Australia Pacific LNG Project

Volume 3: Gas Pipeline

Chapter 10: Marine Ecology

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10. Marine ecology

10.1 Introduction

10.1.1 Purpose

This chapter provides a description of the marine ecology in the vicinity of the Australia Pacific LNG Project (the Project) gas pipeline crossing of The Narrows. It is proposed that the potential impacts to the coastal environment associated with the construction of the pipeline crossing would be minimised through the use of horizontal directional drilling (HDD) below the waterway.

In the event that HDD is determined not to be feasible, based on final engineering investigations or construction constraints, Australia Pacific LNG would instead use dredging equipment to excavate a trench across the seabed of the Narrows into which the pipeline would be installed. A similar dredged trenching methodology would be used to cross The Narrows if a joint approach involving other LNG proponents is implemented. Potential impacts of HDD and alternative pipeline crossing options have been identified, along with a series of mitigation measures, focusing predominantly on the construction phase of development.

Australia Pacific LNG has followed the sustainability principles established for the Project when identifying impacts to the marine and coastal environment and in the development and implementation of control measures and management plans. Of Australia Pacific LNG's 12 sustainability principles, key principles in relation to the gas pipeline's crossing of The Narrows include:

- Minimising adverse environmental impacts and enhancing environmental benefits associated with Australia Pacific LNG's 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 Australia Pacific LNG's workforce, its property, the environment and the communities affected by its activities
- Working cooperatively with communities, governments and other stakeholders to achieve positive social and environmental outcomes, seeking partnership approaches where appropriate

The final sustainability principle listed above is particularly relevant in relation to the proposed methodology to be adopted for the crossing of The Narrows.

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

The Queensland Government's *Environmental Protection (Water) Policy 2009* aims to achieve the object of the *Environmental Protection Act 1994* in Queensland waters by establishing environmental values (EVs) and water quality objectives (WQOs).

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 bay with a natural water depth to 12m and is protected from the open ocean by Curtis and Facing Islands. Port Curtis has areas largely unaffected by human activity, as well as areas highly modified by port developments and various industries.

The gas pipeline will cross from the mainland to Curtis Island between Friend and Laird Point. This is at the start of The Narrows, a 20,903ha passage separating Curtis Island from the mainland and one of only five tidal passages within Australia. The proposed location of the pipeline crossing 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, and extensive seagrass beds. These habitats support species of conservation significance such as dugong and marine turtles, as well as fisheries production. The wetlands are 'Areas of state significance (natural resources)' under the State Coastal Plan.

The Port Curtis region, including the proposed location of the pipeline crossing, is within a Dugong Protection Area. Various species of marine turtles also forage in these seagrass and bare sedimentary habitats. The endemic flatback turtle nests on the eastern beaches of Curtis Island near the township of South End.

10.2.2 Marine parks, wetlands and World Heritage areas

The Narrows area was previously included as part of the Mackay/Capricorn Marine Park, but is now included in the Great Barrier Reef Coast Marine Park. It is designated as area QI HP-22-01 in Schedule 3 of the Marine Parks (Great Barrier Reef Coast) Zoning Plan 2004.

The Narrows is zoned as a habitat protection zone, with the southern boundary of this zone forming a straight line across The Narrows at latitude 23°45.000' (Figure 10.1). The objectives of the habitat protection zone are:

- To provide for the conservation of the areas of the marine park within the zone through the protection and management of sensitive habitats that are generally free from potentially damaging activities
- To provide opportunities for reasonable use of the areas.

The alignment for the pipeline crossing will be determined having regard to the Department of Infrastructure and Planning's proposal for a common gas pipeline corridor across to Curtis Island. Whilst the alignment of this common corridor for the pipeline crossing across the wetlands on the mainland and 'The Narrows' is not currently finalised, an indicative route has been provided by the Queensland Government. For the purposes of this EIS, this indicative route has been assessed. The route in part traverses the Habitat Protection Zone of the Great Barrier Reef Coast Marine Park as described in Schedule 3 of the Marine Parks (Great Barrier Reef Coast) Zoning Plan 2004. A route that traverses the Marine Park is not Australia Pacific LNG's preferred route. Australia Pacific LNG is working with other industry proponents to define an alternate route which is immediately to the south and outside the 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. Wetlands at Laird Point, including the proposed location for the LNG facility, are within the Curtis Island Nationally Important Wetland (QLD021).

The nearest declared fish habitat areas are:

- Fitzroy River which includes large parts of the northern and north-western parts of Curtis Island (FHA-072) – approximately 23km from the proposed development site near Laird Point
- Colosseum Inlet (FHA-037) – approximately 35km from the proposed site
- Rodds Harbour (FHA-036) – approximately 50km from the proposed site.

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Users of the information must obtain independent professional advice in relation to dealings with property. Reliance on the information is at the user's own risk, associated with the use of the information.

151° 06' 00"
151° 09' 00"
151° 12' 00"
-23° 42' 00"
-23° 45' 00"

Curtis Island
State Forest
Habitat
Protection
Habitat
Protecti
Graham Creek
Laird
Point
Friend
Point
The Narrows
Targinie
State
Forest
Targinie
State
Forest
Targinie
State
Forest

Boundary line as per the Great Barrier Reef Coast Zoning Plan

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SCALE - 1 : 50,000 (at A3)
Latitude/Longitude
Geocentric Datum of Australia 1994
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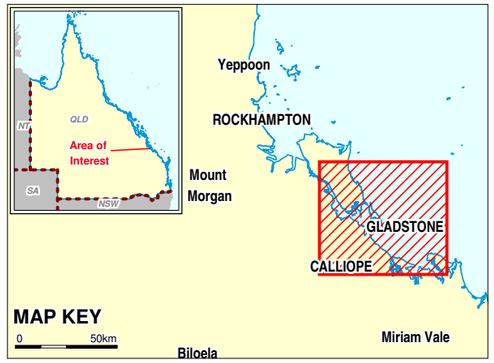

LEGEND

- Gas pipeline route
- Gladstone State Development Area
- Gladstone State Development Area corridor
- State marine park management areas

Protected Areas

- State forest

Waterbodies

- Mangrove flats
- Saline coastal flats

Source Information

Gladstone State Development Area Corridor (GSDAC)
Gladstone State Development Area (GSDA)
Department of Infrastructure and Planning, Queensland 2010

State Marine Parks (QLD)
Environmental Protection Agency 2010

Preferred gas pipeline alignment
supplied by Origin Energy on 03/11/2009

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Figure 10.1 Marine Park Boundary Curtis Island

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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

Seagrass meadows, mangrove and saltmarsh areas are the primary environmental features of interest in the vicinity of the proposed pipeline crossing. These vegetated habitats significantly contribute to the high primary productivity of estuarine areas. These structurally complex habitats maximise food availability and minimise predation for fish, prawns and crabs (Halliday and Young 1996; Thomas and Connolly 2001; Heck et al. 2003).

