CLIENTS | PEOPLE | PERFORMANCE

Gladstone Ports Corporation

Report for Western Basin Dredging and Disposal Project

Marine Ecology Assessment

November 2009

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

Contents

Table Index

Figure Index

Appendices

1. Introduction

1.1 Background

The Gladstone Ports Corporation (GPC) contracted GHD to undertake scientific studies in support of the development of an Environmental Impact Statement (EIS) for the proposed Western Basin Dredging and Disposal Project (the "Project"). The Project has been declared 'Significant Project' under the *State Development and Public Works Organisation Act 1971,* and as such will be assessed under the statutory conditions and regulations of this Act. The Australian Government Minister for the Department of Environment, Water, Heritage and the Arts (DEWHA) determined that the Project is also a 'controlled action'. Accordingly the Project will also be assessed against controlling provisions under the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act).

The EIS comprises multiple elements, including sections on the description and assessment of potential impacts on the benthic marine ecological values of the Project area. This document provides a summary of the benthic marine ecological surveys performed to date and recommendations for incorporation into the EIS. Additional documents that complement with this report are the Marine Megafauna Assessment (Appendix R of the main EIS), the Terrestrial Ecology Assessment (Appendix P of the main EIS), the Water and Sediment Quality Reports (Appendix K and L respectively of the main EIS) and the Numerical Modelling Report (Appendix J of the main EIS). Readers should be familiar with all relevant documents to assist in providing context to the findings reported here.

1.2 Project Location

The area surveyed for benthic marine ecology encompasses the Western Basin Reclamation Area, the areas of capital and maintenance dredging, and the areas with the potential to be impacted by the construction and operation of the proposed Project ("Project Area").

The Project Area is located 10 km north of Gladstone City and is comprised of shallow subtidal and intertidal mud flats and deeper water channels. An area within the Project Area is identified for reclamation works and several areas identified for dredging works. The landward edge of the bay in which the Western Basin Reclamation Area is located is bounded by mangrove communities. These intertidal vegetation communities and the fauna they support have been assessed in detail separately in the Terrestrial Ecology Assessment (Appendix P of the main EIS). Where relevant to marine ecological findings, information on these systems is provided here.

A wide range of habitats were sampled during the field investigations. The different areas selected for sampling under the program included those known to be regularly dredged and traversed by shipping traffic, those areas expected to be impacted by the proposed reclamation and dredging works and reference areas against which potential impacts and shifts in community structure were able to be assessed. Accordingly, areas targeted for sampling included the Western Basin Reclamation Area, the existing channels, areas targeted for future dredging works and offsite areas in The Narrows, Fisherman's Landing Basin and Pelican Banks, south east of Curtis Island (Figure 1-1). These areas are hereafter referred to as the Study Area.

1.3 Purpose and Scope

This report has been collated from information sourced through a focused desktop assessment of available information (including previous studies in the region and Government agency databases) and from the results of the benthic marine ecology survey undertaken in June 2009.

The purpose of this report is to supply sufficient information on the benthic marine ecology values of the Project Area and adjacent surrounds such that the impacts of the proposed project on these values, including any cumulative impacts related to associated/adjacent projects, can be assessed. Information and recommendations on mitigation measures identified in this report will be used to support the findings of the EIS.

1.4 Approach to the Study

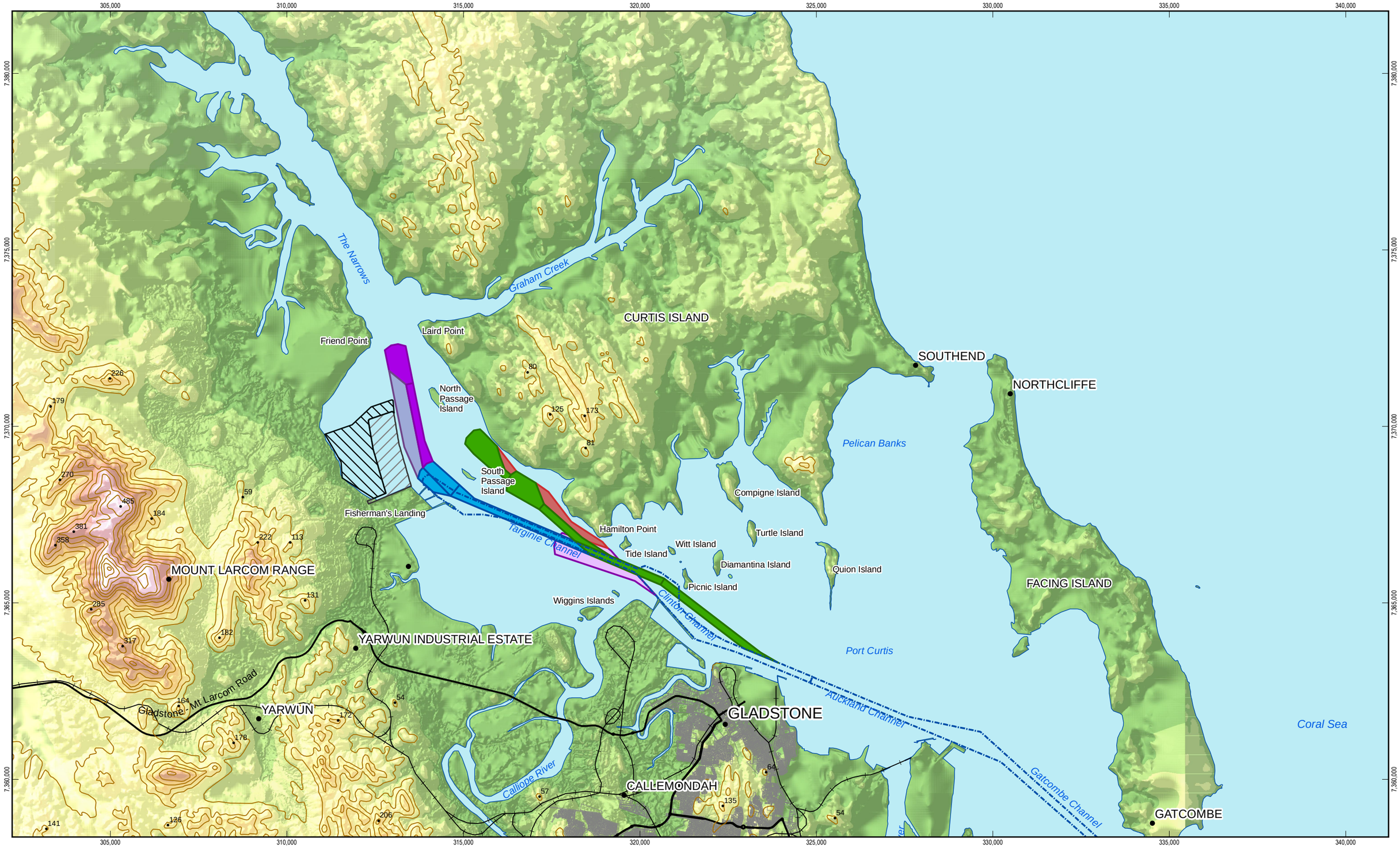
The marine benthic flora and fauna communities, including commercially and recreationally important fishery species, occurring in the areas potentially affected by the Project were assessed and described to facilitate a risk based assessment of potential impacts.

Studies performed included field and desktop investigations to:

- Identify, characterise, delineate and map the existing benthic communities including:
  - Seagrass meadows;
  - Algal assemblages;
  - Soft sediment invertebrate assemblages;
  - Soft coral and sponge communities; and
  - Scleractinian (hard) coral habitats;
- Identify fish and crustacean (e.g. crab) species present; and
- Detect the presence and spatial distribution of marine pest species (if any detected).

Information collected from the reference areas provided information on the local importance of the seagrass meadows and their associated benthic fauna for assessment of the relative potential impact. This assisted, with desktop studies, in characterising the regional importance of locally described assemblages. This regional assessment was assisted by available historical data and on-going monitoring of the seagrass beds and their benthic communities in the region by the Department of Employment, Economic Development and Innovation (DEEDI; formerly Department of Primary Industries and Fisheries (DPI&F)).

Legislative requirements pertaining to marine fauna and flora are provided in the body of the EIS document and only covered briefly within this report. Marine sensitive areas, in terms of the marine resource management areas of the Great Barrier Reef World Heritage Area (GBRWHA), Great Barrier Reef Marine Park (GBRMP) protection zones and other protected areas, are covered in the body of the EIS and are also briefly described here.



1:100,000 (at A3)

0 1 2 3 4 5

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

- Town and Locality
- Contour (50m interval)
- Railway
- Major Road
- Western Basin Reclamation
- Fisherman's Landing Northern Expansion
- Built Up Area
- Existing Channels, Swing Basins and Berths
- Wiggins Island Coal Terminal (Approved)
- Stage 1A - North China Bay LNG Precinct
- Stage 1B - Fisherman's Landing LNG
- Stage 2 - Laird Point LNG
- Stage 3 - Fisherman's Landing
- Stage 4 - Hamilton Point

Port of Gladstone
Western Basin Dredging and Disposal Project

Marine Ecology
Survey Area

Job Number	42-15386
Revision	A
Date	30 Aug 2009

Figure 1-1

G:\42\15386\GIS\WesternBasinProjects\MXDs\42-15386_WB_006_MarineAssessment.mxd

Level 4 201 Charlotte Street Brisbane QLD 4000 Australia **T** +61 7 3316 3000 **F** +61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

2. Desktop Review

2.1 Policy and Legislation

Legislative requirements and obligations pertaining to the Project are addressed within the body of the EIS. The following is provided as an overview of the known obligations imposed by the relevant policies for the protection of marine flora and fauna.

2.1.1 International Conventions and Treaties

Migratory marine bird species that travel seasonally between Australia and Northern Asia are protected through international agreements between the Government of Australia and the Governments of Japan (JAMBA), China (CAMBA) and Korea (ROKAMBA). Ratified in 1981 under the *Commonwealth National Parks and Wildlife Conservation Act 1975*, this legislation has since been superseded by the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The Convention on the Conservation of Migratory Species and Wild Animals (CMS or Bonn Convention) aims to conserve terrestrial, marine and avian migratory species throughout their range. Provisions of this convention have also been incorporated into the EPBC Act.

Relevance to the Project

Avifauna were assessed under the Terrestrial Ecology Assessment (Appendix P of the main EIS), which complements this report, and are not discussed further in this document.

2.1.2 Commonwealth Legislation and Policy

Environment Protection and Biodiversity Conservation Act 1999

Overview

The EPBC Act is the legislation applicable to developments that may have an impact on matters protected under the Act. The object of the EPBC Act is to protect the environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (ecologically sustainable development).

The Project has undergone referral in accordance with the EPBC Act and the Minister responsible determined that the proposal is a controlled action and therefore requires assessment approval under this Act.

The EPBC Act incorporates legislation that provides for the protection of matters of National Environmental Significance (Protected Matters). A number of Protected Matters covered by the EPBC Act are relevant or potentially relevant to this project, and include:

- Listed threatened species;
- Listed cetaceans;
- Listed migratory species;
- Listed marine species;
- World Heritage properties;

- Natural Heritage properties; and
- The Commonwealth Marine Areas.

Listed Threatened Species and Cetaceans

The EPBC Act provides legislative protection for all nationally threatened fauna and flora species, and ecological communities. The Act seeks to provide a standard by which species and communities can be listed as threatened, develop recovery actions and plans for such threatened species and communities, identify areas of critical habitat for threatened species, provide a list of key threatening processes, and provide plans by which threatening processes can be abated. All cetaceans are covered by the EPBC Act, regardless of their conservation status.

Listed Migratory Species

The EPBC Act legislates protective status to all species that migrate to Australia (and/or its territories), and/or fly over/travel through Australia's marine waters. Specifically, any species listed under international agreements and conventions pertaining to migratory species are protected under the Act. Such agreements include migratory marine bird species that travel seasonally between Australia and Northern Asia, which are protected through the Bonn Convention and the JAMBA, CAMBA and ROKAMBA international agreements noted above.

Listed Marine Species

The EPBC Act provides legislative protection for species that inhabit or naturally occur in Commonwealth Marine Areas. Such species are listed under the Act as Marine species. The legal protective status of listed marine species does not necessarily extend to State waters, unless there is a high likelihood that actions in State waters will significantly impact upon listed marine species of National Environmental Significance.

Relevance to the Project

Section 4.5 of this document reports against the matters of National Environmental Significance and Protected Matters and these are also addressed in the Marine Megafauna Assessment (Appendix R of the main EIS) and within the main body of the EIS.

Great Barrier Reef Marine Park Act 1975

Overview

Activities, which have direct or indirect impacts on the GBRMP, are required under the *Great Barrier Reef Marine Park Act 1975* (GBRMP Act) to obtain a Marine Parks Permit prior to undertaking development. The Great Barrier Reef Marine Park Authority (GBRMPA) considers the *Great Barrier Reef Marine Park Regulations 1983, Sea Dumping Act 1981*, *National Assessment Guidelines for Dredging 2009* and any GBRMPA policies when assessing an application made under the GBRMP Act.

Relevance to the Project

The Project is not located within the GBRMP. Despite this exclusion, the GBRMPA has been consulted and informed of progress throughout the planning and investigative stages of the Project.

2.1.3 Queensland State Legislation and Policy

Legislation Relevant to the Great Barrier Reef Marine Park

A number of Queensland legislative instruments assist in providing legal protection for the World and National Heritage listed Great Barrier Reef, managed primarily under Commonwealth law. These are discussed in detail in the body of the EIS and include:

- *Coastal Protection and Management Act 1995;*
- *Environmental Protection Act 1994;*
- *Fisheries Act 1994;*
- *Integrated Planning Act 1997;*
- *Marine Parks Act 2004;*
- *Native Title (Queensland) Act 1993;*
- *Nature Conservation Act 1992;*
- *Transport Operations (Marine Pollution) Act 1995;*
- *Transport Operations (Marine Safety) Act 1994;* and
- *Workplace Health and Safety Act 1995.*

Nature Conservation Act 1992 (Qld) and Subordinate Legislation

The Nature Conservation (Wildlife) Regulations 2006 (Qld) pursuant to the *Nature Conservation Act 1992* (Qld) categorizes flora and fauna species occurring in Queensland as presumed extinct, endangered, vulnerable, rare, common, international or prohibited. The management intent pertaining to each species is described within the Regulations, as are the principles relating to the use and taking of those listed species.

