reef Coast Marine Park, but no construction activities for the LNG facility will occur within this marine park.

Ramsar wetlands are not located within or adjacent to the proposed development site. The closest Ramsar wetlands are Corio Bay and Shoalwater Bay, which are approximately 150km north of the site. The proposed location for the LNG facility is in part within the Curtis Island Nationally Important Wetland (QLD021).

The nearest declared fish habitat areas are the Fitzroy River which includes large parts of the northern and north-western parts of Curtis Island (FHA-072), Colosseum Inlet (FHA-037) and Rodds Harbour (FHA-036) which are respectively approximately 23km, 35km and 50km from the proposed development site near Laird Point.

Wetlands that will be disturbed as part of the proposed project are areas of state significance (natural resources) under the State Coastal Plan. The following matters are relevant to the conservation and management of Queensland's coastal wetlands, including land within 100m of a coastal wetland:

- Maintenance of an area between the wetland and any adjacent use or activity, of a width and with characteristics that will safeguard the functions of the wetland and allow for natural fluctuations of location
- Minimising any modification of the natural characteristics of the wetland, including the topography, groundwater hydrology, water quality, and plant and animal species
- Minimising any adverse impact on coastal wetland values from proposed access
- Any adverse impact on the wetland as a result of proposed or potential pest insect control
- The appropriate management of acid sulfate soils
- Maintaining the role of wetlands in providing protection from coastal hazards, including any impacts from potential changes in sea level rise
- Minimising potential changes in fire regimes that may have adverse impacts on the coastal wetland
- The need to retain the values and functionality of saltflats, to assist in the maintenance of estuarine system viability
- The need to maintain the coastal wetland functions to provide habitat for rare, threatened and migratory species
- The potential for a proposal to introduce plant or animal species non-native to the local area that may have or are likely to have adverse impacts on the coastal wetland ecosystem
- Minimising impacts on the sustainability of economic productivity, including critical inshore habitat for fisheries-related species
- The need to restore and rehabilitate degraded coastal wetlands
- Any long-term maintenance and management implications, particularly for government agencies.

10.2.3 Extent and condition of marine habitats

The primary environmental features of interest in the vicinity of the proposed LNG facility site are the seagrass meadows, mangrove and saltmarsh areas. These vegetated habitats contribute significantly to the high primary productivity of estuarine areas. They also provide structurally complex habitats maximising food availability and minimising predation for fish, prawns and crabs (Halliday and Young 1996; Thomas and Connolly 2001; and Heck et al. 2003). Rocky intertidal and shallow sub-tidal environments also exist in the study area and these are important foraging areas for various fish species. Man-made structures such as jetties and seawalls also provide additional hard substrata within the Port Curtis region. Extensive unvegetated intertidal banks also occur in the area around Laird Point, and these banks also provide foraging opportunities for fish at high tide and shorebirds at low tide.

Seagrass

Around 20 per cent of the intertidal (7,246 hectares) and sub-tidal (6,332 hectares) seabed of Port Curtis are covered by seagrass. Generally, the area of the seagrass bed and seagrass biomass peaks in later spring and summer and is lowest over winter (McKenzie 1994; Lanyon and Marsh 1995). A map of seagrass beds in the northern part of Port Curtis is shown in Figure 10.1and the key parameters of the seagrass beds are shown in Table 10.1. Figure 10.1 is based on data from Rasheed et al. (2003) that was collected from November 2002 to December 2002. Sub-tidal seagrass beds in Port Curtis have shown more variability in seagrass cover in comparison to intertidal seagrass beds (Chartrand et al. 2009). A small seagrass bed consisting of aggregated patches of *Zostera capricorni* occurs in the vicinity of the proposed LNG facility.

The EIS for the Western Basin Dredging and Disposal Project developed by Gladstone Port Corporation (Gladstone Ports Corporation (GPC) 2009) states that from baseline monitoring in 2002, the seagrasses, *Halophila ovalis* and H. spinulosa, occur sporadically immediately around North Passage Island. Since this baseline, there has been no further baseline monitoring in the Laird Point or North Passage Island areas. However, video surveying conducted for this EIS in May 2009 from sub-tidal sites adjacent to Laird Point, did not encounter any seagrasses.

Mangroves and saltmarsh

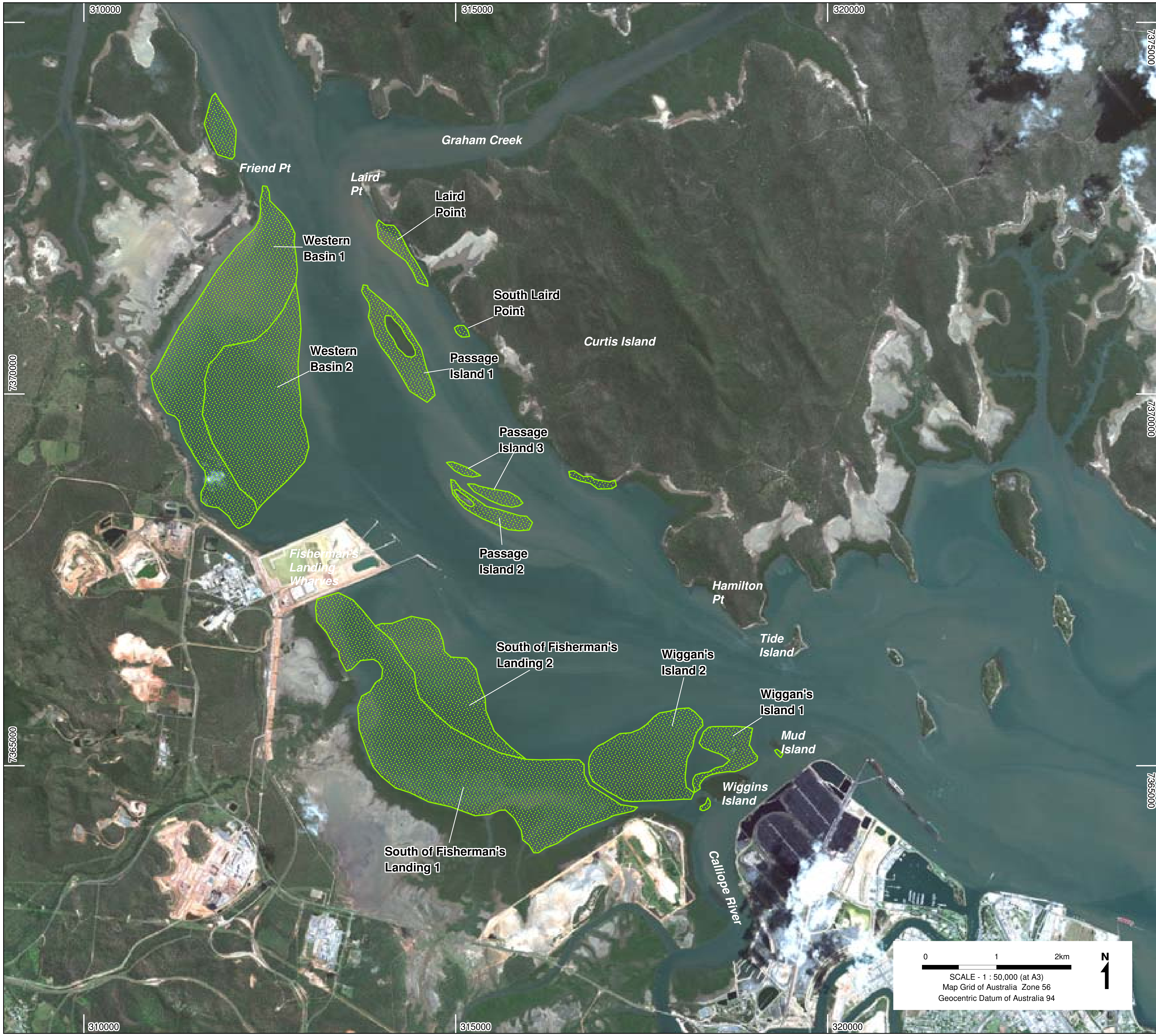
Mangroves provide a structurally complex habitat that can provide food and protection directly for juvenile fish and invertebrates. The mangroves also act as a source of carbon exported by the tide to other areas and contribute to the food web elsewhere in a region (Manson et al. 2005; Meynecke et al. 2008). Extensive mangroves occur along the coastline from the Gladstone City precinct and into the Narrows (Danaher et al. 2005). Within the Gladstone region it is estimated there are 3,875 patches of mangroves with an area of 203km^2 and a perimeter of 4,855km (Manson et al. 2005). However, Duke et al. (2003) reported a regional loss of almost 40 percent of mangrove area in Port Curtis between 1941 and 1999.

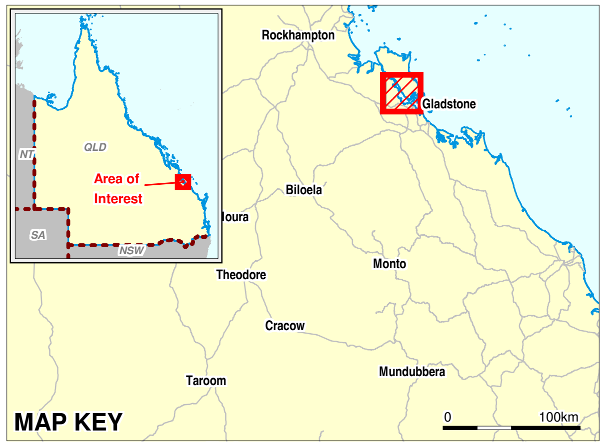
Fourteen species of mangroves are reported from the Port Curtis region, with red mangrove (*Rhizophora stylosa*), grey mangrove (*Avicennia marina*) and yellow mangrove (*Ceriops tagal*) being dominant. Red mangrove tends to dominate the seaward edge of the assemblage while yellow mangrove and grey mangrove are generally more abundant on the landward edge. The mangrove assemblage is considered to be in a healthy state at the proposed development site and in Port Curtis in general.

Also present in the Port Curtis region are saltmarsh and salt pans, which are largely bare, but contain patches (or isolated plants) of salt marsh species such as *Sueda* spp, *Sarcocornia quinqueflora* and *Sporobolus virginicus*. While these habitats receive only limited tidal inundation, fish can extend many hundreds of metres into salt marsh habitats on spring tides, and their importance for fisheries production is well documented (Morton et al. 1987; Thomas and Connolly 2001; Sheaves et al. 2007).

Rocky reefs and rocky shores

Intertidal rocky shores occur at a number of locations in the Port Curtis region including in the vicinity of the proposed LNG Facility and associated marine infrastructure. These rocky shores are best described as a ‘rubble field’ with significant oyster cover, and other marine invertebrates associated with oyster cover. Rasheed et al. (2003) identified rubble reef areas in the deep channel area from the vicinity of Graham Creek to Fishermen’s Landing which contained medium density cover (>15% of the area surveyed) of bivalves, ascidians, bryozoans and hard corals. Other such areas of reef habitat are located in the vicinity of Hamilton Point.