Rocky intertidal and shallow subtidal environments in the study area are important foraging areas for various fish species, while man-made structures such as jetties and seawalls provide additional hard substrata within the Port Curtis region.

Extensive un-vegetated intertidal banks around Laird Point and Friend Point provide foraging opportunities for fish at high tide and shorebirds at low tide.

Seagrass

Around 20% of the intertidal (7,246ha) and subtidal (6,332ha) seabed of Port Curtis is covered by seagrass. The seagrass bed and seagrass biomass area usually peaks in late 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 10.2, and the key parameters of the seagrass beds are shown in Table 10.1. Subtidal seagrass beds in Port Curtis have shown more variability in seagrass cover in comparison to intertidal seagrass beds (Chartrand et al. 2009).

Table 10.1 Description of seagrass beds in the northern part of Port Curtis*

General location	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 and 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*, *Halophila spinulosa* and *Halophila 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 *Z. capricorni* of light cover with *H. ovalis*, *H. decipiens* and *H. 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
Wiggans Island 1 (4)	Aggregated patches of *Z. capricorni* of light cover with *H. ovalis*	0.8 ± 0.4	35.8 ± 1.7
Wiggans 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

* Modified from Rasheed et al. (2003)

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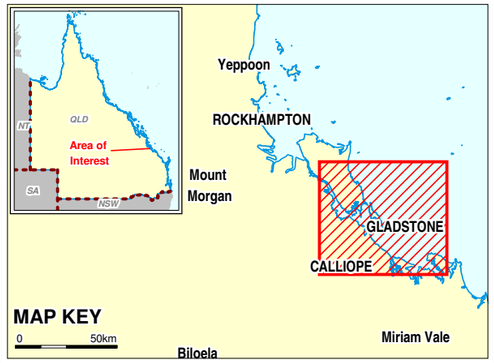
Graham Creek
Friend Pt
Laird Pt
Laird Point
Western Basin 1
South Laird Point
Curtis Island
Western Basin 2
Passage Island 1
Passage Island 3
Passage Island 2
Fisherman's Landing Wharves
Hamilton Pt
Tide Island
South of Fisherman's Landing 2
Wiggan's Island 2
Wiggan's Island 1
Mud Island
Wiggins Island
South of Fisherman's Landing 1
Callope River



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
Supplied by GeoEye-1 on 24 March 2009. AAM Hatch 2009

0 1 2km

SCALE - 1 : 50,000 (at A3)
Map Grid of Australia, Zone 56
Geocentric Datum of Australia 1994

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Figure 10.2 - Seagrass Distribution

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Mangroves and saltmarsh

Mangroves provide a structurally complex habitat that provides food and protection for juvenile fish and invertebrates. It is also a source of carbon that may be 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% 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. However, these 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 Laird Point. These rocky shores are best described as a 'rubble field' with significant oyster cover, and associated invertebrate animals. Rasheed et al. (2003) identified rubble reef areas in the deep channel area, from the vicinity of Graham Creek to Fishermen's Landing. The identified rubble reef includes medium density cover (>15% of the area surveyed). The types of species which inhabit the reef are bivalves, ascidians, bryozoans and hard corals. Similar reef habitat was identified in the vicinity of Hamilton Point.

10.2.4 Marine habitats within proposed development footprint

Intertidal habitats

The Project requires disturbance of intertidal areas in the vicinity of Friend Point and an area on Curtis Island just south of Graham Creek. Friend Point has intertidal flats and an extensive mangrove forest dominated by red mangrove. The intertidal flats are principally mudflats although areas of rubble field are also present. The pipeline will be completely buried in the intertidal environment and will only emerge once it is outside the marine environment.

The area of the proposed pipeline landing on Curtis Island consists of a sandy beach with isolated mangrove trees that extends into an area of saltpan. The latter contains saltmarsh plants including salt couch, common samphire and seablite.

These areas are shown in Figure 10.3, Figure 10.4 and Figure 10.5.

Figure 10.3 Friend Point showing areas of rocky shore and mudflats

Figure 10.4 Area in vicinity of proposed buried pipeline landing on Curtis Island

Figure 10.5 Saltmarsh plants in the vicinity of gas pipeline landing on Curtis Island – common samphire (top and bottom) and marine couch (top)

Subtidal habitats

An Outland Technology Inc. video and video recording system was used at selected sites along the proposed gas pipeline route. This provided visual information on typical seabed features along the crossing of The Narrows.

The proposed route is principally bare sedimentary area, with large quantities of unconsolidated shell and rubble material present at many of the survey sites sampled. Some macroalgae was found attached to shell and rubble at a number of locations. Evidence of bioturbation was largely absent. No hard coral was present and there was no reef structure that afforded any vertical relief, although isolated epifauna individuals such as gorgonians were present. Selected pictures from the seabed are shown in Figure 10.6.