The Nature Conservation (Dugong) Conservation Plan 1999 (Qld), under the *Nature Conservation Act 1992* (Qld) is a tool that allows for dugong recovery actions to be conducted in Commonwealth-nominated Dugong Protection Areas (DPAs). The restrictions were initially implemented under the *Fisheries Act* 1994, then declared as legislation under the *Queensland Nature Conservation 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 (GBRMPA 2009). The DPAs have the specific objective of protecting dugongs by limiting exposure to threatening processes. The Port of Gladstone (Rodds Bay), in which the Project Area is located, is a declared “Zone B” DPA. Zone B DPAs are subject to restrictions on fishing net mesh sizes, and how this gear can be deployed. These restrictions are contained within the Fisheries Regulation 2008 (Qld) under the *Fisheries Act 1994* (Qld).

Relevance to the Project

The values for which flora and fauna are protected under various legislative tools are recognised within this report and have been considered during the assessment of risks and mitigation measures that has been undertaken for the Project.

2.1.4 Marine Resource Management Areas

The Project is located within or adjacent to several marine resource management areas including:

- Great Barrier Reef Marine Park;
- Great Barrier Reef World Heritage Area;
- Dugong Protection Zone Area Zone B;
- Fish Habitat Areas;
- Great Barrier Reef Coast Marine Park;
- The Narrows; and
- Gladstone Port Limits and Pilotage Area.

Great Barrier Reef Marine Park

The GBRMP was established in 1975 under the *Great Barrier Reef Marine Park Act* 1975, the object of which was to make provision for the establishment, control, care and development of a marine park in the Great Barrier Reef Region. The Great Barrier Reef Marine Park Authority (GBRMPA) and the Queensland Parks and Wildlife Service (QPWS) are jointly responsible for the everyday management of the GBRMP and GBRWHA.

The Project Area is located outside of, but adjacent to the GBRMP. The GBRMP boundaries closest to the Project area at the eastern coastlines of Curtis and Facing Island (Figure 2-1). The GBRMP zones in the vicinity of the Port Limits include:

- Habitat Protection Zones at:
  - The north entrance to Port Curtis – between Curtis and Facing Islands Seal Rocks;
  - The eastern side of Facing Island the eastern side of Facing Island; and
  - Seal Rocks – to the south of the shipping channel.
- Marine National Park Zones on:
  - The eastern side of Curtis Island; and
  - The northern side of Rodds Bay Peninsular.
- Conservation Park Zones to the north of Curtis Island and Rodds Bay Peninsula (Figure 2-1).

Great Barrier Reef World Heritage Area

The GBRWHA extends to the low water mark on the mainland coast and the proposed Project is located within the GBRWHA. The (GBRWHA) was inscribed on the World Heritage List in 1981 (DEWHA, 2008a). The GBRWHA is protected under the International Treaty-Convention concerning the Protection of the World Cultural and National Heritage, adopted by the United Nations Educational, Scientific and Cultural Organization (UNESCO).

Dugong Protection Area Zone B

The Project Area is located within the northern limits of the Rodds Bay Dugong Sanctuary (Figure 2-1), which is a Zone B (restricted use) Dugong Protection Area.

Fish Habitat Areas

The Queensland *Fisheries Act 1994* allows for the protection of declared Fish Habitat Areas (FHAs) from physical disturbance associated with coastal development. Each FHA is assigned a management level (A or B) depending on the level of protection that is warranted. There are currently 73 declared FHAs

along the Queensland coast, however the Project is not located within any FHAs. The closest FHA is Colosseum Inlet (level A and B – FHA 037) located approximately 30 km to the south of the Project (Figure 2-1). The Calliope River, the mouth of which is located approximately 10 km south of the Project, is an area that is currently under consideration for FHA declaration (DEEDI 2009a).

Great Barrier Reef Coast Marine Park

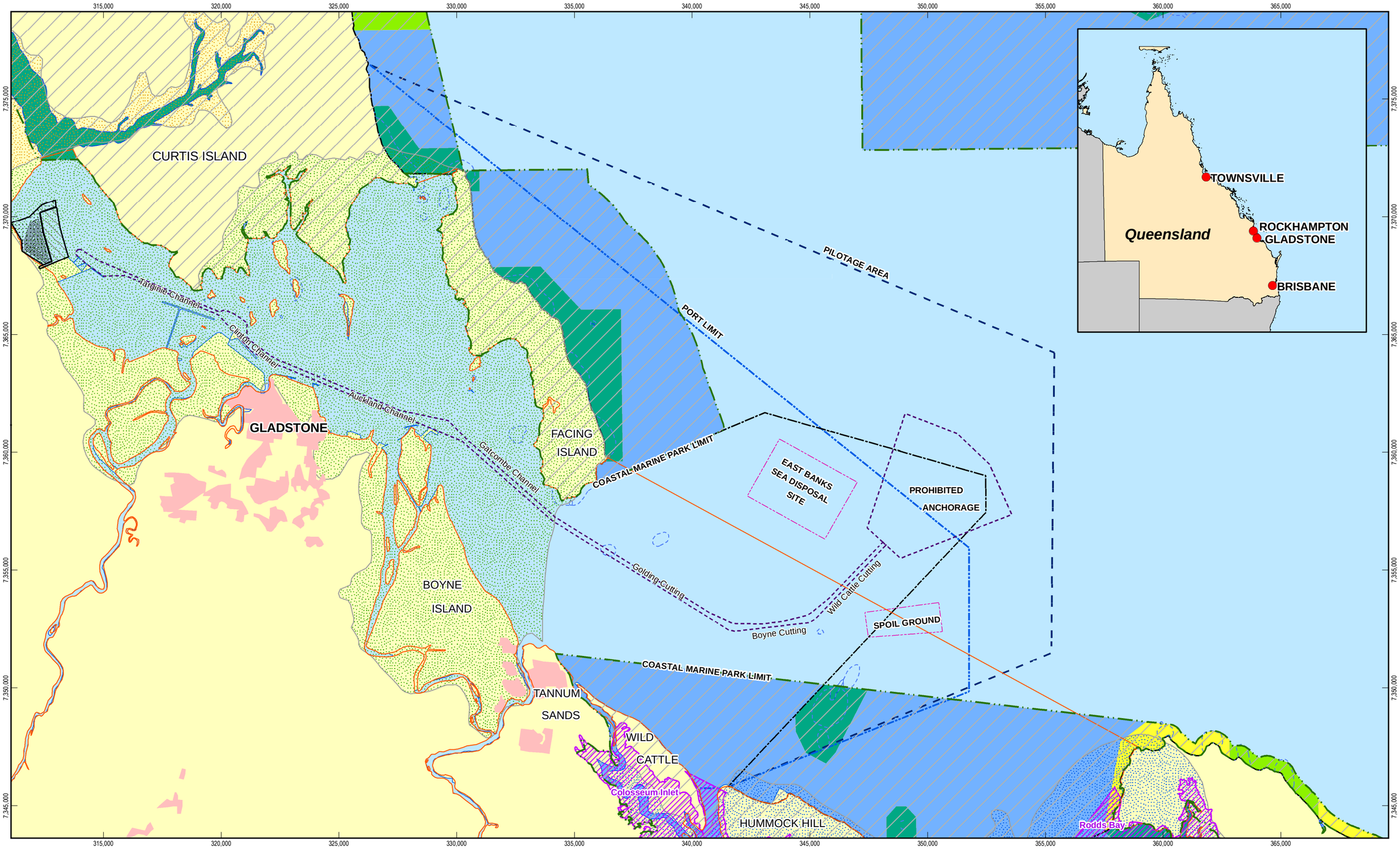
The Great Barrier Reef Coast Marine Park (GBR Coast MP) is a state marine park that extends the length of the federal GBRMP and provides Queensland-specific protection measures for tidal lands and waters (DERM 2009) while retaining complementarity with the GBRMP (Commonwealth). The Project is located outside, but adjacent to, the GBR Coast MP. The MP boundaries nearest to the Project Area are at the southern limit of The Narrows, between Friend and Laird Points, and eastern coastlines of Curtis and Facing Island (Figure 2-1). There is also a Habitat Protection Zone under the GBR Coast MP in The Narrows.

The Narrows

The Narrows, part of the GBR Coast MP, was listed on the National Estate Register on 26th October 1999 as it represents an uncommon passage landscape, and is only one of five narrow tidal passages separating large continental islands from mainland Australia (DEWHA 2009b). The Project is located adjacent to the southern boundary of The Narrows (Figure 2-1).

Gladstone Port Limits and Pilotage Area

The Project Area lies within the Gladstone Port Limits, which extend from Conner Bluff on Curtis Island in the north to Tiber Point on Hummock Hill Island in the south (Figure 2-1). The GPC administers all port operations and shipping within this area. The Project is also located within the Gladstone Pilotage Area which extends from the same landward points, but includes a greater area to the east.



1:150,000 (at A3)

0 1 2 3 4 5

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 56

N

- Pilotage Area
- Spoil Ground
- Port Limits
- Existing Channels, Swing Basins & Berths
- Western Basin Reclamation Footprint
- Fisherman's Landing Northern Expansion
- Dugong Protection Area Rodds Bay (Type B)
- Fish Habitat Area
- GBRM Park Boundary (Commonwealth)
- Coastal Marine Park
- Directory of Important Wetlands
  - Colosseum Inlet - Rodds Bay
  - Port Curtis
  - The Narrows
- GBR Coastal Marine Park Zoning
  - Conservation Park
  - General Use
  - Habitat Protection
  - Marine National Park

Port of Gladstone
Western Basin Dredging and Disposal Project

Job Number 42-15386
Revision A
Date 11 Sep 2009

Protected Areas and Marine Park Boundaries in Port Curtis

Figure 2-1

G:\42\15386\GIS\WesternBasinProjects\MXDs\42-15386_WB_302_rev_a.mxd

Level 4 201 Charlotte Street Brisbane QLD 4000 Australia **T** +61 7 3316 3000 **F** +61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

2.2 Marine Ecological Values of the Project Area

2.2.1 Seagrass Communities

Background Information

The seagrass meadows of Queensland are known to provide a valuable nursery habitat for commercial and recreational fisheries species, as well as being important food resources for threatened species such as marine turtles and dugong (Taylor *et al.* 2007). Seagrass meadows also display measurable responses to changes in water quality, which make them potential indicators for estimating the relative health of ecosystems (Collier and Waycott 2009, Rasheed *et al.* 2008, Fourqurean *et al.* 2003).

In collaboration with GPC, the former DPI&F (now DEEDI) initiated an annual long term seagrass monitoring program in Port Curtis and Rodds Bay. An initial baseline study undertaken in 2002 (Rasheed *et al.* 2003) identified 135 discrete coastal and deepwater seagrass meadows. Thirteen of these meadows were selected for long-term monitoring which was conducted annually from 2004 to 2008 (Rasheed *et al.* 2005; Rasheed *et al.* 2006; Taylor *et al*. 2007; Rasheed *et al.* 2008; Chartrand *et al.* 2009). These studies provide the basis for the current understanding of the seagrass communities in the area and are described here to enable comparison to the results of the current marine ecological survey.

Seagrass Diversity

This monitoring program has identified six seagrass species within the Gladstone Port Limits and Rodds Bay (Rasheed *et al.* 2008):

- *Halodule uninervis* (wide and narrow leaf morphology) (Forsh.) Aschers. in Boissier;
- *Halophila decipiens* Ostenfeld;
- *Halophila minor* (Zoll.) den Hartog;
- *Halophila ovalis* (R. Br.) Hook. F.;
- *Halophila spinulosa* (R. Br.) Aschers. in Neumayer; and
- *Zostera capricorni* Aschers.

Extensive areas of seagrass communities were located in the 2002 baseline survey along the coastal areas from the Narrows to Rodds Bay in the intertidal to subtidal habitats (<5m below mean sea level (MSL) refer Rasheed *et al.* 2003). Seagrasses occurred on the majority of shallow sand and mud banks in this area but rarely extended far into the subtidal areas off the edge of the banks. These meadows varied in area, biomass, community structure and species dominance (Rasheed *et al.* 2003).

In 2002, the coastal seagrass communities covered a total area of approximately 7,000 ha and were delineated into as 129 individual meadows, with 12 meadows completely subtidal. Each of these subtidal meadows were observed immediately adjacent to sand and mud banks (depths < 4 m below MSL), generally small in spatial extent and dominated by *Halophila* species.

Intertidal seagrass communities dominated by *Zostera capricorni* were the most widely distributed throughout the area, accounting for approximately 5,000 ha of the coastal seagrass habitat. *Halophila ovalis* often occurred with *Zostera capricorni* to form light and moderate biomass mixed species meadows commonly present as aggregated patches on the sand and mud banks (Rasheed *et al*. 2003).

The 2002 baseline survey did not record any deepwater seagrass meadows within this projects Study area, that is, in the inner port areas west of Facing Island. Six large deepwater meadows that were recorded were dominated by low biomass *Halophila* species and occurred offshore from Facing Island and around Seal Rocks, West Banks and East Banks (Rasheed *et al.* 2003).

The 2002 surveys identified two meadows in the Western Basin region of the Study Area:

- An intertidal meadow in a band along the shoreline of the area consisting of aggregated patches of light density *Z. capricorni* with *H. ovalis* and *H. decipiens* and *H. spinulosa* also present; and
- A subtidal meadow across the remainder of the area consisting of light aggregated patches of *H. decipiens* with *H. ovalis.*

Other meadows were present across the Study Area (Rasheed *et al.* 2003):

- In Fisherman's Landing Basin there was a large meadow similar in density and composition to the intertidal meadow in Western Basin and this was bounded by a small area of a subtidal meadow of light aggregated patches of *H. decipiens*;
- Areas of light to moderate density *Z. capricorni* with *H. ovalis* were noted among the Passage Islands, opposite the Project Area;
- No seagrass beds were observed within the channel area of The Narrows while the banks were generally lined with seagrass beds of varying composition ranging from small subtidal meadows of moderate *Halophila* (*H. decipiens*, *H. spinulosa* and *H. ovalis)* to larger intertidal meadows of light to moderate mostly *Z. capricorni* with some *Halophila;* and
- An extensive intertidal meadow of moderate density *Z. capricorni* with *Halophila* was observed on the eastern side of Curtis Island.

The channel, swing basins and berth pockets proposed to be dredged for the Project did not contain any seagrass beds in 2002 (Rasheed *et al.* 2008).

Of the 13 annually monitored meadows, the only meadows that occurred in the Study Area included in the long term monitoring program were those in Western Basin (two meadows); to the south of Fisherman's Landing (two meadows); and on the eastern side of Curtis Island (one meadow).

Spatial and Temporal Variation

The annual monitoring program undertaken by the DEEDI found that the seagrass meadows in Port Curtis and Rodds Bay vary spatially from year to year with respect to the meadow boundaries, and temporally with respect to the biomass, community structure and species dominance (Figure 2-2; Rasheed *et al*. 2008).