MAP KEY

LEGEND

Seagrass distribution

Source Information

Seagrass distribution
Digitized from: Rasheed, M.A., Thomas, R., Roelofs, A.J., Neil, K.M. and Kerville, S.P. 2003. Port Curtis and Rodds Bay seagrass and benthic macro-invertebrate community baseline survey, November/December 2002. QDPI Information Series QI03058 (DPI, Cairns).
Satellite Imagery
Captured by GeoEye-1 on 24 March 2009

AUSTRALIA PACIFIC LNG PROJECT

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Figure 10.1 Seagrass Distribution

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Table 10.1 Description of seagrass beds in the northern part of Port Curtis (modified from Rasheed et al. (2003))

General location[1]	Seagrass species and general description	Biomass (g/dw/m^2)	Seagrass area (ha)
Laird Point (30)	Aggregated patches *of Zostera capricorni* of light cover.	2.9 ± 1.5	14.9 ± 1.3
South of Laird Point (32)	Isolated patches of *Z. capricorni* of light cover.	N/A	2.4 ± 0.3
Passage Islands 1 (31)	Aggregated patches of *Z. capricorni* of light cover with *Halophila ovalis*	0.9 ± 0.2	40.0 ± 2.6
Passage Islands 2 (35)	Aggregated patches of *Z. capricorni* of light cover with *H. ovalis*	0.7 ± 0.2	22.1 ± 2.0
Passage Islands 3 (33 & 34)	Aggregated patches of moderate *H. ovalis* with *Z. capricorni*	1.0 ± 0.5	10.1 ± 0.8
Western Basin 1 (including Friend Point) (8)	Aggregated patches of *Z. capricorni* of light cover with *H. ovalis*, *H. spinulosa* and *H. decipiens*	2.1 ± 0.3	269.1 ± 11.3
Western Basin 2 (9)	Aggregated patches of *H. decipiens* with *H. ovalis*.	0.9 ± 0.3	268.3 ± 14.9
South of Fishermen's Landing 1 (6)	Aggregated patches *of Zostera capricorni* of light cover with *Halophila ovalis*, *Halophila decipiens* and *Halophila spinulosa*	1.1 ± 0.1	464.0 ± 12.9
South of Fishermen's Landing 2 (7)	Aggregated patches of *H. decipiens*	0.9 ± 0.2	72.6 ± 11.3
Wiggins Island 1 (4)	Aggregated patches of *Z. capricorni* of light cover with *H. ovalis*	0.8 ± 0.4	35.8 ± 1.7
Wiggins Island 2 (6)	Aggregated patches of *Z. capricorni* of light cover with *H. ovalis* and *Halodule uninervis*	1.4 ± 0.3	149.8 ± 2.5

10.2.4 Marine habitats within the proposed development footprint

Intertidal habitats

The location for the LNG facility is principally saltpan which is inundated on spring tides. The development location surrounds a large stand of mangroves extending between 120 and 200m from a small tidal creek draining into Port Curtis. This stand of mangroves contained red mangrove, yellow mangrove, grey mangrove and blind your eye mangrove. This area of mangrove will be retained. While the saltpan is largely unvegetated, isolated plants of various saltmarsh species are present as are a number of small isolated mangrove trees (Figure 10.2). The landward edge of the saltmarsh contains small stunted mangroves, and isolated patches of mangroves also occur along a number of

[1] The number in parentheses corresponds to the meadow number in the report by Rasheed et al.. (2003).

natural drainage lines within the proposed development site and small isolated mangrove trees occur in a number of locations. Crab burrows (most probably *Uca* spp.) were associated with the isolated mangrove trees. Saltmarsh species recorded included common samphire, marine couch and spiny sea rush (Figure 10.3).

The seaward edge of the proposed development site (Port Curtis) consists of an upper area of sandy beach extending into a predominantly rocky shore which transitions to mud flat in the lower part of the shore (Figure 10.4). Taylor et al. (2007) identified a small area of seagrass (principally *Zostera capricorni*) occurred on these mudflats.

Figure 10.2 Views of the proposed LNG facility site showing the largely unvegetated saltpan. The aspect is looking towards the mangrove stand in the centre of the saltpan area. Evidence of crab burrowing activity in association with isolated mangrove trees is shown in the bottom picture

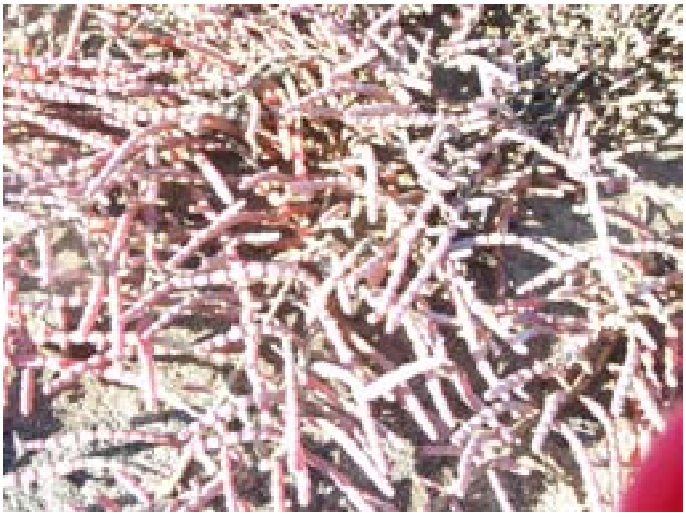


Figure 10.3 Examples of saltmarsh plants - the common samphire (top and bottom) and marine couch (top)

Figure 10.4 Rocky shore with mangroves (top) and boulders transitioning into mudflats.

Sub-tidal habitats

The sub-tidal area in the vicinity of the LNG facility is principally bare substrate (sand/mud). A high amount of unconsolidated shell and rubble material was present at many of the sites surveyed. Some isolated macroalgae was present attached to shell and rubble at a number of locations. No hard coral was present and there was an absence of a reef structure affording any vertical relief, although isolated individuals of various animals such as gorgonians (sea whips) were observed. Representative pictures from the seabed are shown in Figure 10.5.

10.2.5 Water quality

Water quality studies in Port Curtis have generally been consistent in identifying water quality conditions within Port Curtis as good, although strongly influenced by tidal state with reduced water quality conditions generally occurring at low tide. Port Curtis is recognised as a well mixed estuary and traditionally assumed to also be well flushed and readily dispersed to the offshore environment. However, Apte et al. (2005) showed while water circulation within the Port Curtis estuary was strong, material had difficulty in discharging from the estuary. It was found the time for the total mass of water to exchange by two thirds of its original mass, was approximately 19 days.

Many of the nutrients and metals present are associated with particulate (rather than dissolved) phases. Salinities in Port Curtis estuary, including The Narrows closely resemble ocean water and in some areas can be higher, possibly due to a combination of low freshwater inputs, evaporative losses and limited discharge to coastal waters (Apte et al. 2005).

Within the estuary, common contaminants have been assessed including: various metals, fluoride, cyanide and tributyltin (TBT). Metals within the Port Curtis estuary have consistently been recorded as occurring below the Australia and New Zealand Environment and Conservation Council/Agriculture and Resource Management Council of Australia and New Zealand (ANZECC/ARMACANZ) (2000) guidelines (Apte et al. 2005; Jones et al. 2005). However, metal concentrations, particularly dissolved copper, nickel, lead and zinc are elevated in comparison with pristine coastal water sites in Australia (Apte et al. 2005). In particular copper and nickel have elevated concentrations in The Narrows and elevated concentrations of lead and zinc are present in Port Curtis.

Apte et al. (2005) concluded based on the distribution of copper and nickel concentrations in The Narrows these contaminants are likely to be representative of naturally occurring concentrations. Water from the Fitzroy River is the principal source of copper and nickel to the region and, under certain conditions, may flow into The Narrows and ultimately Port Curtis.

In comparison, lead and zinc concentrations in Port Curtis are considered most likely to be influenced by human input. TBT is a contaminant of concern in Port Curtis and has been identified as occurring in concentrations above trigger levels within the water column, particularly around Fisherman's Landing and the mid and southern harbour (Jones et al. 2005). However, in comparison levels are much lower than reported in ports around Australia (Andersen 2004). TBT has been found to have bio-accumulated in the biota of Port Curtis (oysters, mud whelks and mud crabs), but is expected to decrease over the coming years, as TBT continues to be phased out as an anti-foulant on ships worldwide.

Figure 10.5 Examples of the seabed in the vicinity of Laird Point.

For the purposes of describing water quality based on the ANZECC/ARMCANZ (2000) guidelines, Port Curtis can be described as slightly to moderately disturbed. The ANZECC/ARMCANZ (2000) guidelines allow for a broad scale assessment of water quality condition, but where applicable, locally relevant guidelines should be adopted. The locally relevant guidelines are the Queensland water quality guidelines (QWQG). They have been drafted to address the need for more locally specific water quality guidelines by:

- Providing guideline values (numbers) tailored to Queensland regions and water types
- Providing a process/framework for deriving and applying local guidelines for waters in Queensland.

The QWQG water quality objectives for the Central Coast Queensland Region (Department of Environment and Resource Management 2009) and the default trigger values for physical and chemical stressors for slightly disturbed ecosystems in marine waters of tropical Australia (ANZECC/ARMCANZ 2000) are presented in Table 10.2.

Table 10.2 Water quality objectives for tropical marine waters near Gladstone

	QWQG (DERM 2009)	ANZECC/ARMCANZ (2000)
Ammonia (as nitrogen) (µg/L)	8	1 – 10
Oxidised nitrogen (µg/L)	3	2 - 8
Organic nitrogen (µg/L)	180	
Total nitrogen (µg/L)	200	100
Filterable phosphorus (µg/L)	6	5
Total phosphorus (µg/L)	20	15
Chlorophyll-a (µg/L)	2.0	0.7 – 1.4
Dissolved oxygen (% saturation) upper	100	ND
Dissolved oxygen (% saturation) lower	90	90
Turbidity (NTU)	6	1 – 20
Secchi (m)	1.5	ND
Suspended solids (mg/L)	15	ND
pH upper	8.4	8.4
pH lower	8.0	8.0
Conductivity (µS/cm)	n/a	ND

10.2.6 Sediment quality

Sediment quality within the footprint of the MOF has been characterised as part of a wider study which characterised sediments within the proposed approach channels, swing basins and berth areas. This study was completed in accordance with the National Assessment Guidelines for Dredging (NAGD)

(DEWHA 2009) and is provided as an addendum to the Gladstone Ports Corporation Western Basin Dredging and Disposal Project EIS. Sediments were also analysed against the Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland (Department of Environment (DOE) 1998). Sediments were tested for a range of contaminant substances including:

- Metals
- Benzene, toluene, ethylbenzene and xylene (BTEX)
- Total petroleum hydrocarbons (TPH)
- Tributyltin (TBT)
- Organophosphorus (OPP) and organochlorine pesticides (OCP)
- Polychlorinated biphenyls (PCB)
- Polycyclic hydrocarbons (PAH)

The presence of acid sulphate soils (ASS) was also assessed.