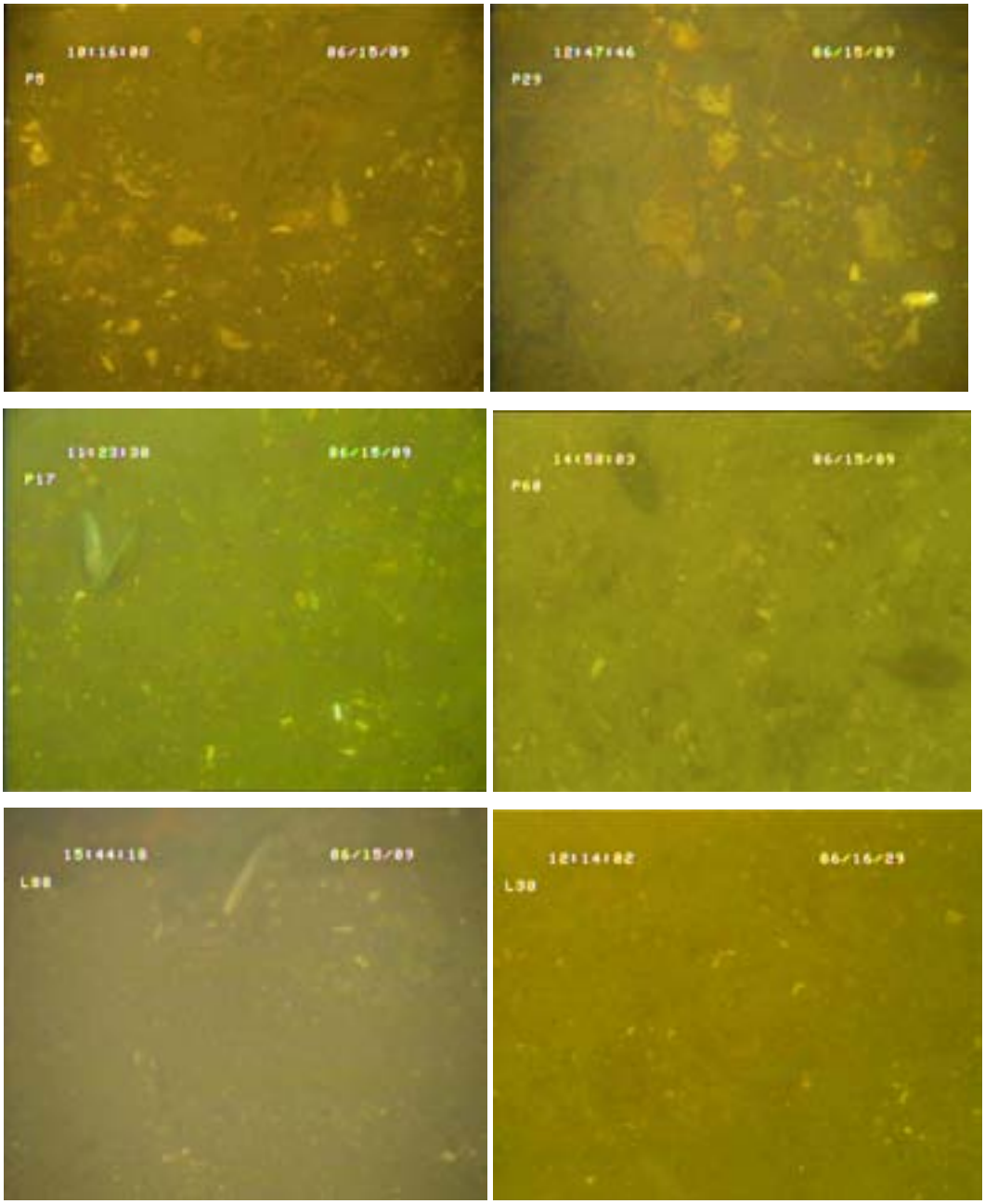

Figure 10.6 Predominantly bare sediment showing a significant amount of shell material

10.2.5 Water quality

Water quality studies in Port Curtis have generally identified water quality conditions within Port Curtis as good but strongly influenced by tidal state, with reduced water quality conditions usually occurring at low tide.

Port Curtis is recognised as a well mixed estuary and also traditionally assumed to be well flushed and readily dispersed to the offshore environment. However, Apte et al. (2005) observed that, while water circulation within the Port Curtis estuary was strong, material had difficulty in discharging from the estuary. It was found that it took around 19 days for the total mass of water to exchange by two thirds of its original mass.

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

Within the estuary, common contaminants that have been assessed include various metals, fluoride, cyanide and tributyltin (TBT). Metals within the Port Curtis estuary have consistently been recorded 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, while elevated concentrations of lead and zinc are present in Port Curtis.

Based on the distribution of copper and nickel concentrations in The Narrows, Apte et al. (2005) concluded that 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 inputs. 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). Levels are expected to decrease over the coming years as TBT continues to be phased out as an anti-foulant on ships worldwide.

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 or framework for deriving and applying local guidelines for Queensland waters.

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

Table 10.2 Water quality objectives for tropical marine waters near Gladstone

	QWQG (DERM 2009)	ANZECC/ARMCANZ (2000)
Ammonia N (µg/L)	8	1–10
Oxidised N (µg/L)	3	2–8
Organic N (µg/L)	180	
Total N (µg/L)	200	100
Filterable P (µg/L)	6	5
Total P (µg/L)	20	15
Chlorophyll-a (µg/L)	2.0	0.7–1.4
DO (% saturation). Upper	100	ND
DO (% 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 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 per cent 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 1992, 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 (GBRMPA 2007).

The Rodds Bay/Port Curtis area, including the area adjacent to the proposed development site, is designated a Dugong Protection Area B (refer to Figure 10.7). 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).