The area of the intertidal seagrass meadow in the Project Area fluctuated from 2002 to 2008 (Table 2-1). Results indicated that seagrass cover was, however, stable from 2002 to 2004, receding in area in 2005, then expanding to its maximum recorded area in 2007, and then reducing again, although slightly, in 2008. The reported biomass of this same meadow dropped markedly from 2002 to 2005, then increased to its highest level in 2007, and in 2008 dropped back to pre-2006 levels. The intertidal meadow within Fisherman's Landing Basin exhibited similar spatial and temporal trends in area and biomass indicating changes were not in response to site specific influences but Port wide variability. Rasheed (*et al*. 2008) stated that there was generally an increase in the proportion of *Zostera capricorni* that accompanied these increases in biomass.

The 2006 to 2007 intertidal meadow increases in both area and biomass were attributed to local climatic factors conducive to intertidal seagrass health that reduce thermal stress and desiccation that can occur due to exposure at low tide and periods of increased rainfall, decreased monthly air temperatures, solar irradiation, hours of daytime exposure and freshwater flows (Rasheed *et al*. 2008). Chartrand (*et al.* 2009) also attributed the 2008 decreases in biomass to local climatic factors including high local rainfall and high flow of the Calliope River, highlighting the highly variable interactions between climatic conditions and seagrass meadow attributes.

Table 2-1 Area and Biomass of Seagrass in Monitoring Meadows in the Project Area*

	Area ± Reliability Estimate (R) (ha)					
Meadow	2002	2004	2005	2006	2007	2008
Intertidal	269.1 ± 11.3	268.3 ± 12.5	231.1 ± 12.3	275.2 ± 12	309.9 ± 12	294.9 ± 12.6
Subtidal	268.3 ± 14.9	284.4 ± 7.1	7.0 ± 1.1	143.9 ± 8	153 ± 8.3	242.5 ± 8.2
	Mean Biomass ± Standard Error (g dry weight m^{-2})					
Intertidal	2.1 ± 0.3	0.14 ± 0.08	0.06 ± 0.04	1.28 ± 0.49	3.89 ± 0.77	0.69 ± 0.25
Subtidal	0.9 ± 0.3	1.93 ± 0.27	0.001 ± 0.001	4.98 ± 0.72	4.64 ± 0.63	0.30 ± 0.09

* Adapted from Chartrand *et al.* 2009

The subtidal meadows in the Project Area and to the south of Fisherman's Landing did not fluctuate over time in the same pattern as the intertidal meadows. The subtidal seagrass community in the Project Area dropped to an extremely low area and biomass in 2005 and while both factors subsequently increased, the area did not return to its original 2002 distribution while biomass rose to its highest recorded level (Table 2-1).

The subtidal meadow within Fisherman's Landing Basin appeared to follow this same trend over time, but with a markedly reduced biomass (lowest level in 6 years) observed in 2007 (Rasheed *et al*. 2008). The climatic conditions that were beneficial for the intertidal meadows are likely to have had the opposite effect on the subtidal meadows as the decreased solar irradiance would likely have resulted in reduced light available for seagrass growth. Intertidal and subtidal seagrasses monitored in other Queensland locations have exhibited similar changes in biomass and spatial distribution with changes strongly linked to climatic conditions and exposure (Rasheed *et al*. 2008).

The seagrass meadow east of Curtis Island was the most stable bed in the long term monitoring program with both area and biomass remaining relatively consistent over the 5 years. This intertidal meadow has less estuarine influences than the more inshore meadows and this combined with regular tidal flushing of oceanic water may account for its relative stability (Rasheed *et al.* 2008).

The species composition of the seagrass communities in the Study Area, within Fisherman's Landing Basin and at Pelican Banks was fairly consistent over time. The only marked change occurred in the intertidal meadow to the south of Fisherman's Landing where the species dominance shifted annually between *Z. capricorni* and *H. ovalis* (Rasheed *et al*. 2008).

From this study it is apparent that the changes over time in the area and biomass of these seagrass meadows are not correlated (Rasheed *et al.* 2008). Given the long term survey of the seagrass beds in

the Project Area conducted by DEEDI indicates that biomass cannot be used as a proxy for area discussions were undertaken with DEEDI (L. Johns, QPIF, June 2009) which indicated the area of seagrass bed is appropriate for estimating potential impacts (and any required offsets) than biomass values. Accordingly meadow areas are reported for the purposes of this assessment.

Local and Regional Context

The 2002 baseline survey identified 129 coastal seagrass meadows within Port Curtis and Rodds Bay (Rasheed *et al*. 2003), two of which occur within Western Basin. Several other meadows identified may also be potentially affected by the Project's activities. Most of these intertidal and subtidal seagrass meadows were comprised of *Z. capricorni* with *Halophila* species (*H. ovalis*, *H. decipiens*, *H spinulosa*). The species composition of the Western Basin intertidal meadow (270 ha in 2002) was light *Z. capricorni* with *H. ovalis* and in the 2002 baseline survey, 13 other large (> 20 ha) intertidal meadows were identified with this specific species composition, totalling 1,377 ha, and an additional 12 large meadows had the same dominant species (2632 ha) (Rasheed *et al.* 2003).

The species composition of the Western Basin subtidal meadow was light *H. decipiens* with *H. ovalis* (268 ha in 2002). Whilst none of the other 11 coastal subtidal meadows shared this specific composition, six were dominated by the same species (94 ha), and three were dominated by other *Halophila* species (24 ha; Rasheed *et al.* 2003). In this local context, the area of intertidal seagrass potentially impacted by the Project is considered very minor with existing communities well represented in the local area. The subtidal area of seagrass potentially impacted is more substantial in comparison to other subtidal meadows in the area, though its species are also well represented in the area. In the last published survey of the area, the meadows in the Project Area totalled an area of 537 ha and in Fisherman's Landing Basin they covered 519 ha (Chartrand *et al*. 2009).

Coles *et al.* (2007) undertook a review of the seagrass research and monitoring programs that have been undertaken in the GBRWHA. Information was stratified into the six Natural Resource Management Regions that make up the GBRWHA:

- Cape York;
- Wet Tropics;
- Burdekin;
- Mackay-Whitsundays;
- Fitzroy; and
- Burnett-Mary.

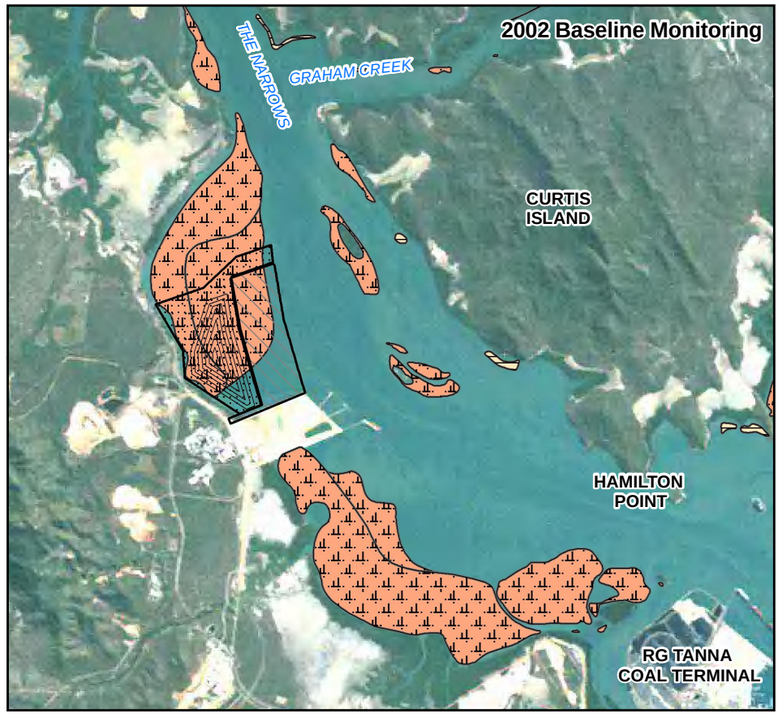
The majority of seagrass meadows found in the Fitzroy region, where the Project is located, were on large intertidal flats. Within the Fitzroy region the following areas of seagrass were mapped (Coles *et al*. 2007):

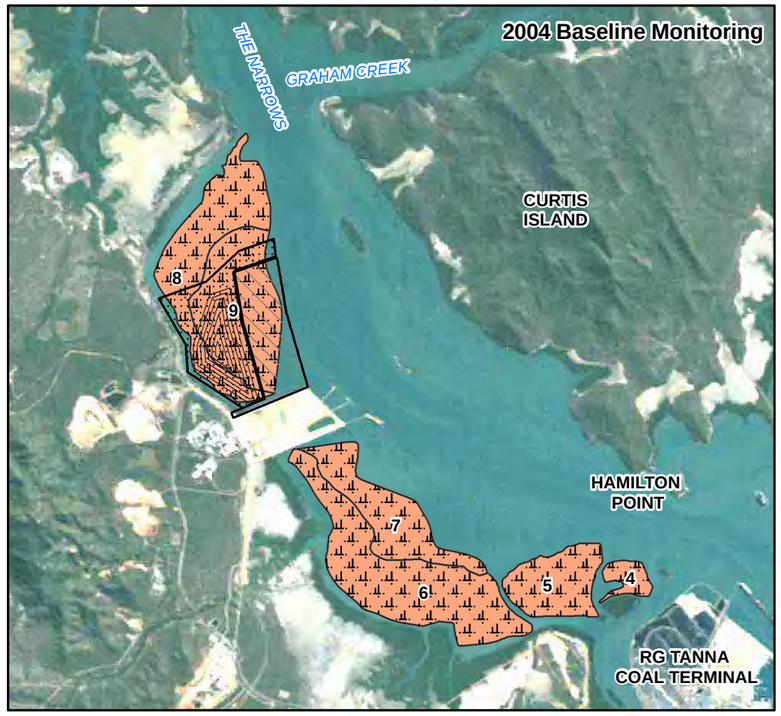
- 16,756 ha of seagrass in coastal habitats;
- 3,702 ha of seagrass in estuarine habitats; and
- 536 ha of seagrass in reef habitats.

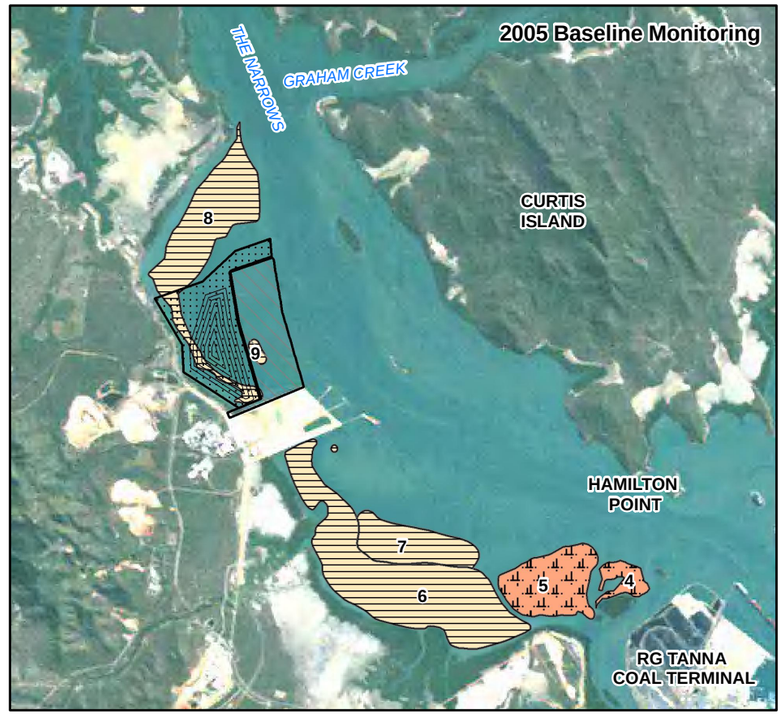
Expansive meadows of *H. uninervis*, *H. ovalis*, and *Z. capricorni* on coastal intertidal flats, similar to the intertidal meadows in the Project Area and Fisherman's Landing Basin, were found at Ince Bay, Clairview, Shoalwater Bay and Rodds Bay (Coles *et al.* 2007). However, in the Fitzroy region the areas

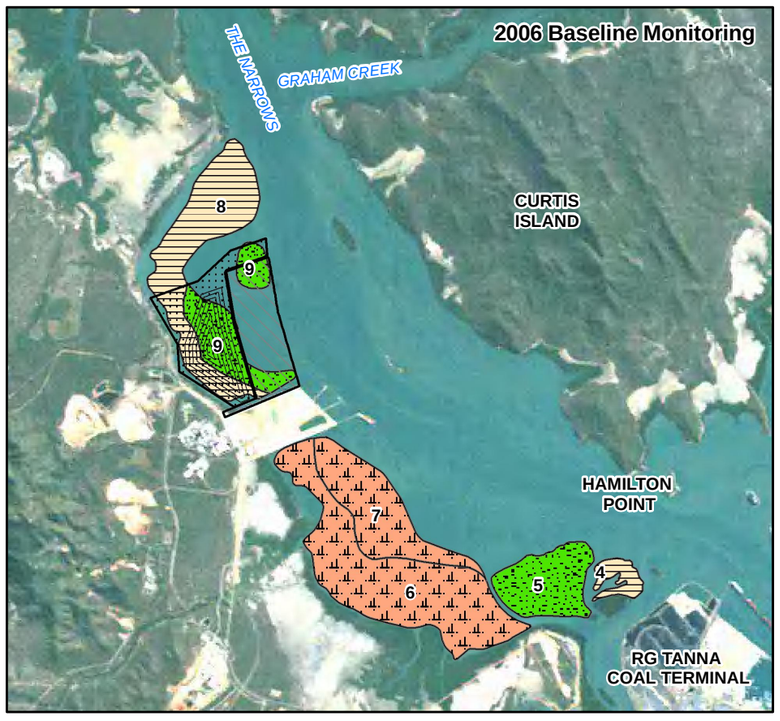
of shallow subtidal coastal seagrass meadows, similar to those in the Project Area and south of Fisherman's Landing, were small. Coles *et al.*. (2007) indicate this is likely due to the exposure of the majority of the coastline to south-easterly winds resulting in high scouring and reduced seagrass settlement.