Results of analysis from sediments within the footprint of the MOF did not detect any BTEX, TPHs, OPPs, OCPs, PCBs, or PAHs. The majority of metals species tested were detected, however all detections were below relevant NAGD screening levels and environmental investigation levels (EILs) and health investigation levels (HIL-A) stipulated in DOE (1998). On that basis, sediments are considered chemically suitable for both dredging and placement at sea or on land.

Results of ASS testing indicate that the Holocene sediments within the footprint contain negligible actual acidity (ie no actual ASS). However, samples close to the shoreline have very high potential acid sulphate soils (PASS) decreasing to negligible PASS with distance from the shoreline. Acid neutralising capacity is present through the majority of sediments, however is generally insufficient to neutralise all the potential acidity generated.

10.2.7 Marine species of conservation significance

Dugong

Dugongs are more closely related to elephants than to other marine mammals such as whales and dolphins, but their closest living aquatic relatives are the manatees. The dugong is listed as vulnerable to extinction under the Queensland *Nature Conservation Act 1992* (NC Act) and vulnerable by the International Union for the Conservation of Nature (IUCN).

There is a significant and long-term decline in the population of dugong along the Queensland urban coast (Dobbs et al. 2008). Dugong numbers in the Great Barrier Reef along the urban coast of Queensland have fallen by 97 percent since the 1960s (Marsh et al. 2001). Dugong are long-lived (up to 70 years) with low levels of reproductive output. After a gestation period of between 13 and 15 months, a female produces a single calf with calving intervals between three and seven years. Their slow breeding rate and long life span mean that dugongs are particularly susceptible to factors that threaten their survival, and population recovery, even when impacting processes are removed, is slow.

Anthropogenic impacts on dugong include traditional hunting, incidental capture in large meshed commercial fishing nets, the shark control program, boat strike and destruction of, and alienation from, seagrass habitat.

Sixteen dugong protection areas are declared under the NC Act, and as special management areas under the *Great Barrier Reef Marine Park Regulations 1983* and the Great Barrier Reef Marine Park

Zoning Plan 2003. The Great Barrier Reef Marine Park Authority's primary management intent for dugong conservation in the Great Barrier Reef Marine Park is to facilitate the recovery of dugong populations such that they fulfil their ecological role within the Great Barrier Reef ecosystem (Great Barrier Reef Marine Park Authority 2007).

The Rodds Bay/Port Curtis area, including the area adjacent to the proposed development site, is designated dugong protection area B. Dugong protection areas are a two-tiered management scheme where dugong protection area A represents the most significant dugong habitat in the southern Great Barrier Reef, while dugong protection area B represents less significant but still important habitat. The main difference in management arrangements between dugong protection areas A and B relate to commercial mesh netting fishing regulations.

As with all other marine mammals, dugongs must surface to breathe. However, unlike other marine mammals such as some whales and dolphins, dugongs cannot hold their breath under water for very long. Dives generally last for only a few minutes. Dugongs have poor eyesight but acute hearing. They almost solely consume seagrass, although in Moreton Bay large amounts of ascidians (sea squirts) may be consumed (Preen 1995). Dugong (*Dugong dugon*) are associated with seagrass beds in the Port Curtis region, but the region is not identified as supporting large populations of these animals. The nearest large populations of dugong occur in Shoalwater Bay to the north and Hervey Bay to the south. The dugong that do occur in the Port Curtis region are centred around the Rodds Bay area (Lawler and Marsh 2001), but they are recorded using seagrass beds in the northern part of Port Curtis such as those near Wiggins Island (Taylor et al. 2007; Chartrand et al. 2009).

Marine turtles

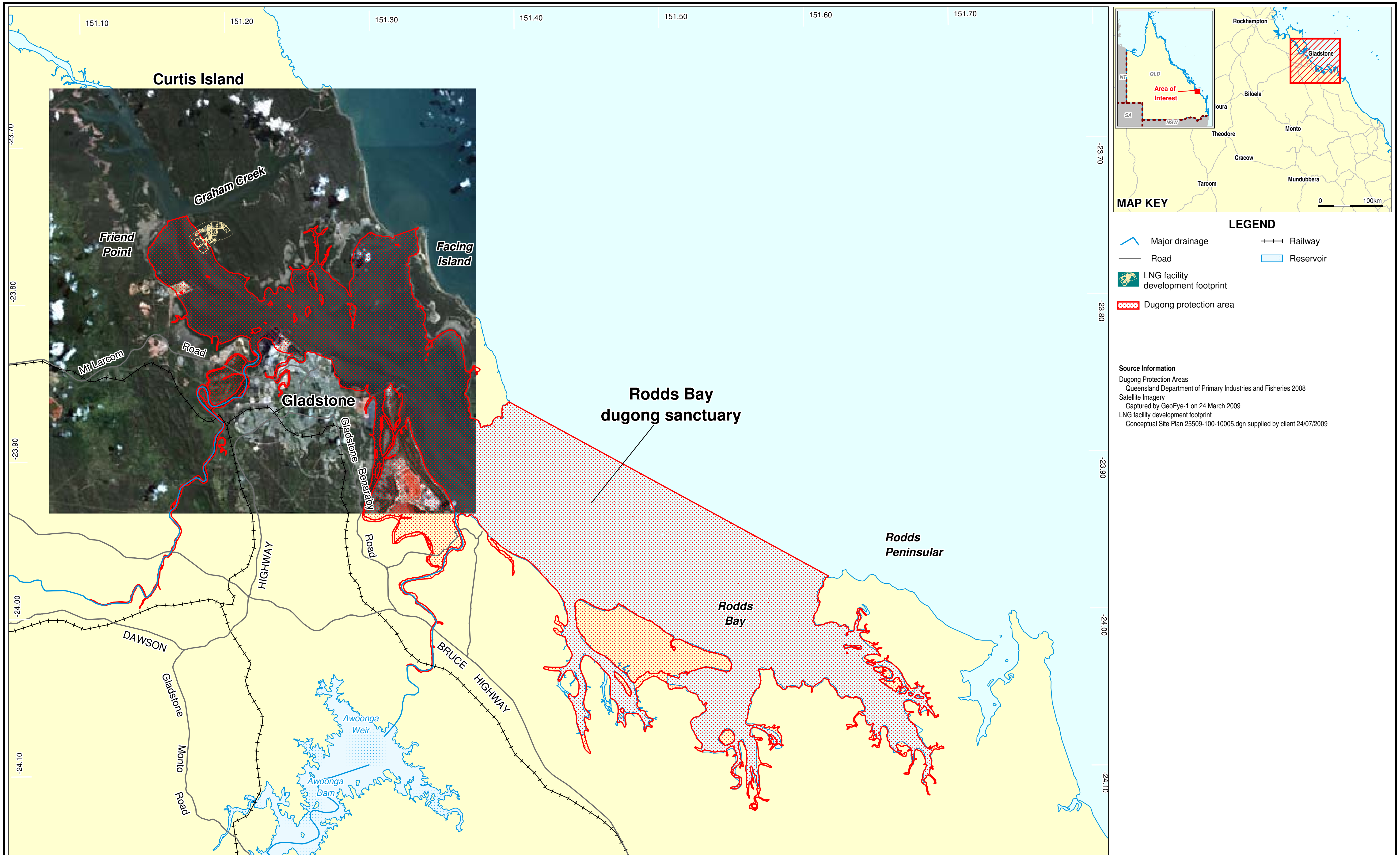
The conservation status of marine turtle species found in Australian waters is identified in Table 10.3. Currently, there is a recovery plan in place under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) for all marine turtle species in Australia.

Table 10.3 The conservation status of marine turtles found in Australian waters.

Species name	Conservation Status		
	IUCN	EPBC Act	NC Act
Green turtle (*Chelonia mydas*)	Endangered	Vulnerable	Vulnerable
Hawksbill turtle (Eretmochelys imbricata)	Critically endangered	Vulnerable	Vulnerable
Flatback turtle (*Natator depressus*)	Data deficient	Vulnerable	Vulnerable
Olive Ridley turtle (*Lepidochelys olivacea*)	Vulnerable	Endangered	Endangered
Leatherback turtle (*Dermochelys coriacea*)	Critically endangered	Endangered	Endangered
Loggerhead turtle (*Caretta caretta*)	Endangered	Endangered	Endangered

Key: IUCN = The International Union for the Conservation of Nature, EPBC Act = Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, and the NC Act = Queensland *Nature Conservation Act 1992*.

Marine turtles are long-lived and late maturing with maturity reached at between 30 and 50 years of age (Miller 1996). Marine turtles nest on mainland coastal beaches and offshore islands. They do not nest in estuarine areas such as those at and adjacent to the area of the proposed development location at Laird Point.



AUSTRALIA PACIFIC LNG PROJECT

Volume 4 Chapter 10
Figure 10.6 Dugong Protection Areas

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Female marine turtles emerge from the water, generally at night, and move up the shoreline to select a nesting location. Most females do not nest in consecutive years (Miller 1996). However, a female marine turtle may lay several clutches of eggs per year (Limpus et al. 1984). Nesting marine turtles generally demonstrate fidelity to a nesting beach and return to nest on their natal beach with a very high degree of precision (Limpus et al. 1984). The process by which turtles select nesting sites along a beach has not been clarified (Miller 1996), however light regime is considered to have a significant impact on the emergence of female marine turtles from the ocean.

Once hatched, lighting cues are identified as critical for hatchlings to move from the beach to the ocean – a behaviour known as sea-finding. In simple terms where there are no anthropogenic light sources, hatchlings move from away from the dark silhouetted shoreline towards the brighter ocean horizon. Brightness in this context however, is a term encompassing wavelength and intensity (Witherington and Martin 1996). Further, the heterogeneity of the light regime can also act as a cue. That is, hatchlings may orientate away from a horizon that has spatial patterns of light and shadow which in practical terms would see them orientate away from the shore and head towards the more homogenous light environment of the ocean horizon (Godfrey and Barreto 1995; Witherington and Martin 1996). Changes to lighting regime can impact hatchlings if light sources are at the nesting beach, on the foreshore adjacent to the nesting beach, or offshore. Lights at a nesting beach can result in turtle hatchlings heading inland rather than into the ocean with subsequent mortality. Lights adjacent to nesting beaches can result in hatchlings entering the ocean safely, only to re-emerge closer to the light source.

The sex ratio of turtle hatchlings is dependent on the temperature of incubation which is a function of sand colour. Nests in darker sand incubate at higher temperatures and produce more females (Hays et al. 2001).

It is known the endemic flatback turtle (*Natator depressus*) nests on the eastern beaches of Curtis, Facing and Hummock Hill Island (Limpus et al. 2002, 2006; Hodge et al. 2006). The South End area of Curtis Island is the key flatback turtle nesting area in the region and it is identified nationally as a medium density rookery (Limpus et al. 2006). Nesting activity reaches a peak in late November – early December, and ceases by about late January. Hatchlings emerge from nests during early December until about late March, with a peak of hatchling activity in February (Limpus 2007).