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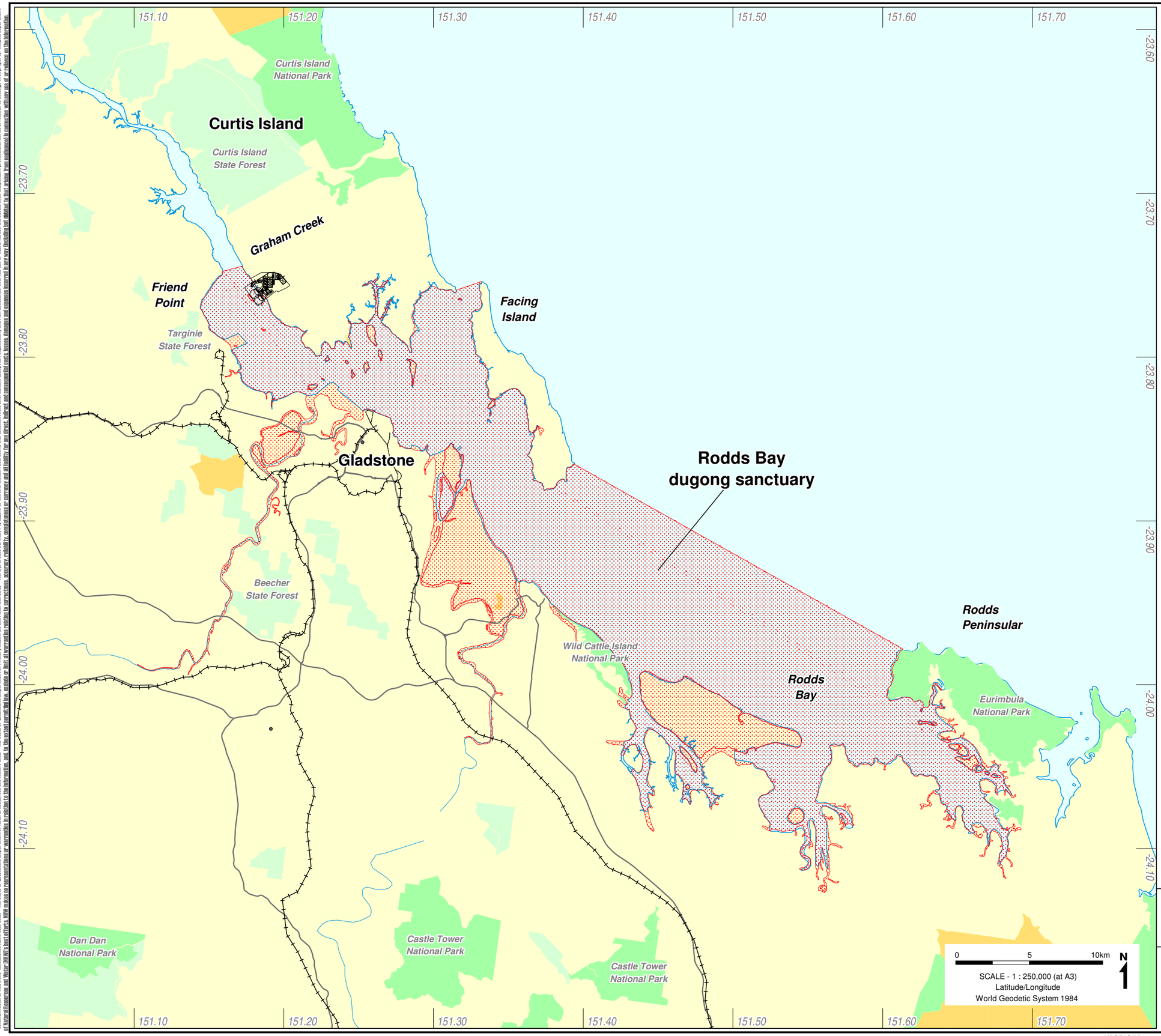

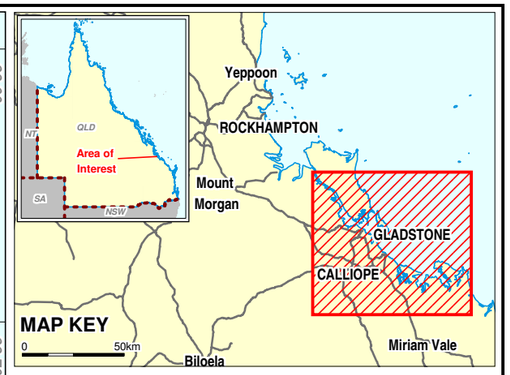

LEGEND

- Major towns
- Road
- Railway
- Major watercourses
- LNG facility development footprint

Protected Areas

- Conservation park
- Forest reserve
- National park recovery
- National park
- National park scientific
- Resources reserve
- State forest
- Timber reserve

Dugong protection area

Source Information

Plant Layout
Indicative Plant Layout supplied by Bechtel. Drawing No. P1-000-10005

Queensland Fish Habitat Areas (DPIF) and Dugong Protection Areas (DPIF)
Department of Primary Industries and Fisheries 2009

Protected Areas (Queensland_estates)
Environmental Protection Agency 2009

AUSTRALIA PACIFIC LNG PROJECT

Volume 3 Chapter 10
Figure 10.7 - Dugong Proptection Areas

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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* for all marine turtle species in Australia.

Table 10.3 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, reaching maturity 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.

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 have not been clarified (Miller 1996), but light regime is considered to have a significant impact on the emergence of female marine turtles from the ocean.

Once hatched, lighting cues are critical for hatchlings to move from the beach to the ocean – a behaviour known as sea-finding. In simple terms, where there are no light sources derived from human activities (anthropogenic), hatchlings move away from the dark silhouetted shoreline towards the brighter ocean horizon. However, 'brightness' in this context encompasses wavelength and intensity (Witherington and Martin 1996).

Further, the heterogeneity of the light regime can also act as a cue. Hatchlings may orientate away from a horizon with spatial patterns of light and shadow, towards the more homogenous light environment of the ocean horizon (Godfrey and Barreto 1995; Witherington and Martin 1996).

Light sources at the nesting beach, on the foreshore near the nesting beach, or offshore will impact hatchlings. Lights at a nesting beach can cause turtle hatchlings to head inland rather than into the ocean, and subsequently die. Lights near nesting beaches can cause hatchlings to enter the ocean safely, only to re-emerge closer to the light source.

The sex ratio of turtle hatchlings depends on incubation temperature, 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 Island, Facing Island 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 to early December, and ceases around 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 to the Flatback turtle, but important rookeries for these two species lie elsewhere.

Cetacean - whales and dolphins

The EPBC Protected Matters Database search identified 10 cetacean species that may occur 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 development locations.

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 in 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 to 2m) waters than Indo-Pacific humpback dolphins (2 to 5 m). 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 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 Fitzroy River is generally considered to be the southern most range of the estuarine crocodile (*Crocodylus porosus*), but individuals straggle as far south as Colosseum Inlet and Seven Mile Creek systems.