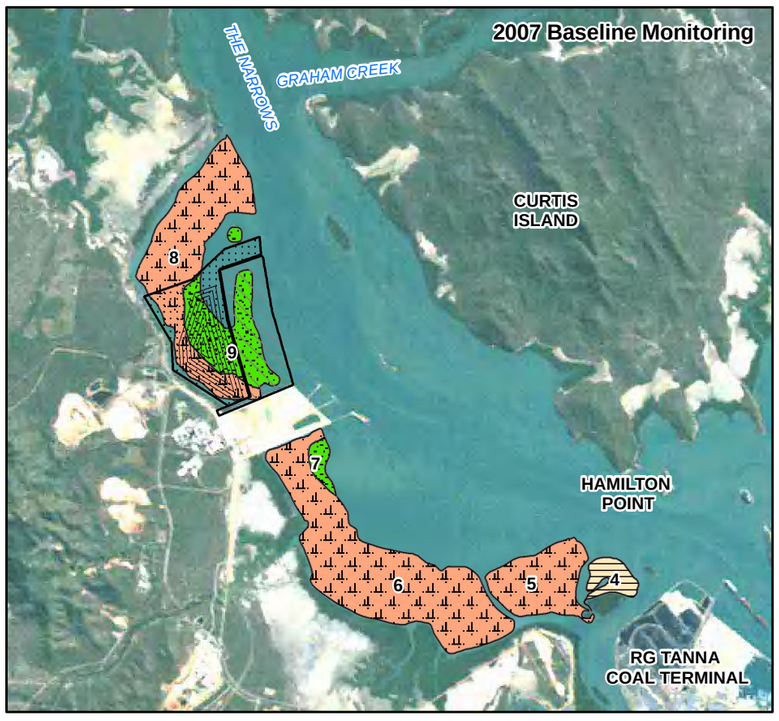
Based on this desktop assessment the areas of seagrass meadows potentially impacted by the Project may be considered small, particularly within a regional context as communities of intertidal seagrass, and to a lesser extent subtidal seagrass, are very well represented in the Fitzroy Region.

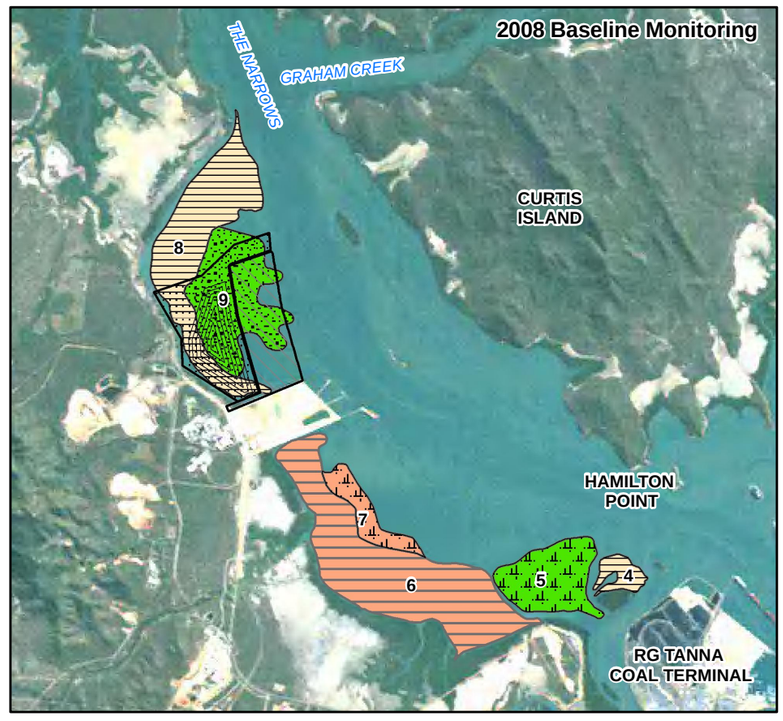












1:100,000 (at A3)

0 1 2 3 4

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

- Western Basin Reclamation Footprint
- Fisherman's Landing Northern Expansion

Note:
Seagrass distribution for 2004, 2005, 2006, 2007 and 2008 is not a complete distrribution as only selected seagrass monitoring meadows were sampled.

Seagrass Cover

- Isolated patches
- Isolated patches / Aggregated patches
- Continuous cover
- Aggregated patches
- Continuous cover / Aggregated patches

Port of Gladstone
Western Basin Dredging and Disposal Project

Annual seagrass Monitoring Meadows (2002-2008)

Job Number	42-15386
Revision	A
Date	14 Sep 2009

Figure 2-2

G:\42\15386\GIS\WesternBasinProjects\MXDs\42-15386_WB_305_rev_a.mxd

Level 4 201 Charlotte Street Brisbane QLD 4000 Australia **T** +61 7 3316 3000 **F** +61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

2.2.2 Benthic Communities

Background Information

The benthic zone of the marine environment is defined here as the surface and subsurface of the sea floor. Fauna that utilise the benthic zone as habitat can be split into two groups:

- The benthic community which includes all fauna that utilise the surface and sub-surface sediment area for feeding and habitat, for example, crustaceans, gastropods, bivalves, polychaetes, and echinoderms (Figure 2-3), among others; and
- The epi-benthic community which includes all fauna that attach to the surface of the sediment or seafloor and feed within the water column, for example, corals, anemones, ascidians, sponges, and bryozoans (Figure 2-4), among others.

Figure 2-3 Examples of Benthic Species From Left to Right: Crustacean, Gastropod, Bivalve, Polychaete and Echinoderm (not necessarily from the Project Area)

Figure 2-4 Examples of Epibenthic Species From Left to Right: Coral, Anemone, Ascidian, Sponge and Bryozoan (not necessarily from the Project Area)

Up to 98% of all marine animal species live in benthic and epi-benthic communities. These communities are essential to the natural processes of the oceans, including nutrient cycles and reef construction (Seibold and Berger 1996). Within marine ecosystems benthic communities are responsible for:

- The production of sediment in the form of shells and skeletal parts known as ‘biogenic’ sediments, this includes calcareous, siliceous and phosphatic hard parts;
- The build up of enormous masses of coastal shelf material, for example the Great Barrier Reef;
- The conservation of water quality, through filter feeding (Peterson and Heck 1999);
- The conservation of sediment quality;
- Bioturbation or the mixing of sediments, which is essential for nutrient release and oxygenation of sediments; and

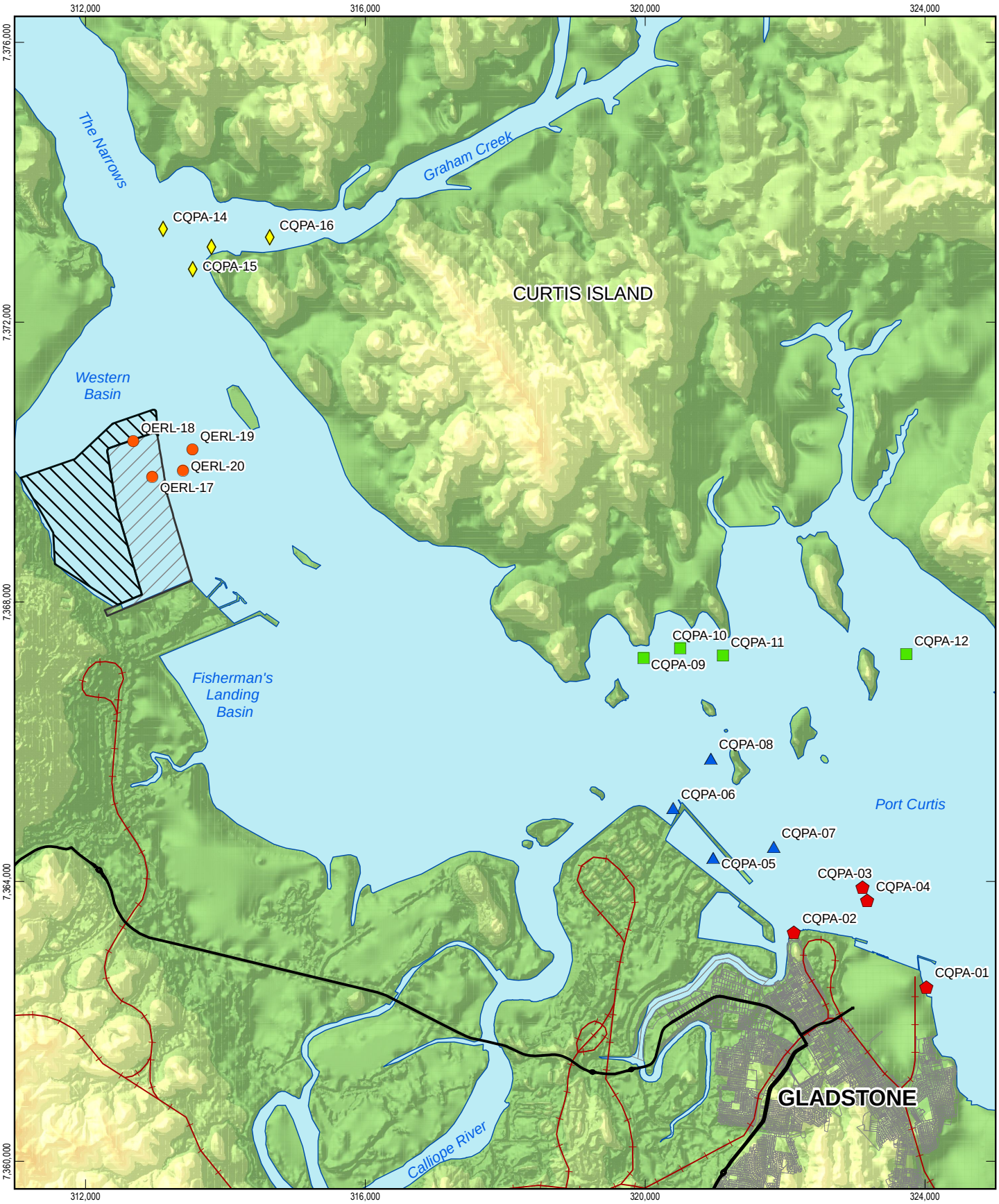
- Providing a food source for many shorebird, fish and ray species (Skagen and Oman 1996).

Benthic Macroinvertebrates

The Centre for Environmental Management (CEM) at the Central Queensland University (CQU), in conjunction with GPC, conducted a long term Port Curtis Macrobenthic Monitoring Programme from 1995 - 2003 (Alquezar and Small 2006). This programme involved bi-annual sampling of five monitoring sites in the Port Curtis area (Figure 2-5) in April (post-wet season) and November (pre-wet season) over nine years. The sites were:

- Graham Creek;
- Fisherman's Landing (located in the Western Basin Project Area);
- Clinton Coal Wharf;
- Auckland Point; and
- Curtis Island.

Across these studies, the surveys identified 45,576 individuals belonging to 544 taxa. The most abundant group were molluscs, contributing 41% of the total abundance, whilst the polychaetes were the second most abundant group contributing 21%. Crustacean and chordates (ascidians) accounted for 29% of the remaining fauna while less common taxa included echinoderms (sea stars sea urchins), cnidarians (anemones and corals), marine worms (Alquezar and Small 2006). Few species were highly abundant with the most abundant species collected across all the years an ascidian and a bivalve mollusc that together accounted for 21% of all fauna. A further five species represented 3-5% of the total abundance while the remaining 537 taxa all occurred infrequently.



LEGEND

- Auckland Point
- Clinton Coal Wharf
- Curtis Island
- Fisherman's Landing (QERL)
- Graham Creek
- Major Road
- Railway
- Western Basin Reclamation Area
- Fisherman's Landing Northern Expansion
- Built Up Area

1:75,000 (at A4)

0 0.5 1 1.5 2

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

Port of Gladstone
Western Basin Dredging and Disposal Project

Centre for Environmental Management
Macrobenthic Monitoring Sites

Job Number	42-15386
Revision	A
Date	01 Sept 2009

Figure 2-5

G:\42\15386\GIS\WesternBasinProjects\MXDs\WB_306_rev_a.mxd

Level 4 201 Charlotte Street Brisbane QLD 4000 Australia T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

The benthic communities were found to have higher species abundance, richness and diversity in the pre-wet season (November) compared to post-wet season (April) for all sites surveyed (Alquezar and Small 2006). Over the eight year survey period the species abundance (number of individuals), richness (number of taxa) and diversity fluctuated considerably in a reasonably consistent manner at all sites indicating that the cause of the observed fluctuations was more likely to be a large scale event (Alquezar and Small 2006). From high abundance, richness and diversity in 1995, the communities decreased significantly until 1999 then steadily increased until 2001, reaching similar levels to those observed in 1995. Following this, another significant drop was recorded between 2002 – 2003. The variations in community structure were considered possibly to be attributed to large scale changes in the environment (not assessed as part of the study) such as changes in freshwater input, salinity and temperature.

Spatial trends over the eight year survey showed Fisherman's Landing/Western Basin sites and the sites at Clinton Coal Wharf and Auckland Point (i.e. sites in close proximity to industry) to have the lowest species abundance and richness while Curtis Island and Graham Creek (referred to as reference sites as they were further away from industry) had the most abundant and species rich benthic communities. The benthic communities at Fisherman's Landing/Western Basin over the eight years on average had six taxa and 12 individuals per sample (0.1m^2 grab sample).

Fisherman's Landing/ Western Basin also shared similar benthic community structure to Auckland Point and Clinton Coal Wharf, with lower abundance and diversity, but higher species evenness (rarity or commonness of each species). Alquezar and Small (2006) suggested this may be due to an increased numbers of species tolerant to anthropogenically modified estuaries in these sites. In this study, sediments across the sites were generally found to consist of more sand and gravel than silt and clay, although variation within and among sites was observed (Note: Fisherman's Landing sediments were not analysed as part of this study). Sediment type, and to a lesser extent, seasonality were found to have influenced the macrobenthic communities spatially and temporally (Alquezar and Small 2006). Currie and Small (2005) found that throughout the eight years of the survey species abundance and richness was lowest on fine muddy sediments in the intertidal and highest in the coarse, sandy sediments that generally occurred in the deeper channels.

The long term trends observed within the Port Curtis benthic communities were also examined by Currie and Small (2005) and they reported that the temporal trends were similar across all common dietary groups, such as filter and deposit feeders, predators and scavengers and that the drivers of the observed changes had a consistent affect at most trophic levels. They also argued that temporal trends in the abundance and richness were related to environmental variables with species richness and abundance positively correlated with regional rainfall, freshwater inflow and turbidity levels. More than 80% of the observed temporal changes in the benthic species richness and abundance was accounted for by changes in turbidity and it was suggested that high turbidity indirectly promotes recruitment and or survivorship of benthic fauna in Port Curtis (Currie and Small 2005).

Epibenthic Macroinvertebrates

Epibenthic macroinvertebrates were investigated as part of the 2002 DEEDI baseline survey (Rasheed *et al.* 2003). Macroinvertebrates were sampled at 143 sites throughout Port Curtis using an underwater video sled and net to capture surface benthos. This survey found that epibenthic macroinvertebrates occurred throughout the Port Curtis region in varying densities with the highest densities associated with hard substrate in the form of coral bommies and rubble reefs. These high-density areas were located

outside Facing Island, within the dredged material disposal ground, and surrounding Seal Rocks (Rasheed *et al.* 2003).