Green turtles (*Chelonia mydas*) and loggerhead turtles (*Caretta caretta*) may also nest sporadically in similar areas as the flatback turtle, however important rookeries for these two species lie elsewhere.

Cetacean - whales and dolphins

The EPBC protected matters database search identified 10 cetacean species occurring in the Port Curtis region including offshore areas. Of these, the Indo-Pacific humpback dolphin (*Sousa chinensis)*, the Australian snubfin dolphin (*Orcaella heinsohni*) and the bottlenose dolphin (*Tursiops aduncus* and *Tursiops truncatus*) are known to occur adjacent to the proposed LNG facility site. Coastal dolphins are recognised among the most threatened species of cetaceans due to their close proximity to a range of direct and indirect human impacts (Thompson et al. 2000).

Both the Australian snubfin dolphin and the Indo-Pacific humpback dolphins usually inhabit shallow coastal waters of less than 20m depth and are often associated with rivers and estuarine systems, enclosed bays and coastal lagoons (Corkeron et al. 1997; Hale et al. 1998; Parra 2006). There are no estimates of dolphin abundance in Port Curtis.

Parra (2006) examined habitat use of both Australian snubfin dolphins and Indo-Pacific humpback dolphins in Cleveland Bay (Townsville). While there was significant overlap in habitat use by the two species, differences were also found. Australian snubfin dolphins preferred slightly shallower (1–2m) waters than Indo-Pacific humpback dolphins (2–5m). Shallow areas with seagrass ranked high in the habitat preferences of Australian snubfin dolphins, whereas Indo-Pacific humpback dolphins favoured dredged channels.

Due to the inshore nature of the proposed project location it is considered the following cetacean species identified in the EPBC protected matters database search do not occur at or adjacent to the proposed development location as they are principally oceanic species: minke whale (*Balaenoptera acutorostrata*), humpback whale (*Megaptera novaeangliae*), Bryde's whale (*Balaenoptera edeni*), Risso's dolphin (*Grampus griseus*), spotted dolphin (*Stenella attenuata*), common dolphin (*Delphinus delphis*) and the killer whale (*Orcinus orca*).

Estuarine crocodile

The southern most range of the estuarine crocodile (*Crocodylus porosus*) is generally recognised as the Fitzroy River although individuals straggle as far south as Colosseum Inlet and Seven Mile Creek systems. While it is plausible estuarine crocodile may be sited near the LNG facility, the area does not represent key habitat for the species. The key areas for estuarine crocodile populations in Queensland is the north western Cape York Peninsula, particularly parts of the Wenlock River and the Lakefield National Park (Read et al. 2004).

Sea snakes

An EPBC protected matters database search identified 12 species of sea snakes that may occur in the region of the proposed development. The species are as follows:

- Horned seasnake (Acalyptophis peronii)
- Dubois' seasnake (Aipysurus duboisii)
- Spine-tailed seasnake (*Aipysurus eydouxii*)
- Small headed seasnake (*Hydrophis mcdowelli*)
- Olive seasnake (Aipysurus laevis)
- Stokes seasnake (Astrotia stokesii)
- Spectacled seasnake (*Disteria kingii*)
- Olive-headed seasnake (*Disteria major*)
- Turtle-headed seasnake (*Emydocephalus annulatus*)
- Elegant seasnake (*Hydrophis elegans*)
- Spine-bellied seasnake (*Lapemis hardwickii*)
- Yellow-bellied seasnake (*Pelamis platurus*).

There are clear and significant knowledge gaps with respect to the distribution and abundance of sea snakes in Australia. However, the following sea snake species are considered to prefer inshore waters with sandy/muddy substrata and moderate turbidity: elegant seasnake, spine-bellied seasnake and the small headed seasnake (Heatwole and Cogger 1993). As such, these are the sea snake species most likely to occur in the vicinity of Laird Point.

10.2.8 Soft sediment macrobenthic infaunal assemblages

Macrobenthic infauna are the animals living in the sediment such as various worms and shellfish. These animals play important roles in the marine foodweb, including being prey items for many large invertebrates and fish species, including species of direct fisheries significance.

Currie and Small (2005, 2006) undertook a comprehensive assessment of the macrobenthic infaunal assemblage of Port Curtis over a six year period, and Alquezar (2008) also undertook additional work, in part, in the area of interest for the Project. Overall, the assemblage sampled by Currie and Small (2005; 2006) throughout the Port Curtis region is dominated by filter feeders which accounted for more than 50% of the total abundance and nearly 30% of the total species richness. The bivalve mollusc *Carditella torresi* was the most abundant species which accounted for more than 14% of the total abundance. The ascidian *Ascidia sydneiensis* was the second most abundant species accounting for less than 4% of the total abundance. A further eight species including five bivalves (*Corbula tunicata*, *Mimachlamys gloriosa*, *Leionuculana superba*, *Mactra abbreviata* and *Placamen tiara*), one sea squirt (*Ascidiacea* sp.), one polychaete worm (*Eunice vittata*) and one shrimp (*Alpheus* sp.) each contributed between 2-3% of the total abundance. The majority of organisms (98% of the species) were collected infrequently and individually contributed less than 2% of the total abundance.

Species richness and abundance were found to be lowest on fine muddy substrates in intertidal areas, and greatest in coarse sandy sediments predominated in the deeper channels of the estuary. Regional rainfall and freshwater inflow positively correlated with macrobenthic infaunal abundance. Some information presented by Currie and Small (2006) can be disaggregated into a smaller spatial scale of relevance to the proposed development locations. Sampling stations closest to Laird Point had macrobenthic infaunal assemblage that was low density and numerically dominated by the deposit feeding bivalve *Leionuculana superba* and the predatory polychaetes *Eunice* sp 1, *Nephtys* sp 1 and *Leanira* sp 1.

10.2.9 Plankton

Plankton consists of phytoplankton (floating plants) and zooplankton (floating animals). Phytoplankton is an important source of primary production in coastal waters and is recognised as an important indicator of environmental health. In particular, phytoplankton is a good indicator of nutrient enrichment from anthropogenic sources. Phytoplankton concentrations are measured by assessing the concentration of chlorophyll *a* in the water column. Chlorophyll *a* is the principal photosynthetic pigment possessed by phytoplankton. Prediction of chlorophyll a winter levels in the Port of Gladstone range from 0.6 to 3.2µg/L and are between 2.0µg/L and 2.3µg/L in waters adjacent to Curtis Island. These values are below the relevant ANZECC/ARMCANZ guideline (2000) trigger value of 4.0µg/L (Currie and Small 2006).

Zooplankton is further divisible into holoplankton – animals spending their whole life cycle as plankton and meroplankton – animals spending only part of their life cycle as plankton. Meroplankton includes larvae of animals such as oysters, as well as fish and prawn larvae including those of commercial and recreational significance. Zooplankton includes animals grazing on phytoplankton as well as carnivores that consume other zooplankton. Both phytoplankton and zooplankton are key components of the food web of coastal waters.

With the exception of Moreton Bay, inshore plankton assemblages in Queensland are not well studied and the research in Moreton Bay is not directly transferable to the Port Curtis region. Although most plankton is microscopic, the most visible component of the planktonic assemblage are the large scyphozoan jellyfishes, such as *Catostylus mosaicus*, which occur in Port Curtis.

10.2.10 Exotic marine species and marine pests

The Port of Gladstone currently receives vessels from various Australian ports as well from overseas ports from a number of countries including: Japan, China, Korea, Singapore and the west coast of the United States of America. Therefore there is the potential for introduction of exotic marine species through ballast water, hull fouling and fouling of internal sea water pipes. A national system for the prevention and management of marine pest incursions is utilised to address all aspects of the prevention, management and control of marine pest incursions. The system considers measures to reduce the risk to primary invasion through ballast water and fouling, as well as measures to control the spread of existing introduced marine pests as a result of translocation. The Port of Gladstone is one of 18 ports in Australia targeted for ongoing monitoring for marine pests as it is recognised that there is an ongoing high risk of introductions and translocations to the area. However, the monitoring program is yet to commence in Port Curtis.

Previously, Lewis et al. (2001) undertook a study of the distribution, abundance and risk of exotic marine species in Port Curtis. The study identified the presence of nine exotic marine species but none of these are classified as marine pest species. Marine pest species are those introduced species that can have a significant impact on marine industries, the marine environment, coastal communities and the economy. The nine exotic marine species present in Port Curtis consists of four bryozoans (*Amathia distans*, *Bugula neritina*, *Cryptosula pallasiana*, and *Watersporia subtoraquata*), two ascidians (*Botrylloides leachi* and *Styela plicata*), one isopod crustacean (*Paracerceis sculpta*), one hydrozoan (*Obelia longissima*) and one dinoflagellate (*Alexandrium* sp.). These species have successfully colonised ports within Australia and worldwide and are unlikely to have significant impact on native assemblages.

10.2.11 Fish and invertebrates

All sub-tropical inshore fish assemblages are temporally and spatially variable at many different scales. Components of this fish assemblage in the Port Curtis region support regionally important commercial and recreational fisheries.

Currie and Connolly (2006) identified the fish assemblage of shallow, nearshore sedimentary parts of Port Curtis area was found to be diverse with 88 species present but dominated by two small schooling species, ponyfish and herring which in combination comprised approximately 50% of the total abundance. The structure of the sub-tidal fish assemblage in the vicinity of Laird Point is similar to most other inshore sites surveyed in Port Curtis. The dominant species present are: common ponyfish, finny scad, herring, yellow perchlet, happy moments, large-scaled grinner, striped cardinalfish, yellow-fin tripod fish, large-toothed flounder and diver whiting. All of these species are common and widely distributed and typical of inshore habitats in sub-tropical Australia.

Saltmarsh and saltpan habitats tend to have lower species richness than other inshore habitats such as mangroves and seagrass (Sheaves et al. 2007), but nonetheless provides important habitat for fish species, including those of recreational and commercial significance. Although fish utilisation of saltmarsh in the Gladstone region is not well studied, Sheaves et al. (2007) presents information on the saltmarsh fish assemblage for Munduran Creek which drains into The Narrows approximately 15km from the proposed development location. The numerically dominant species recorded were mullet, ponyfish and silverbiddies, and these species are likely to be numerically dominant at the proposed development location.

Fish utilisation of the mangroves in the Port Curtis area has not been studied, however Halliday and Young (1996) thoroughly examined density, biomass and species composition of mangrove forests further south at Tin Can Bay. Similar to the mangroves in Port Curtis, the mangroves examined by

Halliday and Young (1996) were dominated by the red mangrove *Rhizophora stylosa*. They recorded 42 species from the mangrove forests and economically important species represented approximately 76% by number and 74% by weight of the total catch. The numerically dominant species were yellowfin whiting, common toadfish, common silverbiddy and the flat-tail mullet.

Although specific information is lacking, the rock and reef habitat within Port Curtis is likely to be utilised by a range of adult and juvenile fish species including: yellowfin bream, sweetlip, estuary cod and blubber-lip bream.