While it is plausible that estuarine crocodile may be sited near the proposed 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).

Seasnakes

An EPBC Protected Matters database search identified that there were 12 species of seasnakes possibly occurring around the project area. These are:

- 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 about the distribution and abundance of seasnakes in Australia. However, some species prefer inshore waters with sandy or muddy substrata and moderate turbidity. These include the elegant seasnake, spine-bellied seasnake, and the small headed seasnake (Heatwole and Cogger 1993). As such, these are the seasnake species most likely to occur in the vicinity of Laird Point.

10.2.7 Soft sediment macrobenthic infaunal assemblages

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

Currie and Small (2005 and 2006) carried out a comprehensive assessment of the macrobenthic infaunal assemblage of Port Curtis over a six year period. Alquezar (2008) also undertook additional work, partly in the area of interest for the Project.

Overall, Currie and Small (2005 and 2006) found that the assemblage sampled throughout the Port Curtis region is dominated by filter feeders. These accounted for more than 50% of total abundance and nearly 30% of total species richness. The bivalve mollusc *Carditella torresi* was the most abundant species, accounting 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 from two to three percent of the total abundance. Most 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 that 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 project locations. Sampling stations closest to the proposed pipeline crossing had low density macrobenthic infaunal assemblage, dominated by the deposit feeding bivalve *Leionuculana superba* and the predatory polychaetes *Eunice* species 1, *Nephtys* species 1 and *Leanira* species 1. These taxa are widely distributed in soft sediment habitat and the assemblage overall is typical of soft sediment habitats in the region.

10.2.8 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 human activity. Phytoplankton concentrations are measured by assessing the concentration of chlorophyll *a* in the water column. Chlorophyll *a* is the phytoplankton's principal photosynthetic pigment. 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 divided into two groups:

- Holoplankton – animals that spend their whole life cycle as plankton
- Meroplankton – animals that spend only part of their life cycle as plankton, such as oyster, fish and prawn larvae, including those of commercial and recreational significance.

Zooplankton includes animals that graze 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 components of the planktonic assemblage are the large scyphozoan jellyfishes such as *Catostylus mosaicus* occurring in Port Curtis.

10.2.9 Fish and invertebrates

All subtropical 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 the Port Curtis area which was found to be diverse. Eighty-eight species were present, but the assemblage was dominated by two small schooling species, ponyfish and herring. Together, these make up around half of the total abundance.

The structure of the subtidal 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, yellowfin tripod

fish, large-toothed flounder, and diver whiting. All of these species are common and widely distributed in Australia's subtropical inshore habitats.

Saltmarsh and saltpan habitats tend to have lower species richness than other inshore habitats such as mangroves and seagrass (Sheaves et al. 2007). However, they still provide 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. This creek 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 also likely to be numerically dominant at the proposed development location.

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. It is unlikely to occur in an estuarine environment such as Port Curtis. Green sawfish (*Pristis zijsron*) are recorded in shallow inshore coastal environments, including estuaries. However, detailed records of species occurrence from 1912 to 2004 identify that no individuals of the species have been 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 Department of the Environment and Resource Management's 'Back on Track species prioritisation framework'. This framework prioritises Queensland's native species to guide conservation, management and species recovery. The estuary stingray uses a range of shallow inshore habitats and is likely to occur frequently within the project area.

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

10.2.10 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 that are endorsed to beam trawl in the Port Curtis area are only permitted to operate in Port Curtis and The Narrows, the 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. Data collated from the logbook program is available via the Coastal Habitat and Resource Inventory System (CHRISweb) database. This is also administered by the Queensland Primary Industries and Fisheries.

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, as well as a significant area in offshore waters east of Curtis Island.

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. 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. There is no data 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 it, such as 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.

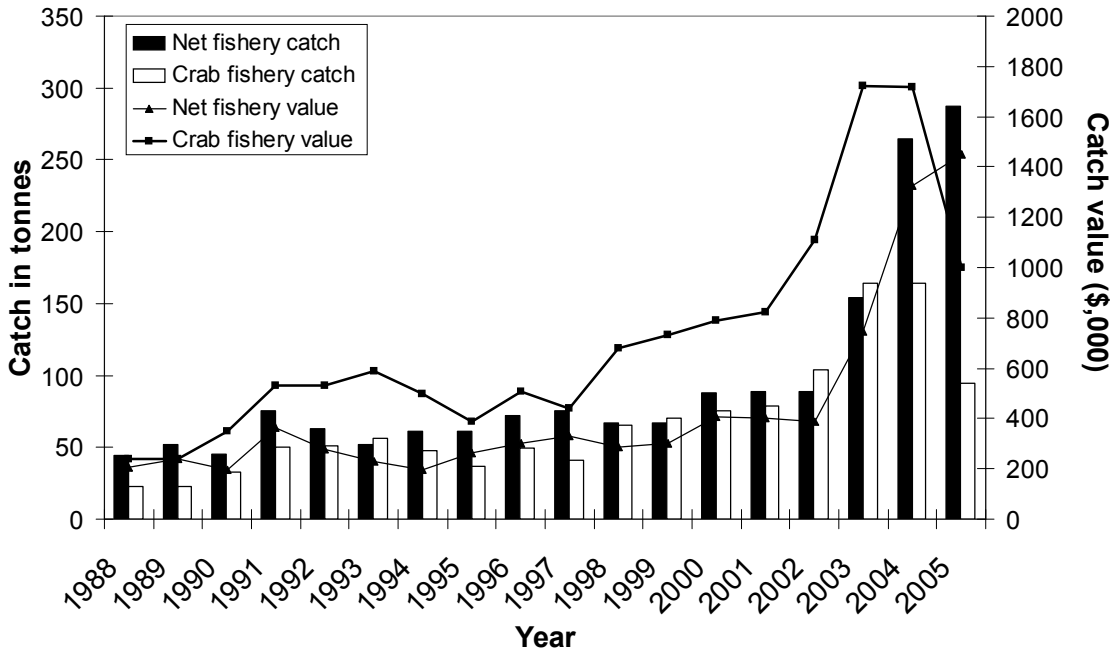

Figure 10.8 Grid S30: annual volume and value of commercial net and crab fishing catch, 1988-2005

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 that can be accessed by the fishery, the available logbook information contained in CHRISweb clearly identifies that it is rarely done so 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 (i.e. the statistical division that 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. A vast majority of these boats are used for recreational fishing. It was estimated that 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. This is the main public boat ramp in the region (Platten et al. 2007).