The inner harbour of Port Curtis ranged from low density areas of open substrate with scattered fauna to high density areas of scallop and rubble dominated reefs. The area directly east Western Basin and north into The Narrows was classified as a medium to high-density benthic community consisting of rubble reefs dominated by bivalves, ascidians, bryozoans and hard corals. Some of the highest density communities were found near the maintained channels within the Port from Clinton Channel up Targinie Channel to the southern area of Western Basin. These were scallop and rubble reefs dominated by bivalves with mixed reef taxa including sponges, soft coral, hard coral, hydroids, bryozoans and gorgonians. These communities were considered to be associated with the high-tidal current flow of the channels (Rasheed *et al.* 2003).

Additionally, the 2002 baseline survey (Rasheed *et al*. 2003) and subsequent annual monitoring events, identified macro-algae as only a minor component of the benthic communities in Port Curtis. An unidentified species of filamentous green algae was also found at the Project Area in varying low densities throughout the monitoring period.

When compared to the rest of Port Curtis region, the Project Area and adjacent surrounds reported relatively low benthic diversity, and contained similar epibenthic diversity as other areas of Port Curtis.

Intertidal Macroinvertebrate Communities

Information on the intertidal macroinvertebrate communities within and adjacent to the Project Area is limited. The Port Curtis Integrated Monitoring Program (PCIMP 2008) examined macroinvertebrate communities in mangrove intertidal areas in 2006 and 2007 for the impact of contaminants. Both the CEM and DEEDI surveys examined only subtidal fauna, however, an examination of these results in conjunction with a review of the physical intertidal environment within and adjacent to the Project area allows for an assessment of the communities likely to be present.

The intertidal environment available as habitat for macroinvertebrate communities includes both natural (soft sediment flats) and man-made (rock revetment walls) features. The soft sediment flats support seagrass meadows and algal stands, as well as mangrove areas and bare flats. Surveys of similar soft sediment flats along the Queensland coast indicate that the associated macroinvertebrate communities are typically comprised of gastropods, bivalves, crustaceans, polychaetes, sponges and ascidians. It is considered likely that the soft sediment flats within and adjacent to the Project Area contain similar assemblages and given the local extent of similar intertidal habitats, it is unlikely that the assemblages present in the intertidal areas within and adjacent to the Project area are locally or regionally unique.

This notion is supported by works recently completed adjacent to the Project Area by URS (2009) as part of studies undertaken in 2008 to assess potential impacts of the proposed Santos Gladstone Liquefied Natural Gas (GLNG) facility and associated infrastructure. Results from this study indicate that around Graham Creek and Friend Point/Kangaroo Island, mangroves dominated the mid to upper intertidal regions with rocky shores in between the mangrove embayments. Oysters and barnacles were common on the rocky shores and the mangrove systems supported a range of taxa including many gastropods, that are common to tropical mangrove stands and mud flats. Molluscs were the dominant group noted of the 57 taxa recorded. Those communities noted, however, were considered to be of relatively low diversity and described as locally and regionally common (URS 2009).

2.2.3 Marine Pests

The term marine pest may refer to a taxa that is introduced to an area but typically also relates to those introduced taxa that are posing a threat to the environment, economy or society of the area to which it has been introduced. Introduced or exotic species are those recognised as having been introduced to a region (usually via anthropomorphic vectors) that is beyond their normal geographic range but which are not posing a threat to the area they have been introduced. In Australia, for management of marine invasives there are a recognised set of pests of concern. These pests have been agreed to through a formal process managed by the National Introduced Marine Pest Coordination Group (NIMPCG), which includes representatives from all states and territories.

Establishment of a marine pest in Port Curtis (Gladstone) waters poses a significant risk to the environment, the economy and society as it would likely impact upon aquatic resources and industries that rely on those resources (e.g. commercial and recreational fishing, aquaculture, port, tourism and shipping). Port Curtis is visited by a large number of commercial and recreational vessels from domestic and international locations. For instance, in 2008 imports were recorded from over 430 commercial vessels sourced from 13 international locations (Table 2-2). Each of these commercial vessels has the potential to introduce marine pests into the area via biofouling and/or ballast water transport vectors.

Table 2-2 Commercial vessel visitation recorded for Port Curtis in 2008

	Vessel count		Vessel Count
Australia	296	China	24
Indonesia	9	Japan	41
Korea	18	Malaysia	2
New Zealand	1	Oman	4
Saudi Arabia	3	Qatar	5
Taiwan	8	Singapore	11
U.S.A. - West Coast	14	Trinidad	1

Source: http://www.cqpa.com.au/viewcontent/ShippingStatistics/CargoComparisonsSelection.aspx

Similarly, fishing trawlers, yachts and other non-commercial/non-trading vessels also have the potential of carrying a marine pest to the Gladstone region either via biofouling of their hull or vessel equipment (including fishing gear). The development of the Project provides opportunity for a future increase in vessel visitation to this area; this is most likely to be commercial traffic decreasing the recreational and fishing vessel traffic to the area. During construction a large number of vessels will be stationed in the area. This increases the chance of marine pest incursions to the local area which could then spread and have an impact in the wider Port Curtis environment. Understanding the potential marine pest risks related to the Project requires an understanding of existing marine pest concerns within the region and approaches for management of future introduction vectors.

A series of marine pest baseline surveys were undertaken in Australian ports prior to 2003 to assist in understanding the current state of marine pest incursions in Australia. The locations surveyed were considered to be first ports of call for internationally sourced vessels. Recognising the high vessel traffic and risks of marine pest introduction to the region, Gladstone was included in this first set of baseline

surveys with CQPA commissioning a port wide baseline survey for introduced marine pests. In 2000 samples were collected from over 20 sites within Gladstone Harbour, primarily focussing on areas likely to house marine pests including wharf piles and adjacent sediments. It is understood that the survey approach was in accordance with the previous national port wide baseline survey requirements, as defined in Hewitt and Martin (1996). A range of macrobenthos and pelagic taxa were sampled with no marine pests were detected during the survey[1]. Ten introduced species were identified, however, none are considered to be a marine pest, that is they were recognised to not be of threat to endemic species, the natural ecology of the Harbour, fisheries or human health. At the time of the survey and reporting the reportable marine pests of concern were those recognised by the Australian Ballast Water Management Advisory Committee. Since that survey and reporting was undertaken information from the original series of baseline surveys has been used to inform development of the *Australian Government's National System for the Prevention and Management of Marine Pest Incursions* (the National System). The National System includes a range of measures to deal with all aspects of the prevention, management and control of marine pest introductions. Addressed under the National System are arrangements to reduce the risk of primary invasions via ballast water or biofouling, as well as measures to control the spread of existing introduced marine pests (IMP) as a result of secondary invasions.

Under the National System, information collected during the first round of baseline surveys has been used to identify 18 locations in Australia to be targeted for ongoing monitoring for marine pests. Recognising the ongoing high risk of introduction to this area, the Port of Gladstone is one of the 18 ports in Australia identified for ongoing monitoring for marine pests. The Port is to be monitored as part of the National System using new monitoring guidelines developed by Commonwealth Department of Agriculture, Fisheries and Forestry (DAFF), in conjunction with other agencies and technical specialists. These guidelines seek to provide standardised approaches to the design, conduct and reporting of each of the marine pest monitoring events. The marine pests of concern to be monitored for using the guidelines focus on those previously identified by a range of ballast and biofouling and vector studies to be of risk to Australian waters. This list currently includes 55 different species but is subject to change. The most current list of species is available by contacting the National System (www.marinepests.gov.au). Monitoring of marine pests within Gladstone under the National System has not yet been undertaken and an extensive period of time has elapsed since the previous pest surveys. Although no marine pests of concern have been detected or reported in the Gladstone none of the surveys undertaken in recent history (seagrass assessments, Santos EIS, PCIMP) have included marine pest assessments within their study frameworks. To manage the potential risks to the Project Area from the reclamation works, it is appropriate to determine a current state of knowledge about marine pests within the Project Area. Accordingly, the marine baseline assessment described within this report sought to identify any detected marine pest species of concern. Findings of that work are provided in Section 4.

2.2.4 Fisheries

Recreational Fisheries

Size and Extent of the Fishery

Consultation was undertaken with the recreational fishing communities that utilise the areas within and immediately adjacent to the Project Area for the adjacent Fisherman's Landing Northern Expansion

[1] http://www.cqpa.com.au/Pages/Environment/enviro_monitor.htm

Environmental Impact Statement (GHD, 2009). This found that recreational fishing is by far the most prominent recreational activity undertaken in and around the Project Area and is governed by the seasonality of targeted species, the tidal signature of the area, and the amount of time available for fishing activities. The majority of recreational fishing undertaken in the area occurs on the weekends, both from the shore and from recreational vessels.

Targeted Species

An investigation into the historical trends of recreational fishing catches (using rod and reel techniques) in the Gladstone region (Platten 2004) found that catches are dominated by whiting (mostly *Sillago ciliata*). Other species often caught in the area include Bream, Flathead, Gar, Long Tom, Steelback, and Grunter (Platten 2004). Direct consultation with local fishing groups also found that Blue Salmon, Barramundi, Triple tail, Mud Crabs and prawns are routinely caught in the Project Area and immediate surrounds.

Regional Context

Port Curtis is an important resource for the local fishing community as it offers protected waters that support a variety of edible and sport fisheries species. Consultation with the local fishing community identified the shoreline adjacent to the Project Area as an important local crab fishing site as it can be safely accessed from the shore, thus recreational fishers without boats can also utilise the area. From an ecological perspective, similar nearby coastal environments exist up The Narrows, and also along the shores of Graham Creek on the lee side of Curtis Island although these are less easily accessible. Further information on recreational fishing and fisheries is provided in the body of the EIS.

Commercial Fisheries

Size and Extent of the Fishery

Consultation with the local commercial fishing community (GHD, 2009) indicated that there are six known commercial operations that utilise the Project Area and adjacent surrounds. The main activities that occur in the Project Area are setting pots to collect mud crab, fish netting, and trawler thoroughfare (but no trawling).

Targeted Species

Species targeted by the local commercial fishing industry include prawns, mud crab, mullet, shark, blue salmon, and barramundi. Additionally, the seagrass habitats available within and adjacent to the Project Area, in particular the *Zostera capricorni* meadows, are likely to provide nursery areas for other fish and crustacean commercial species (Rasheed *et al*. 2008).

Regional Context

Port Curtis is home to a substantial commercial fishing industry that uses various locations in and around Port Curtis and further offshore. Trawlers operate around and south of Gladstone Marina but are not allowed to trawl in specific areas within Gladstone Harbour. The commercial fishery consists of:

- Line fishers;
- Net and crab fishers;
- Trawl fishers; and
- Seasonal prawn fishers.

The fishing effort and yield of all commercial fishing activities in the Gladstone region from 1988 to 2005 were highly variable among years (Table 2-3). From an ecological perspective, similar habitats to those utilised by the commercial fishery within the Project area exist in Port Curtis and The Narrows. These activities are mapped and described in more detail in the body of the EIS.

Table 2-3 Annual Commercial Catches for All Commercial Fishing Activities in the Gladstone Region (grid S30)

Year	Tonnes	Boats	Days	GVP (AUS $)
1988	97.6	71	1774	$809,400
1989	132.1	76	2050	$1,079,900
1990	127.9	96	2459	$1,300,000
1991	265.5	128	3458	$2,642,700
1992	237.0	118	3510	$2,319,700
1993	249.4	143	4041	$3,135,400
1994	159.9	108	3541	$1,425,300
1995	190.5	133	3674	$1,976,500
1996	227.2	127	3710	$1,847,900
1997	167.9	125	3757	$1,404,800
1998	210.8	105	3852	$1,955,000
1999	221.2	108	4343	$2,127,300
2000	224.2	114	4175	$2,019,200
2001	227.4	103	3223	$1,910,600
2002	287.5	82	3676	$2,332,000
2003	467.7	95	4842	$3,857,500
2004	527.5	85	4806	$3,990,800
2005	421.6	65	3772	$2,826,600

Source: http://chrisweb.dpi.qld.gov.au/CHRIS. Accessed: 04 March 2009. Search results for: Fishery Type = 'All (Listed)', Year = 'All', Month = '99', Species = 'All Species', Selected Sites(s)/Grid(s) = ("S30"), returned 137 records.

3. Methodology

3.1 Overview

The objective of the benthic marine ecology survey was to assess the current status of benthic taxa at the time of the survey and characterise the benthic habitats in the Project area and adjacent habitats, defined as the Study Area. As noted under Section 2.2, DEEDI has undertaken an annual seagrass monitoring program since 2002 to comprehensively assess the spatial and temporal variability of seagrasses in the Port Curtis area and adjacent marine environments (Chartrand *et al.* 2009). Considering this comprehensive survey work, it was not necessary for GHD to undertake further broad scale seagrass meadow assessments. Instead focused characterisation of seagrasses at sample sites during other field activities that built upon information collected during the DEEDI surveys was conducted. This enabled an ecosystem assessment of the meadows likely to be influenced by any proposed development works in the context of their use by other species.

The soft sediment community assemblages (including seagrasses and any associated fish taxa) were characterised for diversity, spatial distribution and relative abundances. The surveys enhanced the existing information on these marine benthic communities and provided the ability to assess the potential impacts to benthic communities and any protected species and propose appropriate mitigation measures.

3.2 Benthic Macroinvertebrates

3.2.1 Site selection and survey design

Previous studies provided a good reference for the design of this marine benthic survey as they addressed intertidal, shallow subtidal and deepwater areas of Port Curtis. In particular, the DEEDI seagrass and benthic surveys from 2002 provided a thorough description of the benthic functional groups and their densities across this region. It was also recognised that given the significant currents that occur within Port Curtis there is high potential for offsite impacts from dredging and construction works associated with this project. Accordingly, in conjunction with detailed investigation of the reclamation and dredging areas expected to be directly impacted by the Project, it was appropriate to also sample upstream and downstream of these locations and in the channel opposite the Western Basin Reclamation Area.

To gather data of the benthic assemblages that may potentially be directly or indirectly affected by the Project's construction, dredging and reclamation activities, benthic sampling occurred in the following locations:

- The Western Basin Reclamation Area, both under the proposed reclamation footprint and to the north of the proposed reclamation works;
- Within the existing Targinie and Clinton Bypass shipping channels;
- Within the areas proposed for future dredging (channel, berth pocket and swing basin areas);
- Passage Islands;
- In the Bay on the south side of Fisherman's Landing (Fisherman's Landing Basin);

- Upstream in The Narrows up to Black Swan Island (Figure 3-1). This 'upper limit' in The Narrows was selected as it complements the area used by marine megafauna as determined by earlier GHD surveys for the Fisherman's Landing Environmental Impact Statement (GHD, 2009); and
- Pelican Banks Reference Site.