In terms of fish species of conservation significance, the whale shark occurs in oceanic waters east of Facing and Curtis islands, and as such is unlikely to occur in an estuarine environment such as Port Curtis. The green sawfish (*Pristis zijsron*) is recorded in shallow inshore coastal environments including estuaries. However detailed records of the occurrence of the species from 1912 to 2004 identify no individuals of the species as being recorded in the Gladstone region during that period (Stevens et al. 2005). The estuary stingray (*Dasyatis fluviorum*) is ranked as a high priority species by the DERM Back on Track species prioritisation framework which prioritises Queensland's native species to guide conservation, management and species recovery. The estuary stingray utilises a range of shallow inshore habitats and is likely to occur frequently within the area of the proposed development.

Nektobenthic invertebrates refers to large more mobile benthic invertebrates such as crabs, prawns and lobsters typically absent or significantly underestimated in standard benthic sampling gear such as grabs or sleds. Nektobenthic invertebrates are frequently important for fisheries. Although a comprehensive analysis is lacking, the Port Curtis area provides habitat for various portunid crabs including the blue swimmer crab, juvenile prawns (including tiger prawns, eastern king prawns and banana prawns) and mud crabs (Walker 1997).

10.2.12 Fisheries resources

Commercial fisheries

Net and mud crab fisheries are the principal commercial fisheries operating in the Port Curtis area, although beam trawling also occurs. Net and crab fishers operating in Port Curtis are also permitted to operate anywhere on the east coast in areas where these fishing activities are permissible. Commercial fishers are endorsed to beam trawl in the Port Curtis area are only permitted to operate in Port Curtis, The Narrows, mouth of the Fitzroy River and Keppel Bay.

Commercial fisheries in Queensland are monitored through a compulsory logbook program administered by the Queensland Primary Industries and Fisheries (QPI&F). Data collated from the logbook program is available via the coastal habitat and resource inventory system (CHRISweb) database[2] which is also administered by the QPI&F. A key consideration when interpreting information from the database is the spatial resolution which is very coarse. Commercial net and crab fishers record spatial information on catch and effort in 30 minute grid squares. In the current area of interest this scale includes all of the Gladstone Port Area and The Narrows area as well as significant areas in offshore waters east of Curtis Island (Figure 10.7).

[2] http://chrisweb.dpi.qld.gov.au/chris/

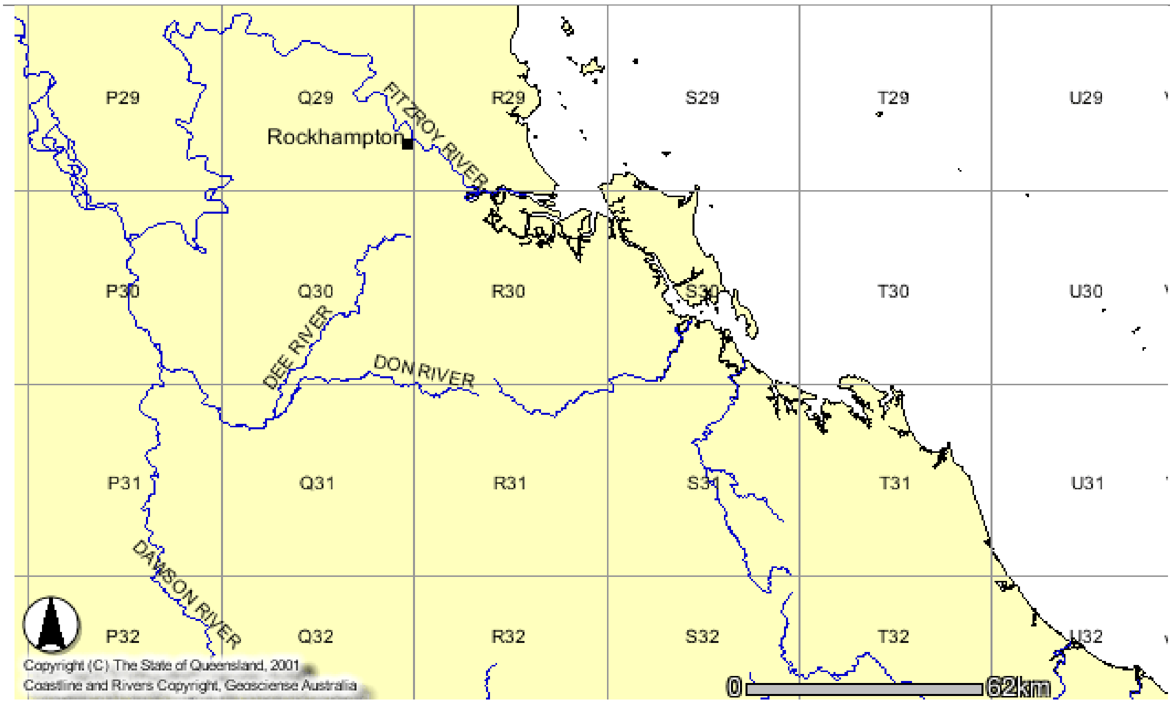

Figure 10.7 Map of the 30 minute grids for recording commercial fishing catch and effort in the Port Curtis region. Grid S30 contains the proposed development location.

The annual volume and value of the catch for the commercial net and crab fishery in the Gladstone Port area (grid S30) between 1988 and 2005 is shown in Figure 10.8.

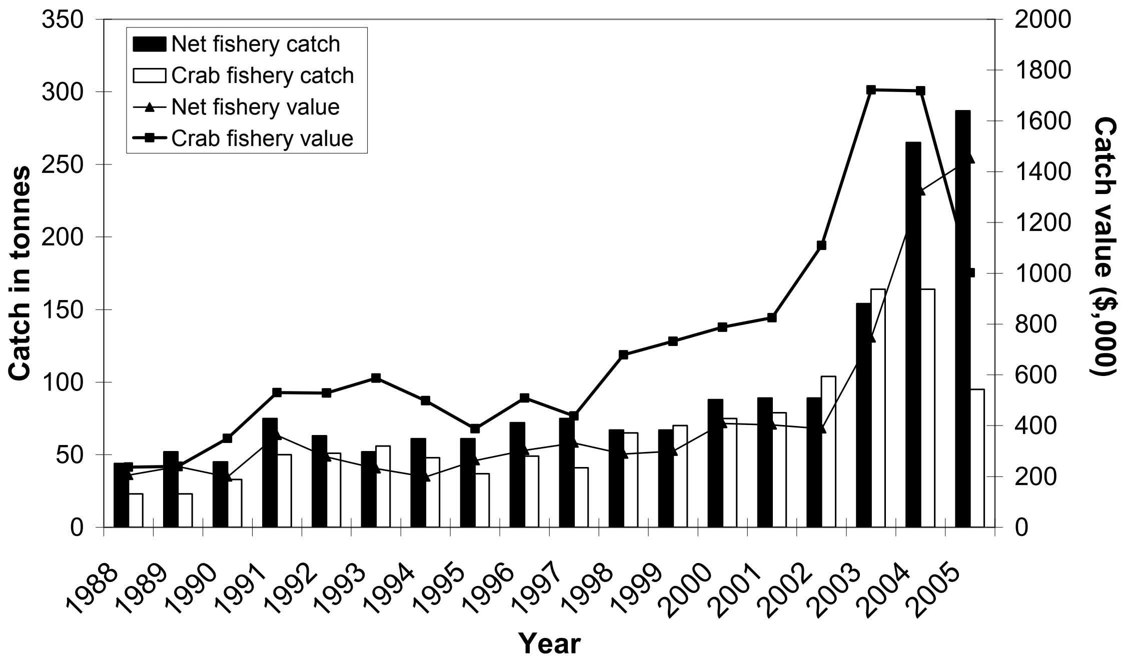

Figure 10.8 The annual volume and value of the commercial net and crab fishing catch between 1988 and 2005 in grid S30

Both the volume and value of the catch in the net and crab fishery has tended to increase over time with a more rapid increase since 2003, particularly for the net fishery. No data is currently publicly available for years after 2005. The crab fishery in the region is almost solely focused on the mud crab (*Scylla serrata*). Most of the commercial mud crab fishery is concentrated in The Narrows and the creeks that drain into (for example Graham Creek, D.McPhee pers. obs). By volume and value key target species in the net fishery include various species of shark, blue threadfin salmon, mullet, barramundi and grey mackerel.

The beam trawl fishery targets various species of prawns with banana prawns, school prawns and greasyback prawns dominant in the catch. The beam trawl fishery within the Port Curtis/Fitzroy River/Keppel Bay area contributes approximately 15% of the Queensland beam trawl catch. However, while the Port Curtis region is within the area and can be accessed by the fishery, available logbook information demonstrates the area is rarely fished in practice.

Recreational fisheries

Statewide recreational fishing surveys have been undertaken in 1997, 1999, 2002 and 2005. These surveys report catch and effort information at a broad spatial scale – the statistical division a fisher resides in. Like information on commercial fishing, information on recreational fishing can be accessed through CHRISweb. In the current instance, the relevant statistical division is the Fitzroy region and the available information demonstrates that whiting, mullet and bream are the three dominant finfish species harvested.

Platten et al. (2007) provide information on the levels of boat based fishing effort through Central Queensland including Gladstone. From 1985 to 2005, boat registrations in the Gladstone region increased 110% from 2,171 to 4,581 with the vast majority of these boats used for recreational fishing. It was estimated between the period June 2005 and May 2007, approximately 16,395 boating trips commenced from the Gladstone boat ramp (adjacent to Gladstone Volunteer Marine Rescue) which is the main public boat ramp in the region. While the number of vessels utilising the Laird Point and Graham Creek area is unknown, the Graham Creek area is recognised as a very important anchorage area for recreational vessels and an important area for recreational fishing, particularly mud crabbing.

Graham Creek is also utilised as a safe anchorage for yachts.

10.3 Impact assessment

Impact assessment involves a risk-based evaluation of the impacting processes and their effect on the existing environment, if the Project proceeds. Australia Pacific LNG identified the key impact mechanisms and possible impacts associated with each mechanism, and then carried out a formal risk assessment.

The Australia Pacific LNG risk tools described in Volume 1 Chapter 4 were used for the marine environment assessment, with a modified set of consequence descriptors that are more applicable to the natural environment.

10.3.1 Habitat reclamation and fragmentation

Impact assessment

Construction of the LNG facility will require the reclamation of approximately 2.4 hectares of mangroves and 24 hectares of saltpan/saltmarsh. The area of mangroves represents 0.03% of the estimated mangrove cover (6,736ha), and 0.5% of the saltpan/saltmarsh habitat (4,573ha) in the Port

Curtis region. The plant footprint site boundaries for the LNG facility have been chosen to minimise the removal of mangrove habitat in particular. A large stand of mangroves and a small mangrove lined creek in the centre of the Project is proposed to be left undisturbed.