The number of vessels that use the area of the gas pipeline crossing is unknown, but the Graham Creek area is recognised as a very important anchorage area for recreational vessels, in particular yachts. It is also an important area for recreational fishing, especially mud crabbing.

10.3 Impact assessment

Constructing the gas pipeline through the wetlands on the mainland and The Narrows has the potential to cause environmental impacts. The construction method chosen has a significant influence over the nature and magnitude of the potential impacts. Two habitat types are affected by gas pipeline construction:

- The intertidal areas including saltmarsh, saltpan, mangroves and intertidal mudlflats
- The subtidal sedimentary habitats in The Narrows.

The exact alignment within the gas pipeline corridor is not currently finalised, but an indicative route is available and is shown in Figure 10.1. The route in part traverses the Habitat Protection Zone of the Great Barrier Reef Coast Marine Park as described in Schedule 2 of the Marine Parks (Declaration) Regulation 2006.

Australia Pacific LNG is considering two potential methods for constructing a gas pipeline across The Narrows, described in Volume 3 Chapter 3:

- HDD, which is the preferred approach
- A conventional dredged trench and bottom pull pipeline installation method.

Similarly, there are two pipeline construction options under consideration for the intertidal section:

- Excavated trench and convention dry pipeline installation
- Excavated and flooded trench and pipe flotation ditch method.

All methods except for HDD require a construction of a trench in which the pipeline is to be laid before backfilling. The HDD method does not require the dredging of a trench, but other potential impacts to the marine environment exist.

The *bottom pull method* is sometimes employed for crossing waterways exhibiting strong currents or where the seabed consists of softer material. It is not suitable where exposed rock exists on the seabed.

The concept of this method is to assemble the pipeline string so its entire length is set out on the shore in the extended axis of the proposed crossing route. It is pulled into the open dredged trench using an anchor winch located on the opposite bank of the waterway.

Construction issues to be managed include the large set out area required for the pipe string to be aligned with the crossing, trenching required for placement and cover of the pipeline, coffer dams and dewatering to exclude water from trenches at the shoreward ends, and access for large excavators to and from the site as well as floating pontoon mounted machinery. The floating pontoons are required

to be anchored into position for dredging of the underwater pipeline trench to take place and will require substantial anchoring systems to hold them from moving with the strong currents in The Narrows.

If either of the above methods that require dredging are used, a cutter suction dredge or a backhoe dredge is the most suitable. The volume of dredging required for the pipeline trench was calculated to be between 90,000m^3 and 200,000m^3. The duration required for the dredging activity is approximately two months.

The potential impact of *horizontal directional drilling* on the waterway environment is considered to be less than other methods because no dredging of the seabed is involved. The typical workspace area required for drill rigs used in HDD operations is in the order of 50m by 75m. Working areas are required to be cleared and graded level. Space requirements will vary depending on the make and model of the drilling rig and how the various components may be positioned. The key components of the drill rig are the rig ramp, drill pipe and the control van.

Accidental spills or releases of drilling fluids have the potential to impact on the coastal environment. Drilling fluid is used for a number of tasks in the HDD process including:

- Cooling and lubricating the drill stem, mud motor and bit
- Providing hydraulic power to the mud motor which in turn converts hydraulic power to mechanical power
- Carrying cuttings out of the bore hole
- Stabilizing the bore hole during the drilling process
- Sealing fractures in the formation.

Drilling fluid is usually a mixture of freshwater and bentonite. Bentonite is a naturally occurring clay that is extremely hydrophilic – that is it has high swelling characteristics. Various chemicals and materials can be added to the drilling fluid to adjust its properties, in particular to control density, viscosity, plugging and sealing capabilities, and specific conditions such as swelling.

Disposal of drilling fluids after use is normally achieved by one of the following techniques:

- Mix and bury on site (not a viable option inside or adjacent to a marine park)
- Land spread (as above)
- Transfer to an approved site or disposal facility.

Disturbance of acid sulphate soils are also likely to occur and this addressed in Volume 3 Chapter 6.

For the two options involving dredging, the following impacting processes will, or may, affect the marine environment:

- Disturbance of the subtidal seabed at the dredge location
- Creation of a turbid plume that is transported from the dredge location to elsewhere in Port Curtis
- Underwater noise generated by dredging activities
- Disturbance such as fragmentation of the mangrove and wetland areas during construction of the gas pipeline across the intertidal areas.

For the HDD option, the following impacting processes will, or may, affect the marine environment:

- Disturbance such as fragmentation of the mangrove and wetland areas during construction of the gas pipeline across the intertidal area, in particular the clearing and grading of a workspace
- Underwater noise generated by drilling activities
- Loss of drilling fluid directly or indirectly into the marine environment.

10.3.1 Impact assessment methodology

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.

10.3.2 Potential dredging impacts

The potential dredging impacts from the pipe flotation ditch method and the bottom pull method are similar and will be discussed together.

Direct disturbance to subtidal habitat

Dredging will result in the direct disturbance to subtidal habitat and the removal of the animals contained in the sediment within the dredged area. Field investigations identified that the proposed dredge footprint was devoid of seagrass and structure-forming organisms.

Following dredging, there are a number of factors that influence the rate and trajectory of macrobenthic infaunal assemblage re-colonisation including:

- Level and frequency of natural disturbance, such as storm events, river flows, and wave environment
- Scale and timing of the dredging operation
- Changes to the sedimentary environment.

The processes involved in re-colonisation include:

- The direct return of organisms following survival of entrainment and release 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 by adults to a dredged location (Van Der Veer et al. 1985). Dredging can cause changes to the physical or chemical characteristics of the sediment, which may influence its suitability for larval recruitment. This can have significant implications for the recovery potential of the assemblage (Snelgrove and Butman 1994; Kenny and Rees 1996).