These areas are all represented visually on Figure 3-1, as are the proposed dredging stages. Most of the existing channel, swing basin and berth pocket areas did not contain seagrass communities in 2002 with the exception of sites adjacent to the Passage Islands. At this location there were some communities similar to those of the inshore region of the Western Basin Project Area, that is, mostly dominated by *Z. capricorni* with patches of *H. ovalis* (Rasheed *et al*. 2003).

A suitable reference area for the Western Basin Project Area ideally supports the same benthic communities as those of the Project Area. The Rasheed *et al.* (2003) surveys mapped a large band of the same inshore *Z. capricorni* dominated seagrass community along the bay on the south side of Fisherman's Landing (Rasheed *et al.* 2003) which was sampled during the survey (Figure 3-1; Fishman's Landing Basin). An additional reference area unlikely to be affected by dredging activities, as predicted by preliminary understanding of hydrodynamic influences from the Project, was identified to the south-east of Curtis Island (Pelican Banks; Figure 3-1) where, in 2002, there was a large meadow of *Z. capricorni* with *Halophila* species (Rasheed *et al.* 2003). Accordingly this area was also sampled during this monitoring program as a Reference Site.

304,000 306,000 308,000 310,000 312,000 314,000 316,000 318,000 320,000 322,000 324,000 326,000 328,000 330,000

7,378,000 7,376,000 7,374,000 7,372,000 7,370,000 7,368,000 7,366,000 7,364,000 7,362,000

Worthington Island
Kangaroo Island
The Narrows
Graham Creek
Laird Point
Friend Point
Curtis Island
North Passage Island
South Passage Island
WESTERN BASIN
Facing Island
Compigne Is.
Boatshed Point
Hamilton Point
Tide Is.
Witt Is.
Turtle Is.
Diamantina Is.
Quoin Is.
Picnic Is.
Wiggins Is.
GALLIOPE RIVER
AUCKLAND CREEK
GLADSTONE

INSET Scaled at 1:30,000

1:75,000 (at A3)

0 0.5 1 1.5 2

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

- Crab Pot
- Sample Transect
- Cast Net
- Intertidal Survey
- Major Road
- Western Basin Reclamation Area
- Fisherman's Landing Northern Expansion
- Existing Channels, Swing Basins and Berths

Port of Gladstone
Western Basin Dredging and Disposal Project

Job Number 42-15386
Revision A
Date 30 Aug 2009

Marine Ecology Sampling Sites

Figure 3-1

G:\42\15386\GIS\WesternBasinProjects\MXDs\42-15386_WB_307_rev_a.mxd

Level 4 201 Charlotte Street Brisbane QLD 4000 Australia **T** +61 7 3316 3000 **F** +61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

3.2.2 Number of sites within each of the areas

The Western Basin Project Area is approximately 650 ha in area (this area includes the Western Basin Reclamation Area (235 ha) and the area to the north of this within Western Basin (415 ha)). To detect existing benthic taxa and any potential marine pests the area was intensively surveyed with 25 sites sampled.

The Reference Area at Pelican Banks was not surveyed as intensively as the Western Basin Project Area. This reference area was sampled to provide data on the benthic fauna and seagrass that is present in a similar area (i.e. habitat with similar hydrological and sedimentary characteristics) with the hypothesis that the Western Basin Project Area is not unique in the region. The level of sampling was determined appropriate to achieve comparability based on data from previous studies and knowledge of the area.

Generally, sites within each sampling area were spatially stratified and not randomly distributed, with distance between sites influenced by on-site environmental conditions including depth. This is a sampling approach that is appropriate for characterising soft sediment taxa that are characteristically disparate in their distribution and strongly influenced by changes in the benthic substrate and other environmental influences (e.g. Cruz-Motta 2000, Neil *et al*. 2003, Roberts *et al.* 1998, Smith and Rule 2001). The numbers of sites surveyed in each area were:

- 25 sites within the Western Basin Project Area;
- 31 sites across the potentially impacted by dredge plume areas including:
  - 11 sites in Passage Islands opposite the Western Basin Project Area; and
  - 10 sites in the bay to the south of Fisherman's Landing;
  - 10 sites up the The Narrows to Black Swan Island;
- 20 Channel sites distributed evenly over the combined four channels, swing basin and berth pocket areas with the potential to be impacted by dredging activities:
  - Targinie Channel;
  - Clinton Bypass Channel;
  - North China Bay; and
  - Hamilton Point area and the Boatshed Point area;
- 18 sites in the Reference Area at Pelican Banks to the south-east of Curtis Island.

In total 94 sites were sampled within the Survey Area for benthic communities and marine pests. The distribution of these sites and locations as described above is visually displayed on Figure 3-1.

To assist in characterising the relative importance of the local habitats for recreationally and commercially targeted pelagic species crab pots and cast nets were also deployed during the survey with the sample locations also shown on Figure 3-1. The site selection for deployment of nets and pots was informed by information collected during the social impact assessment of this and previous works where indigenous, commercial and recreational users of these areas were provided opportunity to identify places of fishery importance. Desktop reviews also provided supporting information that enabled onsite habitat selection for deployment of nets and pots.

3.2.3 Sampling Methodology

The 94 benthic sites were sampled over a seven day period from the 1st to 7th June 2009. A benthic sled-dredge that collects epibenthic and infaunal macrobenthos was deployed at each site to quantitatively assess benthic macroinvertebrate communities and provide ability to semi-quantitatively assess seagrass and algal communities. The sled has a mouth gape measuring 70 cm wide and 20 cm high with a mesh size of 6 mm. At each site, one sled sample was collected by towing the sled behind the survey vessel for a distance of 100 m along the seabed at drift speed (Figure 3-2). Underwater video was not utilised due to poor visibility in many of the shallow areas sampled, as demonstrated on previous projects conducted by GHD recently at this location. At each site a Van Veen grab that collects 0.02m^2 of sediment was also used to sample the sediment for *in situ* visual characterisation of sediment composition, following the methodology of Rasheed (*et al.* 2003).

Figure 3-2 Photographs Illustrating Sled Recovery and Sampling

3.2.4 Taxa Identification, Taxonomic Sufficiency and Analyses

All benthic flora and fauna collected were sorted to major functional groups and identified *in situ* where possible to family or genera units (or lower where possible). Where firm identifications to species level were not possible *in situ* different species were recognised within the family or genera as “Species 1, Species 2” (Figure 3-3). A marine pest assessment of all organisms collected during the survey was undertaken by identifying species that were recognised as being morphologically similar to recognised pests being identified to species level.

Figure 3-3 Photographs of Animal Identification and Sled Sampling Within The Narrows

Analysis of benthic flora and fauna samples to lowest taxonomic unit is a time consuming and costly exercise that requires a considerable degree of taxonomic expertise. For studies such as this, which require examining the relative importance of a purported impact on an assemblage, taxonomic sufficiency is required only to a level that indicates the community response (or lack there-of) to a purported impact. Previous researchers have examined the validity of analysing data at various levels of taxonomic discrimination (e.g. family, order or phylum) to detect changes resulting from pollution and/or disturbance events (see Cruz Motta 2000, Ellis 1985; Olsgard *et al*. 1997, Vanderklift *et al.* 1996, Warwick 1998). Warwick (1998) suggested that responses of benthic communities to anthropogenic environmental variables are more clearly evidenced at a higher level of taxonomic resolution than species level (i.e. family or order), whereas responses of assemblages to natural environmental variables (e.g. variation in water depth) are more distinct at a level of species. This study (and others) indicated that identification of biota to taxonomic levels higher than species (e.g. family or order) resulted in little loss of information and in many cases yielded better discrimination of patterns associated with purported impacts. Accordingly, taxonomic identifications to Family or alternative appropriate functional grouping are considered to provide adequate taxonomic sufficiency for detection of potential impacts to assemblages from this Project. This level of analysis also provides for comparison of data with that collected previously by Rasheed *et al.* (2003) who recorded taxa at a functional level only.

3.3 Additional Marine Fauna Surveys

3.3.1 Fish and Crabs

Desktop review data of fisheries and resource use and consultation outputs were used to define field sampling locations for fish and crabs across the Project Area. Cast netting was conducted to obtain information on the use of the Project Area as a nursery ground for small prey and juvenile fish species and crab pots were deployed to obtain an understanding of the use of the Project Area by recreationally and commercially targeted crab taxa (Figure 3-4).

A standard size cast net was used to sample fishes at seven sites (Figure 3-1), with captured fish identified *in situ*. A series of ten casts was undertaken while drifting through each site, including:

- Three sites in the Western Basin Project Area;
- One site at the Passage Islands;

- One site at Graham Creek – The Narrows;
- One site at Fisherman's Landing South; and
- One site the Reference Area.

Two standard recreational large, round, collapsible crab pots were deployed 200 m apart for a soak time of three to four hours, eight times during the survey. The sites sampled with crab pots and cast nets are shown in (Figure 3-1).

Figure 3-4 Photographs of Cast Netting and Mud Crab Sampling

3.3.2 Intertidal Surveys

Visual non-structured surveys were conducted across the intertidal environments at three locations within the study area in order to compare the current assemblages within the area to data recently collected by URS (2009). These assessments were undertaken at Laird Point (Graham Creek) to the north east of the Study Area, within the Western Basin Project Area and along the beach of the Reference Area at Pelican Banks (Figure 3-1). These surveys included visual observations of taxa within the upper, mid and lower intertidal areas of both sandy/muddy beach areas and on rocky shore areas. Surveys at each location were undertaken during low tide periods on different days during the field trip. Active animals were identified to lowest possible taxonomic unit. Plants, if present, were also identified. Recent signs of benthic faunal activity, including crab exuviae and moults were also noted when observed.

3.4 Data Analyses

The benthic community assemblages (including seagrasses and algae) were characterised for biodiversity, spatial distribution and relative abundances from the field data. In order for the differences and similarities in community composition between the sampling locations to be thoroughly examined the data was explored using a range of statistical techniques, including transformations and standardisations. Descriptive statistics, including number of individuals and number of taxa recorded were used to describe and compare the taxonomic composition of the sampling locations. Taxa that were recorded *in-situ* as volumes (seagrasses and algae) were assigned an abundance value relative to the counted taxa (e.g. gastropods and bivalves) to enable comparison.

The Primer 6 statistical software package (Clarke and Gorley 2006) was used to examine the natural groupings of samples according to community composition (i.e. type, number and abundance) and

dominant sediment type among the six locations. Non-metric multidimensional scaling (MDS) and cluster analyses were undertaken to identify whether samples within locations were more similar to each other than to samples in other locations. These analyses were based on a similarity matrix produced using the Bray-Curtis similarity co-efficient with no transformation or standardisation. The MDS results, with four outliers removed (samples containing no taxa), have been graphically presented to assist in interpretation of the findings.

A comparative measure of the degree of separation of locations (analysis of similarities; ANOSIM, Primer 6) was applied to the similarity matrix. This provided an 'R' statistic to test the null hypothesis that there are no differences in community composition among locations. Pairwise R statistics were also computed to indicate the pair(s) of locations between which differences lie, and to give a measure of separation. Further investigation of these results was undertaken using the SIMPER function in Primer to highlight the taxa principally characteristic of similar locations (Clarke and Gorley 2001, Clarke and Warwick 2001). The data analysis approaches undertaken are considered to be standard methods for interrogating benthic ecological community datasets.

4. Results

4.1 Benthic Macroinvertebrates

4.1.1 Benthic Faunal Composition

Benthic macroinvertebrate communities across the Project Area were characterised by a moderate species richness and abundance compared with the previous long-term nine year benthic survey of Port Curtis (Alquezar and Small 2006); with a total of 2,710 individuals from 244 taxa collected from the six locations. Across all the locations molluscs were the dominant group accounting for 28% of the taxa, followed by crustaceans (18%); polychaetes, echinoderms and algae (each at 9%); corals and anemones (8%); ascidians (6%); sponges (5%); bryozoans (4%); and seagrass and fish (each at 2%). A full taxa list, their common names and presence/absence at each of the locations is provided in Appendix A along with representative photos of some of the taxa collected.

The taxonomic composition of the macroinvertebrate benthic communities were fairly similar to one another at Western Basin, Fisherman's Landing and the Reference Area where around half of all the organisms present were molluscs and crustaceans with seagrass and algae the other dominant benthos. These communities differed from those at The Narrows, Channel and Passage Islands where a more diverse, greater proportion of different types of animals were observed. Specifically, there were more echinoderms, corals and anemones, bryozoans, ascidians and sponges (Figure 4-1). Western Basin and Fisherman's Landing had the least diverse communities of all locations surveyed.

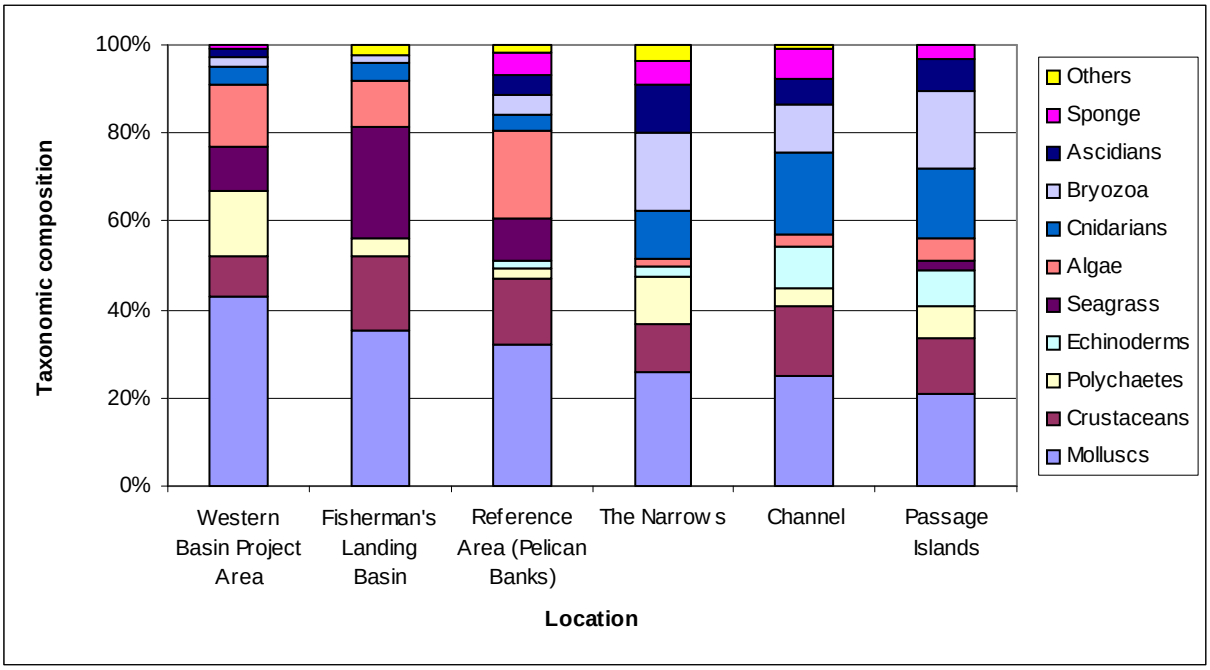


Figure 4-1 Taxonomic Composition of Locations Based on the Number Sampled for Each Major Phyla

Few taxa were highly abundant with the most abundant taxa collected being a common tube dwelling polychaete (Serpulidae sp. 1) and a bivalve scallop (*Chlamys* sp. 1) that together accounted for 25% of

all flora and fauna. A gastropod (*Terebra sp*. 1) and another scallop (*Chlamys* sp. 2) were the next most abundant animals with a combined 13% of total abundance; none of these four taxa occurred in the Western Basin Project Area or Fisherman's Landing with the last two animals each occurring in high numbers in one location only, the Channel and Reference Area respectively (Figure 4-1). The remainder of the benthic organisms were present in low numbers and occurred infrequently. These findings concur well with the nine year survey of Port Curtis that also found the benthic communities to be dominated by molluscs with few species highly abundant. Bivalve molluscs and an ascidian were the most dominant animals during that program together representing 21% of all individuals collected and as with this present study the remainder of the taxa occurred infrequently (Alqezar and Small 2006).