The construction of the marine infrastructure may potentially impact marine fauna through the fragmentation of marine habitat. This potential impact is expected to be less for the Option 2a jetty configuration compared to Option 1b as the trestle length is lower. Dugongs are potentially impacted by destruction of, and alienation from, seagrass habitat. While the Port Curtis region is not identified as supporting large populations of dugongs, the construction of marine facilities can temporarily impact movement of dugong and cetaceans to feeding areas. Dugong survey information currently available does not provide data at a scale suitable for assessing dugongs' use of the Western Basin area (GPC 2009).

Mitigation and offsets

For the marine fish habitat that is to be disturbed, consideration of mitigation and offsets are guided by the Queensland Government Fish Habitat Management Operational Policy FHMOP (2002) Mitigation and compensation for works or activities causing marine fish habitat loss.

The objectives of this policy are to:

- Maintain fisheries values, including fish habitat values
- Seek to ensure the costs associated with fish habitat losses attributed to public or private works are matched with, or are less than, a level of mitigation and/ or compensation appropriate to the disturbance of fish habitat
- Promote maintenance of marine fish habitats through implementation of mitigation or compensation to meet the objective of No Net Loss of Marine Fish Habitat Policy
- Recognise the natural capital of fish habitats
- Create public awareness of the value of fish habitats.

Compensatory activities may be carried out off-site but in the region where the disturbance is occurring, or may be part of a state-wide compensation program. Australia Pacific LNG has investigated a number of compensatory options for marine fish habitat loss. Australia Pacific LNG has consulted widely with local fishing stakeholders on offset options and has identified a preference for offsets at the local/regional level as it is the local/regional stakeholders that will potentially be impacted by the Project. The specific options that have been considered to date include the following:

- Restoration and/or rehabilitation of 'like for like' habitats in the Gladstone region
- Creation of purpose built inshore artificial reefs which also serve to mitigate loss of fishing access
- Fish stocking of Awoonga Dam to further enhance the recreational fishery
- Financial and in-kind support for fish and habitat monitoring through recreational fishing groups specifically CapReef
- Financial and in-kind support for fish habitat or other relevant local marine research projects.

In terms of habitat restoration, Australia Pacific LNG has considered options in the Port Curtis region but has not identified any areas where restoration is necessary or likely to be effective. Australia Pacific LNG has considered options proposed in the Port Alma region to improve connectivity of saltmarsh/saltpan habitat to assist barramundi recruitment, but considered it too far removed from the Project location, in addition to there being significant uncertainties regarding feasibility.

Australia Pacific LNG has considered the creation of inshore artificial reefs using purpose built materials to in part offset habitat loss, but principally to offset loss of recreational fishing access. No specific location for an artificial reef in the Port Curtis region has been identified, however Australia Pacific LNG commits to further investigation of inshore artificial reefs if the community desire for these is strong.

CapReef is a community program monitoring the status of fish resources and the use of fish habitat in Central Queensland. CapReef is a partnership between government agencies, researchers and fishing groups with a strong community focus. Australia Pacific LNG commits to providing resources for programs such as CapReef to undertake relevant components of monitoring associated with fisheries and fisheries habitats.

At the current time however, Australia Pacific LNG has not finalised all options for offsetting the loss of marine fisheries habitat, but APLNG continues to work through the options with stakeholders and relevant agencies to implement activities that effectively compensate for loss of marine habitat.

Overall, the reclamation of habitat for the construction of the LNG facility is predicted to pose a medium risk to the Port Curtis marine environment.

Monitoring of the usage of the area adjacent to the LNG facility by dolphins and dugong will be undertaken prior, during and after construction. The principal aim of this monitoring is to determine if animals are displaced from habitat and whether this impact persists through time. If the impacts persist and are considered significant in terms of the viability of dugong and cetacean populations in Port Curtis, additional corrective actions will be considered. Australia Pacific LNG will also establish a process for visual observations and recording of dugongs and cetaceans during the operational phase of the Project.

10.3.2 Boat strike

Impact assessment

When vessel based activities overlap with habitats utilised by dugong and marine turtles they are at particular risk from boat strike which can cause significant injury or mortality. Marine turtles and dugong are vulnerable to boat strike when they are at the surface breathing and resting between dives. It is commonly accepted that vessel speed and water depth are the main factors affecting the risk of boat strikes with faster vessels in shallower water posing a greater risk. Annually, boat strike is one of the most significant known causes of human induced dugong mortality (Greenland and Limpus 2008).

There is current scientific evidence suggesting that death and injury caused by boat strike has a significant impact on dugong populations in Queensland (Grech and Marsh 2008). A recent study has found the reaction time of dugongs does not change in accordance with the speed of an approaching vessel and therefore faster moving vessels have a greater probability of causing dugong mortality (Hodgson 2004).

For the Project, slow moving vessels such as tugs, barges, and LNG ships are considered to pose an inherently low risk of boat strike to dugong and marine turtles in Port Curtis.

Mitigation

Boat speed limits in key locations where dugong and marine turtles consistently frequent are the recognised approach to mitigating the risk boat strike poses to dugong. Boat speed limits are believed to reduce risks in three primary ways: greater reaction time for boat operators to locate animals and to identify the risk of animal collision, greater reaction time for marine mammals to recognise the presence of vessels and more time to get out of the way and reduced severity of injuries in the event of boat strike (Hodgson 2004). In addition, vessels should utilise predefined and regular routes to reduce the spatial scale of disturbance, and only alter this route for marine safety reasons or if instances of interactions are considerable. Depending on the exact design of the ferry to be used propeller guards should also be considered.

However, it is problematic to consider mitigation for this risk in isolation of other current and proposed fast transport activities within the Port of Gladstone. Australia Pacific LNG will continue to work with relevant government agencies and other industries that are, or proposing to operate fast transport activities to develop practical “whole of basin” approaches to mitigation. .Australia Pacific LNG will establish a process for visual observations and recording of dugongs and cetaceans at and adjacent to the study area.

With mitigation in place, any fast ferries activities that service the LNG facility during the construction and operational phases of the Project are considered to pose a medium risk.

10.3.3 Underwater noise

Impact assessment

Activities associated with construction in the marine environment and operations, in particular vessel movements, have the potential to displace dugong and cetaceans from critical habitat and interrupt critical behaviours through the creation of underwater noise. Cetaceans have been found to avoid some human sound sources for ranges of several kilometres, abandoning valuable habitat in the process (Tyack 2008). There are a number of underwater noise sources that may impact on cetaceans and dugong. These include pile driving and vessel traffic.

Percussive piling for the construction of the material offloading facility (MOF) jetty is most likely to be of a frequency and volume that will cause disturbance to dolphins. While information is limited, Jefferson et al. (2009) identified that Indo-Pacific dolphins avoid areas during pile driving but return once construction ceases. Overall, it is considered that disturbance to dolphins will occur during the construction phase as a result of pile driving, however, dolphins will again utilise the area once construction activities cease. The overlap of dolphin populations with areas of high vessel activity suggests at least, in part, they habituate to boating activities.

Noise generated by vessel activity can also change the behaviour of dugong and result in alienation from important habitat. Potential energetic costs of boat disturbance to dugongs include: a reduction in energy intake, the energy expended while moving, and the possible cost of moving to a different patch on the seagrass beds. Disturbed dugongs may be forced to spend time searching for alternative feed patches and may be forced to feed on less desirable patches with lower nutritional value. Hodgson (2004) found that dugongs were less likely to remain feeding if a boat passed within 50m than if it passed at a greater distance. These movements occurred in response to boats passing at all speeds, and at distances of less than 50m to over 500m. Such disruptions to feeding can affect the health of a population if they occur at significant levels. However, if animals can move to suitable nearby habitat then this may largely mitigate impacts from disturbance (Gill et al. 2001). In the case of Port Curtis, existing high value dugong (seagrass) habitat occurs in areas unaffected by the current development.

For potential direct physiological impacts on marine fauna from underwater noise, refer to Volume 4 Chapter 15.

Mitigation and monitoring

To mitigate the impact, Jefferson et al. (2009) identify the use of bubble curtains and jackets can be effective. A bubble curtain, one option for mitigating piling noise, is created by forcing air from compressors into an enclosure around the noise source. The bubble curtains function by reducing the distance over which percussive sounds from activities such as pile driving are evident.

The use of mitigating strategies including the option of use of bubble curtains, pile cap cushions and applying “soft starts” to pile driving will be implemented. Soft starts refer to the increasing of pile energy gradually over a period of time.

Monitoring of the usage of the area adjacent to the LNG facility by dolphins and dugong will be undertaken prior, during and after construction (refer above).

10.3.4 LNG facility lighting

Impact assessment

Although the nearest nesting beach is in the vicinity of South End on Curtis Island, it is plausible, however unlikely, lighting from the operational LNG facility will impact sea finding behaviour of hatchlings and the selection of nesting areas by adult flatback turtles. Confounding the assessment of the impact of lighting on marine turtles in this instance is the light regime is already highly modified in the Gladstone area and will be further modified by future developments.

Mitigation

No single solution, but rather a combination of solutions is necessary to mitigate light impacts on marine turtle nesting while allowing for safe and efficient construction and operation of coastal infrastructure. Solutions include:

- Physically shielding the lights and directing the lights onto work areas
- Lowering the height of lights
- Reducing the amount of reflective surfaces through the use of matt paints on surfaces where practical
- Use of motion detecting sensors and light timers.

Using long wavelength red, orange or yellow lights and avoiding short wave length white lights is considered effective at mitigating lighting impacts on nesting loggerhead turtles, but is not proven to be effective at mitigating impacts on flatback turtles and as such will not specifically be employed to mitigate the risk to flatback turtles.

Australia Pacific LNG will use a sensitive lighting approach to reduce light spill impact on marine fauna.

10.3.5 Construction of the material offloading facility

Impact assessment

Construction of the MOF will involve the dredging and reclamation of intertidal and sub-tidal areas. The area to be reclaimed is approximately 8.3ha. Refer Volume 4 Chapter 12 for additional information on the impacts and mitigation as a result of the construction of the material offloading facility including associated reclamation works.

The MOF requires the removal of approximately 100,000 m^3 of dredge material. The volume will depend on the final configuration of the marine infrastructure, including the MOF, jetty and wharfs. The duration of dredging is estimated at 60 days. Channel dredging, berth dredging and MOF approach channel dredging for the project is considered in the EIS for the Western Basin Dredging and Disposal Project prepared on behalf of Gladstone Ports Corporation. All dredging is anticipated to be conducted by Gladstone Ports Corporation. The Western Basin Dredging and Disposal Project EIS describes and assesses staged dredging and disposal of approximately 50 million metres cubed within the Western Basin area. Dredging is predicted to commence in 2010 with dredging of the Laird Point area predicted to commence in 2012.

Dredging results in the removal of the animals contained in the sediment within the dredged area, a turbidity plume that is transported outside the dredge area, and the possible mobilisation and transportation of nutrients and contaminants. The resulting channel is also obviously a deeper area than existed previously. Volume 4 Chapter 12 describes the nature and extent of the turbidity plume from constructing the MOF.