No method exists to accurately predict the recovery dynamics of the assemblage once disturbed. In the present case, the assemblage that recolonises the area will also be influenced by the material that

is used to infill and cap the pipeline trench. If rock is used then a rocky reef assemblage would replace the current soft sediment assemblage. The area to be disturbed is also small and maintenance dredging would not be required, so disturbance is not ongoing.

Overall the risk to the benthic assemblage from physical disturbance during dredging activities is identified as low. Beyond minimising the area to be disturbed by dredging activities, no specific mitigation measures are possible to ameliorate the impacts.

Turbidity impacts from dredging

A turbid plume can decrease the ambient light levels that reach the seabed. This can affect photosynthesis through the water column and vegetated habitats on the seabed, such as seagrass and algae. When suspended sediments within a turbid plume settle out, they can also smother benthic organisms. While increases in turbidity naturally occur, the duration of elevated turbidity plumes from the proposed dredging program are much longer than those that occur naturally.

Should dredging be required for gas pipeline construction, the spatial extent of the turbidity plume generated by dredging is described in Volume 5 Attachment 24. The sediment plume will extend into The Narrows and Graham Creek, with elevated turbidity persisting for between 10 days and one month after dredging activity has ceased. Given the duration of dredging of approximately 60 days, the duration of increased turbidity is estimated to be between two and a half and three months. The dredge plume is likely to overlap spatially with the seagrass beds in the vicinity of North Passage Island.

Erftemeijer and Lewis (2006) reviewed the environmental impacts of dredging on seagrass and identified critical thresholds of light availability for a range of seagrass species around the world. Significant differences were found between species, in their respective critical levels and duration tolerances. Variation between different seagrass species' ability to tolerate and recover from periods of reduced light is related to their differing morphological and physiological characteristics. These characteristics represent different strategies for survival in response to stress or disturbance.

Smaller, short lived species, such as several *Halophila* spp., do not survive long once environmental conditions are outside their tolerance levels. However, they tend to recolonise rapidly following an impact. Conversely, larger seagrass species such as *Zostera capricorni* survive longer during periods of low light. This is because they have greater stored reserves which can be mobilised to sustain the plant. Larger species tend to be slow growing, long-lived and resilient, so are more resistance to short- to medium-term disturbances. However, if the impact persists to the point where the seagrasses have exhausted their stored reserves, they would die and recover slowly or not at all.

There is a low overall risk to the benthic assemblages and seagrass beds from a turbidity plume generated during dredging activities. To minimise the turbidity plume generated during dredging and the potential transport of a turbid plume, the following measures are recommended:

- Where practicable, Australia Pacific LNG will deploy silt curtains to prevent migration of turbidity plume
- Dredging will only operate within safe weather conditions, as defined by the Harbour Master, to prevent spills.

The mitigation measures serve to potentially limit both the spatial scale and magnitude of the impact from dredging activities.

Underwater noise

The Project may create underwater noise in the marine environment which can potentially displace dugong and cetaceans from critical habitat and interrupt critical behaviours. A number of marine mammal species, particularly cetaceans, have sensitive hearing and rely heavily on sound for communicating, navigation and locating prey (Gordon and Moscrop 1996). Marine mammals have been found to avoid some human sound sources for ranges of several kilometres, temporarily avoiding valuable habitat in the process (Tyack 2008; Jefferson et al. 2009).

Noise generated by construction activities including dredging can also change the behaviour of dugong and result in alienation from important habitat. Disturbance may result in dugong expending more energy moving around to avoid noise and less time spent foraging. Disturbed dugongs may be forced to spend time searching for alternative feed patches and may need to feed on less desirable patches with lower nutritional value. However, if animals can move to suitable nearby habitat, 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 away from the potential dredging area. Currently, the nearest significant seagrass areas to the proposed gas pipeline route are those in the Western Basin that are proposed for reclamation.

Underwater noise is discussed in more detail in Volume 3 Chapter 15. Overall the risk to the dugong and cetaceans from underwater noise generated during dredging activities is identified as low. The impact will only persist during dredging operations which are expected to take approximately two months.

10.3.3 Potential HDD impacts

Underwater noise

The application of HDD to construct the pipeline crossing will generate much less underwater noise than dredging, but may still potentially impact the distribution and behaviour of dugong and cetaceans during the period the noise is generated. However, as Jefferson et al. (2009) point out, there is little information on how noise from pipe-laying activities affects cetaceans and no existing information on any potential impacts on dugong.

Underwater noise is discussed in more detail in Volume 3 Chapter 16. The overall risk to dugong and cetaceans from underwater noise generated during HDD activities is identified as low. The impact will only persist during construction activities.

Bentonite

Bentonite is proposed as the principal drilling fluid, and it is possible that some of this material will directly or indirectly enter the marine environment. While bentonite is a natural clay compound, its physical properties can potentially result in significant but localised environmental impacts through elevated turbidity levels. These can persist through re-suspension, smothering of benthic assemblages, and reduced recruitment of benthic animals from physical changes to the seabed (Smit et al. 2008). The 50% hazardous concentrations (HC50) for suspended bentonite based on 50% effect concentrations (EC50s) were 1,830mg/L.

It is recommended that no deliberate discharge of drilling fluid to the marine environment be undertaken and all drilling fluid is disposed of off site. In the event of a potential or actual spill of drilling fluid, it is recommended that drilling fluid pumping and the drilling activity should cease immediately and corrective action taken. With mitigation measures in place, the risk is reduced to low.

10.3.4 Disturbance and fragmentation of wetlands

The gas pipeline will be constructed across saltpan/saltmarsh habitat that drains into Targinie Creek on the mainland, and across foreshore flats on the mainland and on Curtis Island. The saltpan/saltmarsh area is only inundated on the spring tides. The area of mangrove, saltpan/saltmarsh and intertidal flats in Port Curtis is extensive. Here, mangroves cover 6,736ha, saltpan/saltmarsh cover 4,573ha and seagrass covers 4,501ha.