Sediments collected during this study varied across the Study Area from fine muddy silts and clays to coarse sand, shell and rubble. The two locations with the most similar sediment type were the Western Basin Project Area and Fisherman's Landing; these both had only fine silt and mud sediments. The Reference Area had a mixture of silt, mud and sand sediments with a few sites dominated by shell, while The Narrows had similar sediment types but a much greater percentage area dominated by shell. The Channel was the location with the most diverse sediments, no silty sediments and a dominance of coarse sand, rubble and some rock. While the Passage Islands were dominated by silt and mud, there was also a high percentage of sites with clay and some with shell (Figure 4-2, Appendix B).

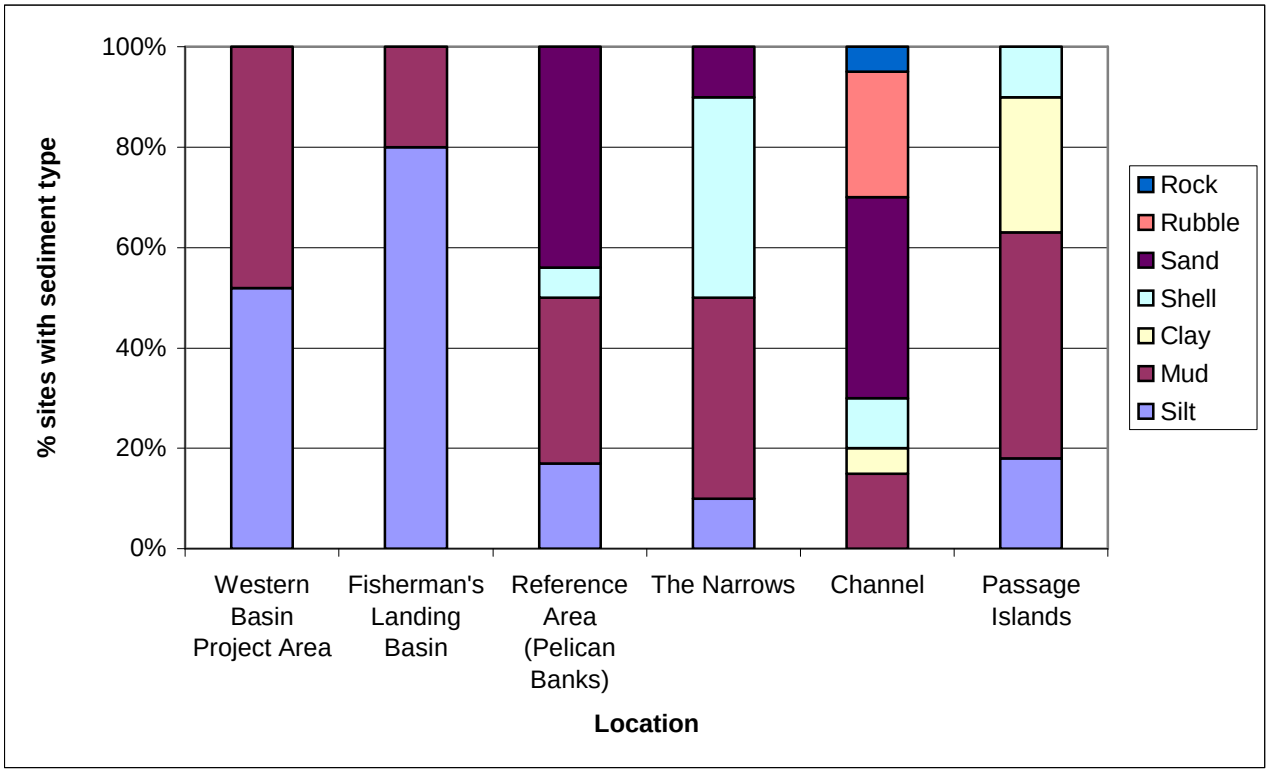


Figure 4-2 Percent of Sites with Dominant Sediment Type at Each Location

The depths across the Study Area ranged from <1 m - 17 m. The Western Basin Project Area, Fisherman's Landing and the Reference Area were all very shallow areas only ranging from 0.5 m - 3 m. The deepest areas were in the Channel (3 m -17 m); although the sites at this area varied in their depth

with some sites quite shallow. The Passage Islands also had shallow and deep sites (0.8 m – 14 m) while The Narrows were less variable ranging between 5 m – 11 m (Figure 3-1).

4.1.2 Benthic Community Structure and Composition

The benthic community structure at the Western Basin Project Area was very similar to that at Fisherman's Landing and these were distinctly different from all other locations surveyed. These two areas had the lowest number of taxa and abundance (Figure 4-3, Figure 4-4).

The most diverse communities in terms of number of taxa were at the Channel, followed by The Narrows, Reference Area and Passage Islands (Figure 4-3). The abundance of the benthic animals follows a similar pattern across these four locations but with more variability in the numbers of individuals collected at each of the sites within the locations (Figure 4-4). The prevalence of seagrass and algae was highest at Fisherman's Landing and Reference Area and least at The Narrows, Channel and Passage Islands (Figure 4-5). The prevalence of the marine flora was graphed separately as they were assigned a relative biomass.

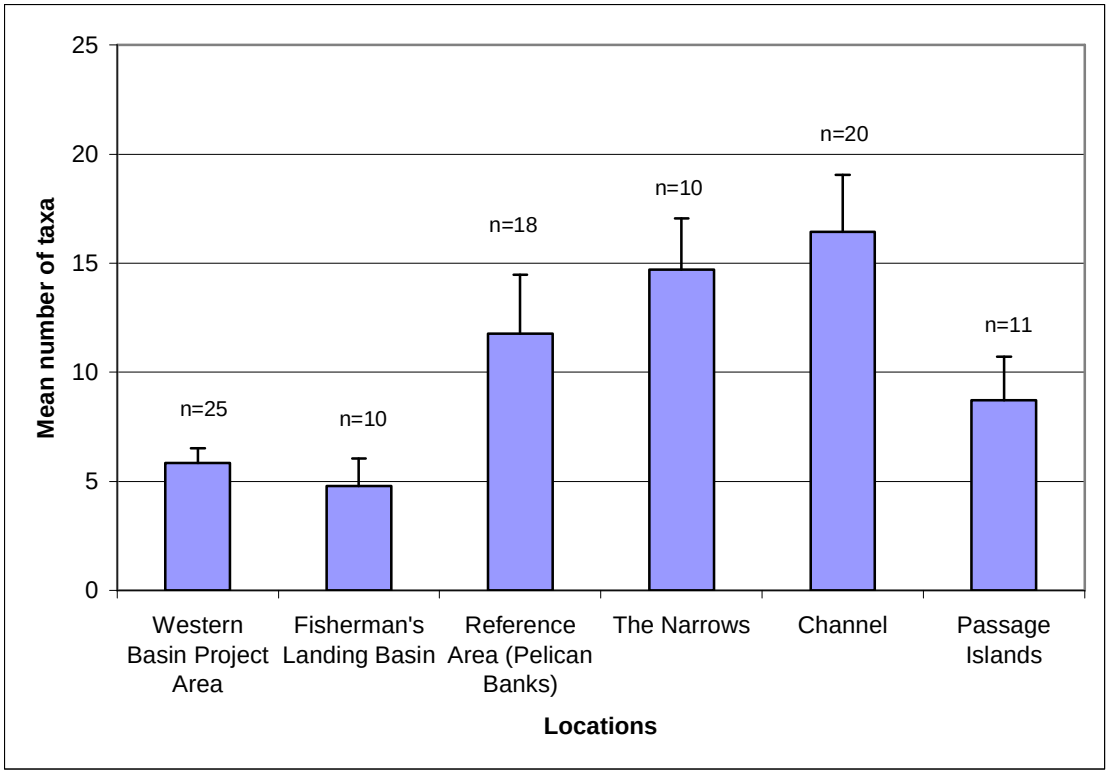


Figure 4-3 Mean (±se) Number of Taxa Observed Per Location

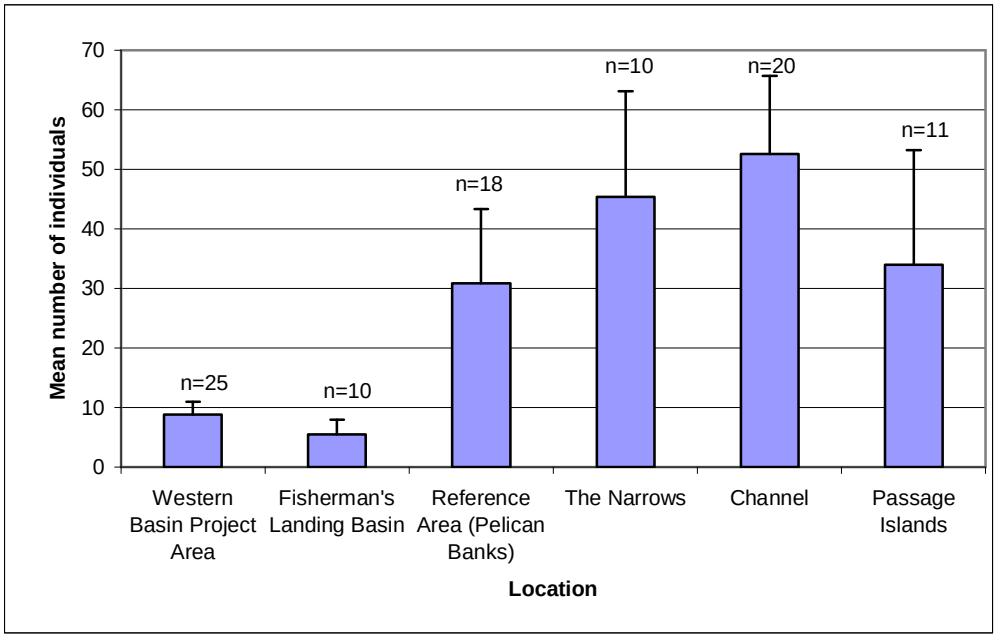


Figure 4-4 Mean (±se) Number of Individuals Observed Per Location

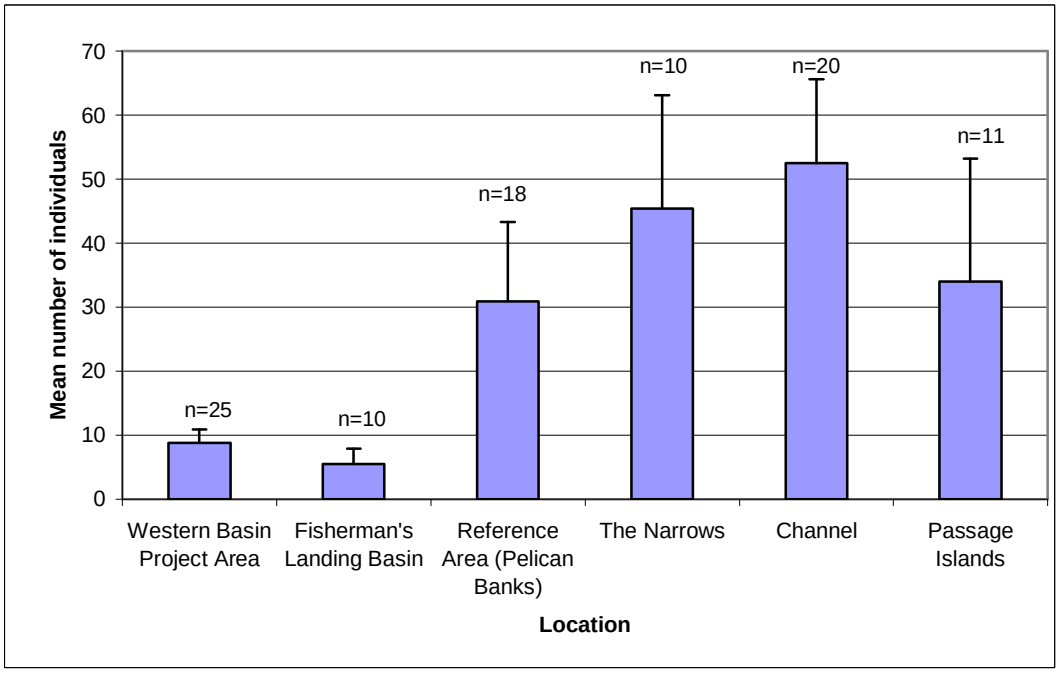


Figure 4-5 Mean (+se) Relative Abundance of Seagrass and Algae at Each Location

The long term benthic study of Port Curtis also found that Western Basin and Fisherman's Landing had the lowest richness and abundance with similar number of taxa and numbers of individuals. Over 8 years Alquezar and Small (2006) recorded, on average, six taxa per sample compared with six and five taxa per sample in Western Basin and Fisherman's Landing respectively observed in this study (Figure 4-3).

The long-term study recorded just slightly higher numbers of individuals with on average 12 per sample compared to nine and six for the Western Basin Project Area and Fisherman's Landing Basin respectively (Figure 4-4). The presence of the same number of taxa and similar numbers of individuals in this one off sampling event of the Western Basin Project Area to a nine year long term study confirms the validity of these findings and that the Western Basin Project Area is characterised over the long term by a fairly depauperate benthic subtidal community structure.