Sediment analysis identified that sediments to be dredged from the MOF are present at concentrations below the screening levels of the NAGD and EIL and HIL-A of the Draft guidelines for the assessment and management of contaminated land in Queensland (DOE 1998). Consequently, the sediments are considered to be uncontaminated and therefore are unlikely to be a source of contamination to the reclamation area. There is however, potential to disturb ASS during the dredging associated with the construction of the MOF and placement of this material in the reclamation area may potentially lead to the oxidation of PASS and subsequent generation of acidic leachate and migration of the acid leachate to groundwater and the harbour, impacting on water quality.

A turbidity plume can decrease the ambient light levels extending through to the seabed which can affect photosynthesis through the water column and impact vegetated habitats on the seabed such as seagrass and algae. The intensity and duration of the decreased light intensity affect the likelihood and magnitude of impacts. When suspended sediments in a turbidity plume settle out, they can also potentially smother benthic assemblages. While increases in turbidity are a natural event, the duration of elevated turbidity plumes from the proposed dredging program are much longer than those that occur naturally.

Following dredging there are a number of factors which influence the rate and trajectory of re-colonisation of the macrobenthic infaunal assemblage including the level and frequency of natural disturbance (storm events, river flows, and wave environment), the scale and timing of the dredging operation, and the changes to the sedimentary environment. The processes involved in re-colonisation including the following:

- The direct return of organisms through surviving entrainment and being released in discharge waters
- Passive re-colonisation via erosion of the pit wall

- Active re-colonisation as animals move into the disturbed area
- Larval recruitment.

Some larger and more robust animals such as molluscs may survive entrainment in discharge waters and may facilitate re-colonisation of adults to a dredged location (Van Der Veer et al. 1985). Changes to the physical or chemical characteristics of the sediment caused by dredging can have large implications for the recovery potential of the assemblage as it influences the suitability for larvae recruitment (Snelgrove and Butman 1994; Kenny and Rees 1996).

Mitigation and monitoring

Mitigation measures documented in this section reflect requirements for dredging and reclamation works for MOF construction.

The construction of the MOF involves the reclamation of intertidal habitat. The Australia Pacific LNG approach to compensatory measures for the loss of habitat was discussed previously in Section 10.3.1.

To minimise impacts during dredging and material placement, the following measures will be considered:

- Development of a dredge management plan consistent with the plan for the Western Basin Dredging and Disposal Project and including:
  - Dredging operation within safe weather conditions (as defined by the Harbour Master) to prevent spills
  - Management of tailwater decant to maintain water quality within background levels
- Placement of geo-textile fabric on the inner face before commencement of infilling to minimise the transport of fine sediments from within the MOF
- Where practical, deployment of silt curtains to prevent migration of turbidity plumes
- Development of an ASS management plan which may include the following mitigation measures:
  - Appropriate treatment of soils via the addition of good quality agricultural lime at the determined rate
  - Post placement testing of the sediments to ensure sufficient acid buffering capacity
  - Installation of groundwater monitoring bores.

The mitigation measures serve to potentially limit both the spatial scale and the magnitude of the impact from dredging and material placement activities. With mitigation in place the risk to the benthic environment from the proposed dredging and reclamation activities is medium.

10.3.6 Fishing access

Impact assessment

With an influx of employees to the region for the Project, the number of potential recreational anglers in the region will also increase. Approximately 45% of residents in the Fitzroy statistical division go recreational fishing at least once per year (Henry and Lyle 2003).

As marine traffic under the facility's jetty would be precluded for safety and security reasons, the construction and operation of the proposed LNG facility will result in a loss of fishing access to both commercial and recreational fisheries. Further, the commercial net fishery provisions of the *Fisheries Regulations 2008* creates an exclusion zone to mesh nets of 200m around any wharf or jetty.

Although not quantified, the area around the proposed LNG facility is utilised by recreational anglers and to a lesser degree by commercial mud crabbers and net fisheries. It is not considered however, to be a prime location for any of these fishing activities. While, commercial beam trawling is also licensed to operate within the Port Curtis region, available information suggests that the level of commercial fishing effort throughout the Western Basin is low.

Australia Pacific LNG has sought feedback from the community and has determined that Option 2a will be less obtrusive for recreational boaters in the harbour seeking access to Graham Creek. This access is sought not only in severe weather as a safe harbour but also for recreational reasons. The Western Basin can become rough under certain weather conditions and smaller boat seek to travel up north in the Western Basin by skirting the western shore of Curtis Island. A jetty out to and past North Passage Island, in the case of an Option 1b berthing configuration, would be restrictive to small boats and passage would need to be on the western side of the North Passage Island. Marine traffic under the jetty would be precluded for safety and security reasons.

Mitigation and offsets

Australia Pacific LNG has shown through the stakeholder engagement process to date that it is committed to working with fishing stakeholders to minimise loss of fishing access. A number of options to offset loss of fishing access have been investigated, and these options have been considered in combination with those for addressing habitat loss. Australia Pacific LNG has consulted widely with fishing stakeholders to attempt to offset loss of fishing access. As well as further investigation of inshore artificial reef opportunities, Australia Pacific LNG will continue to consult with recreational fishing groups in the Gladstone region, relevant agencies and the Gladstone Ports Corporation to further investigate opportunities for recreational fishing offsets. This may include providing support for the ongoing fish stocking activities at Awoonga Dam.

Overall the risk to fishing access is considered low.

10.3.7 Introduced marine pests

Impact assessment

Gladstone Harbour currently receives vessels from a large number of countries including Japan, China, Taiwan and Korea where LNG vessels will originate from. While exotic marine species are currently present, none of these species are categorised as marine pests. However, pests may be introduced through discharge of ballast water or improper anti-fouling practices.

Mitigation and monitoring

There are existing protocols in place to minimise the risk of marine pest incursions and the early detection of an incursion if one occurs. There is a national system for the prevention and management of marine pest incursions which includes three major components: prevention, emergency response and ongoing control and management of existing pests. Since 2001 requirements have been in place for the management of internationally sourced ballast water that apply to all ships arriving from overseas. These requirements are implemented through the *Quarantine Act 1908* and are administered by the Seaports Program within the Australian Quarantine Inspection Service (AQIS).

No ballast water may be discharged from internationally trading vessels in Australian waters without express written permission from AQIS. All ships are required to comply with the International Convention of Pollution from Ships (MARPOL) as established by the International Maritime Organisation. This specifically addresses items such as bilge pumping, sewage and garbage.

ConocoPhillips, the Australia Pacific LNG joint venture partner that will build and operate the LNG facility has a marine vetting standard that would apply to shipping operations related to the Project. The standard sets out safety and environmental requirements to meet the company's marine transportation need to ensure prudent management of marine risk.

With the existing protocols in place, the risk of marine pest incursions as a result of the Project is medium.

10.3.8 Plankton entrainment

Impact assessment

Intake of saltwater for the desalination plant will result in the entrainment and mortality of plankton including fish and crustacean larvae of species of commercial and recreational significance. It is not currently possible to predict the quantities of plankton entrained or the impact of the entrainment on the structure of assemblages in Port Curtis. However, the volume of water entrained relative to the volume of Port Curtis is very low and there is a high level of natural mortality among planktonic organisms.

Mitigation and monitoring

Overall strategies to reduce water demand and collect and use stormwater will reduce (but not remove) the overall need for desalinated water, and hence will reduce the volume of plankton that will be entrained. The intake will be appropriately screened to prevent the intake of larger animals and the intake rate will be as low as practical by using an appropriate intake design. The intake of plankton will be considered when designing the position of the seawater intake within the water column and the velocity of the intake water. However, it is not possible to prevent the intake of all plankton.

With mitigation measures in place, the risk of plankton entrainment is low.

10.3.9 Desalination plant discharge

Impact assessment

Water demand for the LNG facility during operations is primarily driven by the continuous demand for demineralised water required for the Acid Gas Removal Unit (AGRU). Potable water during construction and operation is also required. This water will be supplied through the collection of stormwater, the reuse on-site of treated effluents and the operation of a seawater desalination unit with seawater sourced in Port Curtis directly offshore of the LNG facility. Water demand during the construction and operational phases of the project are shown in Table 10.4 and Table 10.5 respectively.

Table 10.4 Water demand during construction period

Requirement	Volume or rate
Hydrotest water	160,000m^3
LNG facility concrete work	31,500m^3

Requirement	Volume or rate
Site preparation/dust control	6,000m^3
Potable water	433,000m^3
Potable water demand rate	Varies from 1 to 35 m^3/hr over construction period

Table 10.5 Water demand during operations

Requirement	4 LNG trains m^3/hr
Treated water demand	1.6
Potable water demand	13.3
Laboratory usage	2.4
Clinical usage	2.0
Demineralised water	26.7
Safety showers	6.0
Fire water flush demand	1.6
Total water demand	53.6
Add 20% margin	10.7
Recommended freshwater demand	**64.5**
Total seawater intake to the plant	**160.8**

Desalination plants produce a hyper-saline brine (highly concentrated salty water) waste stream, containing seawater constituents at around double their normal concentrations. Additionally, the waste stream also contains small amounts of additives used for treatment and cleaning during the desalination process. Typical additives include sodium hypochlorite, sodium bisulphite, sulphuric acid, citric acid and anti-scalant.

The assessment considered the operational case (higher volume). Operation of the desalination plant will produce a brine waste stream to be discharged into Port Curtis, at a rate of up to 130m^3/hr. As a consequence of the increased salinity, the brine discharge tends to be negatively buoyant and will tend to sink to the seabed under calm conditions. The likely discharge concentrations of brine stream constituents are provided in Table 10.6. Physico-chemical parameters and potential contaminants are considered in turn.

Table 10.6 Likely discharge concentrations of brine stream constituents from the desalination plant at Port Curtis

Characteristic	Estimated discharge value
pH	6.0 – 8.0
Total suspended solids (mg/L)	15 – 40
Calcium (mg/L)	600 – 750

Characteristic	Estimated discharge value
Magnesium (mg/L)	2,000 – 2,500
Potassium (mg/L)	600 – 800
Sodium (mg/L)	19,000 – 22,000
Chloride (mg/L)	30,000 – 33,000
Flouride (mg/L)	1.5 – 3
Sulfate (as SO_4) (mg/L)	4,000 – 6,000
Strontium (mg/L)	15 – 25
Chlorine (mg/L)	<1
Anti-scalant (mg/L)	8
Flocculent (mg/L)	5
Polymer (mg/L)	1
Silicon dioxide (mg/L)	1 – 2
5 day biochemical oxygen demand (mg/L)	5 – 10

The brine impact assessment has identified the toxicological risks posed by known compounds in the desalination effluent from the desalination plant that could be considered as contaminants to the receiving marine environment in the vicinity of the discharge location. The spatial scale of elevated salinity of the magnitude that could result in any ecologically meaningful impact is in the order of tens of metres from the discharge location. Predicted maximum salinity close to Laird Point is approximately 36.08ppt and within Graham Creek the maximum salinity ranges between 36.04ppt and 36.07ppt. Salinity increase in The Narrows for an upstream distance of 5km is similar to Graham Creek (refer Volume 4 Chapter 12).