The spatial scale of disturbance from gas pipeline construction will be approximately 3km long and 25m wide. This represents 0.16% of the saltpan/saltmarsh habitat within Port Curtis. However, disturbance during construction will also result in habitat fragmentation, locally altered tidal flows. These altered tidal flows can impact saltmarsh plants and mangroves, potentially leading to localised dieback (Arnold 1995). Therefore, there is a clear potential for impacts to be greater in area than the area directly disturbed by construction.

If HDD is used for the pipeline crossing of The Narrows the typical workspace required for drill rigs is around 50m by 75m or 0.375ha. This needs to be cleared and graded level. This area represents only 0.008% of the saltpan/saltmarsh habitat within Port Curtis. Additional access roads will also be required but there exact area and location is not currently known.

Construction activities should be undertaken to minimise the area of disturbance and hydrodynamic changes across the saltpan/saltmarsh habitat, including ensuring that no 'ponding' occurs. With effective mitigation that utilises adaptive management to address the impacts, the risk would be reduced to low.

10.4 Conclusion

10.4.1 Assessment outcomes

The proposed gas pipeline route will traverse wetland habitat on the mainland side of The Narrows in the vicinity of Friend Point, across The Narrows itself and then on to Port Curtis near Laird Point. The sub-tidal area within the proposed gas pipeline route lacks seagrass and reef habitat. Impacts from the gas pipeline are limited to construction activities only. Within the marine environment, the gas pipeline will remain buried.

Two pipeline construction methods across the marine section of The Narrows have been proposed – one involves HDD and the other involves dredging. HDD is the preferred approach, but if it not feasible, based on final engineering investigations or construction constraints, Australia Pacific LNG would dredge a trench across the seabed for installation of the pipeline.

The potential impact of HDD on the waterway environment is considered to be less than the alternative because no dredging of the seabed is involved. The impacts from the dredging methods if they are utilised will be dependent on the final volume of dredged sediment to be disturbed. Regardless of the method chosen, wetlands including saltmarsh/saltpan and mangroves will be disturbed, but the area disturbed is not significant relevant to available habitat. Provided construction methods do not result in changes to hydrology of the wetland, construction impacts will be low.

Dredging will result in direct impacts to the seabed within the dredge footprint as well as impacts from turbidity and the settling of suspended sediment that may be transported away from the dredge location. HDD does not result in such impacts. Dredging will also result in the generation of underwater noise that may lead to cetaceans and dugong temporarily leaving areas adjacent to the disturbance. Generation of underwater noise from HDD is considered less than dredging by virtue of no direct contact with the surface of the seabed or the water column.

Table 10.4 summarises the environmental values, sustainability principles, potential impacts and mitigation measures for marine ecology associated with the gas pipeline crossing. It also includes the residual risk level for each key item. Details of the risk assessment methodology are presented in Volume 1 Chapter 4.

Table 10.4 Summary of environmental values, sustainability principles, potential impacts and mitigation measures

Environmental value	Sustainability principles	Potential impact	Possible cause(s)	Mitigation and management measures	Residual risk level
Benthic assemblages and water quality	Minimising adverse environmental impacts and enhancing environmental benefits associated with Australia Pacific LNG's 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 Australia Pacific LNG's workforce, its property, the environment and the communities affected by its activities	Reduced abundance and species richness of the benthic assemblage, with potential flow on effects to fisheries production.	Physical disturbance of the seabed and the creation and transport of a turbidity plume from dredging activities.	Minimise the area to be disturbed. Where practicable, Australia Pacific LNG will deploy silt curtains to prevent migration of turbidity plume. Dredging will only operate within safe weather conditions, as defined by the Harbour Master, to minimise unintentional releases of sediment.	Low
Wetlands	Minimising adverse environmental impacts and enhancing environmental benefits associated with Australia Pacific LNG's activities, products or services; conserving, protecting, and enhancing where the opportunity exists, the biodiversity values and water resources in its operational areas	Disturbance and fragmentation of saltmarsh/saltpan and mangrove habitat. Potential die-back of mangroves and saltmarsh plants, with subsequent flow on impacts to fisheries production.	Physical disturbance and changes to the hydrology of the wetlands due to gas pipeline construction activities.	Minimise any modification of the natural characteristics of the wetland, including the topography, groundwater hydrology, water quality, and plant and animal species. Minimise any adverse impact on coastal wetland values from proposed access.	Low

Environmental value	Sustainability principles	Potential impact	Possible cause(s)	Mitigation and management measures	Residual risk level
Cetaceans and dugong	Minimising adverse environmental impacts and enhancing environmental benefits associated with Australia Pacific LNG's 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 Australia Pacific LNG's workforce, its property, the environment and the communities affected by its activities	Underwater noise, potentially causing displacement of cetaceans and dugong from feeding habitat during construction activities.	Dredging and gas pipeline construction activities.	Warning noise will be given so that marine fauna will move from the area. For example, equipment at start up will be operated for a brief moment and shut down to allow for flight of marine fauna to move out of the area. Once enough time has elapsed for the marine fauna to move out of the area work will commence. Monitor noise during construction and implement procedures not to exceed noise criteria.	Low
Benthic assemblages and water quality	Minimising adverse environmental impacts and enhancing environmental benefits associated with Australia Pacific LNG's 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 Australia Pacific LNG's workforce, its property, the environment and the communities affected by its activities	Release of bentonite and drilling fluids into the marine environment if HDD is utilised. Elevated turbidity and potential smothering of benthic plants and animals.	HDD pipeline construction activities.	No direct discharge of material into the marine environment. Stop work and determine the source of any unintentional releases and undertake appropriate corrective action.	Low

10.4.2 Commitments

Australia Pacific LNG is committed to managing the potential impacts that constructing the gas pipeline may have on the marine environment, particularly when constructing the gas pipeline crossing of The Narrows.

Australia Pacific LNG will:

- Develop a construction methodology that will minimise disturbance
- Work with State Government, Gladstone Ports Corporation and other proponents proposing similar crossings to achieve an outcome that minimises cumulative impacts
- Establish a process for visual observations and recording of dugongs and cetaceans.

If HDD is not the adopted construction method, Australia Pacific LNG will select an appropriate plan to construct a pipeline trench across The Narrows. All dredging activities will be in accordance with dredge management procedures, to reduce potential impact to the water course and marine flora and fauna.

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