The major issue of potential concern is residual oxidant concentrations (chlorine and disinfection by-products).Chlorine in discharge can potentially impact marine organisms. Residual chlorine in the brine will be treated through a dechlorination process prior to discharge to reduce chlorine concentration. This process of dechlorination will also reduce the likelihood that chlorination by-products are formed. As a result, there are unlikely to be any significant impacts on the receiving environment from discharge of residual oxidants or any other residual contaminants present in the brine waste stream.

An environmental monitoring program will be developed for the LNG facility and this may include monitoring of suspended solids from liquid discharges to reduce potential impacts from smothering and the affects of increased light attenuation in the water column on sensitive marine receptors such as seagrass. To mitigate impacts from high suspended solids loads on the marine environment, waste materials collected off screens and filters will likely be transferred to land fill, rather than into the brine stream discharged into the marine environment. This will be further investigated during detailed design.

The predicted salinity levels and the other constituents in the discharge are not predicted to have significant impacts.

Overall, risk from the desalination plant discharge, is identified as medium.

10.3.10 Freshwater discharge

An impact assessment was undertaken for the discharge of treated sewage effluent and treated stormwater (from process areas of the LNG facility) based on these wastes being discharged through separate waste streams from the desalination plant brine. This is considered to be a conservative impact assessment approach as options for combining waste streams are being considered in detailed design. A conservative approach on the discharged rate has also been taken. The expected maximum discharge rate has been considered, however it is expected that treated sewage effluent and stormwater will be reused for on-site irrigation. Any treated water that is not used onsite will be discharged in a controlled manner through an outfall in Port Curtis.

Treated sewage will be stored in a tank for dechlorination purposes, as required, prior to being used for irrigation purposes or discharged to Port Curtis. It is likely that treated sewage effluent will be discharged with the desalination plant brine.

Table 10.7 and Table 10.8 provides indicative water quality information for treated sewage effluent and treated stormwater respectively.

Table 10.7 Indicative treated effluent characteristics, sewage treatment plant

Parameter	Concentration
pH	6.5 - 7.5
5 day biochemical oxygen demand	10 - 20mg/L
Oil	5 - 10mg/L
Total nitrogen	< 4mg/L as N
Total Kjeldahl nitrogen	1-4mg/L
Ammonia nitrogen	1-4mg/L
Total phosphorus	<1mg/L
Chlorine	1 - 2mg/L
Total dissolved solids	250mg/l

Table 10.8 Indicative treated effluent characteristics, process and oily water/contaminated stormwater

Parameter	Concentration
pH	6 - 7
5 day biochemical oxygen demand	15 - 30mg/L
Oil	5 - 15mg/L
Total suspended solids	10 - 30mg/L
Total dissolved solids	250 - 350mg/L

Impact assessment

The risk to the marine environment from discharge of treated sewage wastewater is primarily from residual oil, chlorine, nutrient loads and ammonia-N.

The main risk to the marine environment, from the treated sewage effluent and stormwater would be from any oily residue present. Oil concentrations are estimated to be 0.36 to 0.70mg/L. Oil is less dense than water and is biodegradable. As it floats on the surface of water, a major effect of oil on the environment results from shoreline smothering, unless it is first physically or chemically dispersed (ANZECC/ARMCANZ 2000). When oil is spilt at sea, the rate of weathering depends on the nature of the oil, water temperature, wave action and use of dispersants. Initial weathering processes depend on spreading of the oil, evaporation, dispersion, formation of emulsions, dissolving of oil and oxidation (ANZECC/ARMCANZ 2000).

The LC_{50} values previously reported were 0.36−0.70mg/L reported for NW Shelf crudes to *Penaeus monodon*; the lowest figure for other crude oils to crustaceans was 0.2mg/L, to the crab *Ocypode quadrata* (ANZECC/ARMCANZ 2000). There is no trigger value available for oil or total petroleum hydrocarbons. Given however, the lowest LC_{50} value reported was 0.2 mg/L, a 100 fold dilution would be required, to ensure with some degree of certainty, no acute effects are exhibited beyond the near field mixing zone.

The residual chlorine concentrations of 1–2 mg/L predicted in the treated sewage effluent are up to two orders of magnitude higher than the lowest reported no observable effect concentration data. Total nitrogen and phosphorus concentrations of 4mg/L and 1mg/L are anticipated within the treated sewage. In combination, there is the potential for increased aquatic algae or phytoplankton growth within areas affected by a concentrated discharge plume.

Mitigation and monitoring

Wherever possible, water reuse on site is the principal approach to reducing impacts through reducing the need to discharge into the marine waters of Port Curtis. To mitigate impacts from residual chlorine when discharge into the marine environment does occur, treated sewage will be stored in a tank for dechlorination purposes, as required, prior to being discharged to Port Curtis.

It is likely that treated sewage effluent will be discharged with the desalination plant brine. However, considering all constituents in combination, the risk is identified as medium.

10.3.11 Cumulative impacts

Conceptually, cumulative impacts in the marine environment range from existing impacts from recreational and industrial uses simple additions to prior impacts of similar types, to complex interactions of environmental stresses due to multiple (and differing) impacts. The latter is the norm and is relevant for considering cumulative impacts generated from the LNG facility.

A number of potential direct impacts on marine assemblages have been identified and need to be considered in a cumulative sense:

- Dredging and reclamation
- Discharges to the marine environment from desalination and sewage
- Transport of personnel and materials to project areas
- Noise from construction activities in or near marine areas

- Projects' lighting.

An assessment on the cumulative impact of multiple proposed developments has been undertaken and this is reported in Volume 4 Chapter 25.

10.4 Conclusion

10.4.1 Assessment outcomes

The proposed location for the LNG facility is in the vicinity of Laird Point which is within the Gladstone Harbour Port limits and within the Great Barrier Reef World Heritage Area. The existing environment at Port Curtis has been described using up to date information largely drawn from the peer-reviewed literature. The area at and adjacent to the proposed LNG facility contains examples of high value marine habitat – particularly saltmarsh/saltpan and mangrove habitats. Seagrass habitat is found around Channel Island. No coral reef habitat is present. Port Curtis provides habitat for marine species of conservation significance including dugong, inshore dolphins and marine turtles. Directly and indirectly Port Curtis also supports recreational and commercial fisheries.

A number of potential impacts from the construction and operation of the proposed LNG facility and associated infrastructure have been identified and include:

- Dredging and reclamation of habitat for the LNG facility and the MOF
- Desalination plant brine and freshwater discharge
- Fragmentation of marine habitat
- Entrainment of plankton in seawater intake
- Boat strike on dugong and marine turtles
- Underwater noise
- Lighting impacts on marine turtles.

Table 10.9 summarises the key potential risks, the mitigation actions to reduce the impact of the risk, and the residual risk. Considering all constituents in combination, the residual risks are ranked as low and medium. A full description of the risk assessment methodology is given in Volume 1 Chapter 4.

Table 10.9 Summary of environmental values, sustainability principles, potential impacts and mitigation measures

Environmental values	Sustainability principles	Potential impacts	Possible causes	Mitigation and management measures	Residual risk level
Fisheries habitat	Minimising adverse environmental impacts and enhancing environmental benefits associated with its activities, products or services; conserving, protecting, and enhancing where the opportunity exists, the biodiversity values and water resources in its operational areas Identifying, assessing, managing, monitoring and reviewing risks to its workforce, its property, the environment and the communities affected by its activities	Unsuccessful breeding by adults and hatchling mortality increases	Lighting from the LNG facility causing disorientation of nesting adult marine (flatback) turtles and hatchlings	A combination of approaches including: physically shielding the lights and directing the lights onto work areas; lowering the height of lights; reducing the amount of reflective surfaces through the use of matt paints on surfaces where possible; and, use of motion detecting sensors and light timers	Medium
Wetlands		Unavoidable loss of an area of mangroves and saltpan/saltmarsh and flow-on impacts to the marine environment including fisheries production Unavoidable loss of an area of an area of intertidal and sub-tidal habitat (unvegetated) Turbidity impacts during dredging operation	Reclamation for the LNG facility and associated infrastructure	Site layout avoids an area of mangroves Offset strategy	Medium
Cetaceans and dugong			Dredging and reclamation associated with the MOF	Silt curtains if practical, dredging to cease during bad weather conditions	Medium
		Boat strike causing serious injury or mortality of dugong	Fast transport vessels to and from Curtis Island	Vessel speed limit and transit lanes negotiated with other relevant	Low

Environmental values	Sustainability principles	Potential impacts	Possible causes	Mitigation and management measures	Residual risk level
		and marine turtles		industrial users of Port Curtis and relevant government agencies	
		Serious injury or mortality of dugong and marine turtles Interruption to movement of cetaceans and dugong to feeding areas	Dredging and construction activities (particularly pile driving) and vessel traffic	For pile driving activities, use of 'bubble curtains', 'soft starts' and pile cap cushions Monitoring of the usage of the area adjacent to the LNG facility by dolphins and dugong prior to, during and after construction	Medium
Benthic assemblages		Reduced plankton abundance and possible flow-on impacts to recruitment of benthic animals and fisheries production	Intake of saltwater	Optimal position of intake pipe in the water column, screening of intake, lowest practical intake speed, reduced overall water demand and utilisation of water re-use options within the LNG facility	Low
Water quality		The desalination plant stream has physico-chemical properties that are highly elevated above ambient levels and contains various contaminants above relevant water quality guidelines Elevation of nutrients	Desalination plant discharge Treated effluent discharge stream	Reduced overall water demand and utilisation of water re-use options within the LNG facility Use of treated effluent water for irrigation rather than discharge to the marine environment	Medium
Recreation		Loss of fishing amenity	Safe construction and operation of the LNG Facility	Offset strategy	Low

Environmental values	Sustainability principles	Potential impacts	Possible causes	Mitigation and management measures	Residual risk level
			requires the public being excluded from some marine areas		
Marine environment		Significant changes to the structure and function of the marine environment	Marine pests can be introduced by shipping through ballast water and hull fouling	Existing national protocols	Low

10.4.2 Commitments

Australia Pacific LNG is committed to ensuring that environmental stewardship is effectively applied throughout the construction and operation phases of the Project. A considerable amount of planning and consultation work has been undertaken prior to the environmental assessment stage to identify and reduce potential impacts. The EIS has identified specific measures to mitigate and manage specific impacts associated with the construction and operation of the LNG facility. These measures have been consolidated into the environmental management plan (refer to Volume 4 Chapter 24).

In summary, Australia Pacific LNG will:

- Establish a process for visual observations and recording of dugongs and cetaceans
- Use a sensitive lighting approach to reduce light spill impact on marine fauna
- Seek to work collaboratively with other Western Basin projects to offset the loss of sensitive marine habitat
- Work with government, the Gladstone Ports Corporation, other port users and stakeholders to address loss of fishing access
- Utilise community monitoring of fisheries and fisheries habitat where appropriate pre and post construction
- Work with the Gladstone Ports Corporation and other port users to develop an industry wide approach to minimise boat strikes to marine mammals and turtles.

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