Previous work found that sediment type strongly influenced the Port Curtis benthic communities with the lowest species richness and abundance observed in the fine muddy intertidal areas (Currie and Small 2005). Although much of the Project Area surveyed with the sled was not within the intertidal zone, some areas were intertidal and the remainder are considered to be shallow water areas with fine muds and silts. The findings from this survey area therefore consistent with previous observations of a depauperate benthic community within this area.

Previous studies also reported that the benthic community of Port Curtis contained high species abundance and richness in coarse sandy sediments, which generally occurred in the deeper channels (Currie and Small 2005). This is also consistent with the findings of this study where the Channel showed the greatest predominance of coarse sediments, deepest sites and highest number of taxa and individuals. This finding also coincides well with the Rasheed *et al.* 2002 epibenthic study (reported in 2003) where the Channel areas were observed to have among the highest density benthic communities of the Port Curtis area; and in the present survey where a dominance of bivalves (particularly scallops), bryzoans, corals and sponges was also recorded (Figure 4-1, Appendix B).

4.1.3 Benthic Community Composition

The macroinvertebrate community composition (numbers of taxa, individuals and type of flora and fauna) differed among locations with the benthic communities at Western Basin, Fisherman's Landing and the Reference Area being more similar to one another and somewhat different from the communities at The Narrows, Channel and Passage Islands. This was indicated by the grouping of the sites from the first three locations and a grouping of the sites of the other three locations (Figure 4-6). The analysis of similarities (ANOSIM) in species abundance among the six locations confirmed this two-dimensional display of the relationship among sites (Figure 4-6). It indicated that the locations overlap with some similarities and differences among them (Global R=0.36). Further analysis (Pairwise R) indicated that the similarities in benthic communities were highest between Western Basin Project Area and Fisherman's Landing (R = 0.12) with the Reference Area also very similar to these two locations (with R scores of 0.29 and 0.19, respectively). It also revealed that the greatest differences were between the Channel communities and those at the three locations of Western Basin Project Area (R = 0.47); Fisherman's Landing (R = 0.74) and Reference Area (R = 0.55). The Channel communities were most similar to The Narrows (R = 0.18) and Passage Islands (R = 0.29).

The SIMPER analysis highlighted the species characteristic of the similar locations; in Western Basin Project Area, Fisherman's Landing and the Reference Area these were seagrass (*Zostera capricorni* and *Halophila ovalis*), green filamentous algae, bivalves (Corbulidae sp. 1, Veneridae sp.1 and *Venus* sp.1), gastropods (Cerithiidae sp.1) and hermit crabs (Diogenidae). Species characteristic of The Narrows, Channel and Passage Islands were bivalve scallops (*Chalmys* spp.), amphipod crustaceans, spider crabs (Majiidae spp.), gorgonian coral, bryozoans, hydrozoans, ascidians and polychaetes (Serpulidae sp. 1).

Results of multivariate analyses supports descriptions of the benthic community structure and taxonomic composition wherein:

- The communities in the Western Basin Project Area, Fisherman's Landing Basin and to a lesser extent Reference Area are more similar to one another; and
- These areas have fewer different kinds of animals present, lower numbers of taxa and lower abundance than those at the other three locations.

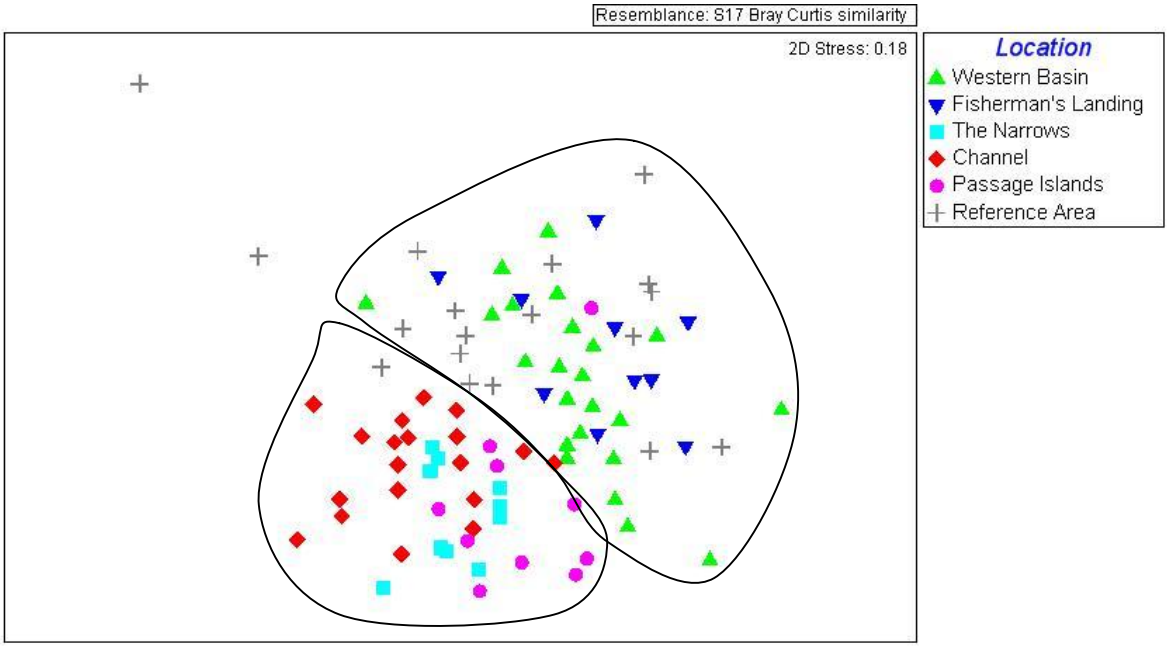


Figure 4-6 Multidimensional Scaling Ordination of All Sites by Location

When the dominant sediment types at each site are included on the MDS of the sites by location (Figure 4-7) the notion that community composition is tightly linked to sediments within the Study Area is supported. The Western Basin Project Area, Fisherman's Landing Basin and Reference Area are mostly comprised of fine muds and silt while the other three locations have more sand, shell and rubble.

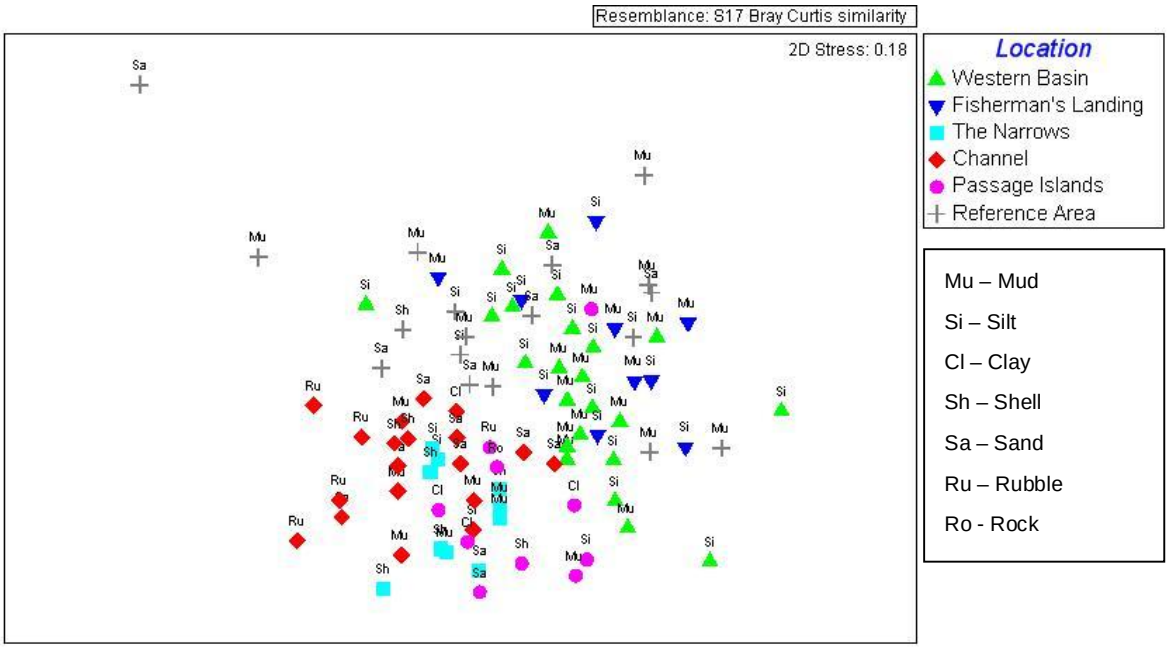


Figure 4-7 Multidimensional Scaling Ordination of Location with Dominant Sediment at Each Site

4.2 Seagrass and Algae

Four species of seagrass including *Zostera capricorni*, *Halodule uninervis* (wide and narrow), *Halophila spinulosa*, and *Halophila ovalis* were recorded at 33 sites (Figure 4-9). Examples of the seagrass collected during this survey are provided in Figure 4-8. Table 4-1 shows a breakdown of the species occurrences per location. *Zostera capricorni* was the most prevalent species, whilst the least prevalent species was *H. uninervis*.

The highest diversity of seagrass occurred in the Western Basin Project Area, Fisherman's Landing Basin and the Reference Area, which all contained three of the four species. The Channel and Passage Islands both contained one species of seagrass and no species were recorded in The Narrows (Table 4-1). Similarly, in decreasing order, the Reference Area, Fisherman's Landing Basin and Western Basin Project Area had highest relative abundance of seagrass, whilst the remaining sites had low or zero relative abundances.

Zostera capricorni | *Halodule uninervis* (wide) | *Halophila ovalis* | *Halophila spinulosa*

Figure 4-8 Examples of the Seagrass Collected During the Survey

Table 4-1 Seagrass Species Occurrence Per Location

	Western Basin	Fisherman's Landing	The Narrows	Channel	Passage Islands	Reference Area	Total
Z. capricorni	6	6	0	1	0	8	21
H. uninervis	0	0	0	0	0	8	8
H. spinulosa	6	2	0	0	2	0	10
H. ovalis	2	4	0	0	0	5	11

Twenty-three algal taxa, comprised of seven Chlorophyta (green algae), seven Phaeophyta (brown algae) and eight Rhodophyta (red algae), were recorded at 47 sites (Figure 4-9). Table 4-2 provides a breakdown of the algal taxa occurrences per location. The most prevalent taxa was a green filamentous algae that occurred at 28 sites.

The highest algal diversity occurred at the Reference Area which supported 17 taxa including seven brown, five green and five red. The Western Basin Project Area was observed to contain seven algal taxa (four red and three green alga). The Channel and The Narrows each contained three taxa, one of each type in the Channel and only red algae in The Narrows. Fisherman's Landing and The Passage Islands both contained two types of algae, one green and one red.

The highest relative algal abundances occurred at the Reference Area (most abundant) and Fisherman's Landing (second most abundant), the taxa driving this pattern were *Sargassum* sp. and green filamentous algae, respectively.

304,000 306,000 308,000 310,000 312,000 314,000 316,000 318,000 320,000 322,000 324,000 326,000 328,000 330,000

7,378,000 7,376,000 7,374,000 7,372,000 7,370,000 7,368,000 7,366,000 7,364,000 7,362,000

Worthington Island
Kangaroo Island
The Narrows
Graham Creek
Laird Point
Friend Point
Curtis Island
North Passage Island
South Passage Island
Facing Island
Compigne Is.
Boatshed Point
Hamilton Point
Turtle Is.
Tide Is.
Witt Is.
Diamantina Is.
Quoin Is.
Picnic Is.
Wiggins Is.
Fisherman's Landing Basin
GALLIOPE RIVER
AUCKLAND CREEK
GLADSTONE

INSET Scaled at 1:30,000

WESTERN BASIN

1:75,000 (at A3)

0 0.5 1 1.5 2

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

Seagrass & Algae Presence
- Seagrass
- Algae
- Seagrass & Algae
- No Seagrass or Algae

- Major Road
- Western Basin Reclamation Area
- Fisherman's Landing Northern Expansion
- Existing Channels, Swing Basins and Berths

Port of Gladstone
Western Basin Dredging and Disposal Project

Job Number	42-15386
Revision	A
Date	30 Aug 2009

Seagrass and Algae Presence/Absence

Figure 4-9

G:\42\15386\GIS\WesternBasinProjects\MXDs\42-15386_WB_308_rev_a.mxd

Level 4 201 Charlotte Street Brisbane QLD 4000 Australia **T** +61 7 3316 3000 **F** +61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

Table 4-2 Algae Taxa Occurrence Per Location

	Western Basin	Fisherman's Landing	The Narrows	Channel	Passage Islands	Reference Area	Total
Chlorophyta							
Udotea sp.	2	0	0	0	0	0	2
Halimeda sp.	0	0	0	0	0	2	2
Codium geppi	0	0	0	0	0	1	1
Caulerpa sp.	0	0	0	0	0	1	1
Acetabularia calyculus	0	0	0	0	0	1	1
Green Filamentous Algae	11	4	0	7	3	3	28
Unidentifiable Green Algae	2	0	0	0	0	0	2
Phaeophyta							
Dictyota sp.	0	0	0	1	0	6	7
Lobophora variegata	0	0	0	0	0	2	2
Padina sp.	0	0	0	0	0	2	2
Sargassum sp.	0	0	0	0	0	2	2
Hydroclathrus clathratus	0	0	0	0	0	1	1
Brown Filamentous Algae	0	0	0	0	0	1	1
Unidentified Brown Algae	0	0	0	0	0	5	5
Rhodophyta							
Champia parvula	0	0	0	0	0	2	2
Dasya sp.	1	0	1	0	0	0	2
Martensia fragilis	0	0	0	0	0	2	2
Chondria succulenta	2	0	0	0	0	5	7
Asparagopsis taxiformis	0	0	0	1	0	5	6
Red Filamentous Algae	2	0	1	0	2	1	6
Calcareous Algae (unidentified)	0	0	1	0	0	0	1
Unidentified Red Algae	1	1	0	0	0	0	2

4.3 Additional Marine Fauna Observations

4.3.1 Fish and Crabs

Of the 16 crab pot deployments five yielded no catch. The remaining 11 pots contained the following:

- Eight female Mud Crabs (*Scylla serrata*) ranging in size (carapace width) from 160 mm – 185 mm;
- One male Mud Crab (*Scylla serrata*) with a size of 165 mm;
- Five male Blue Swimmer Crabs (*Portunis pelagicus*) ranging in size from 100 mm – 155 mm;
- One female *Thalimita* sp. crab with a size of 55 mm;
- One male Tawny Shark (*Nebrius ferrugineus*) measuring 1 m in length; and
- One Cresent Grunter (*Terapon jarbua*) measuring 140 mm Total Length.

The cast netting recorded a total of 62 individuals from the following groups:

- Mullet (Mugilidae);
- Ponyfish (Leiognathidae);
- Whiting (Sillaginidae);
- Beach Salmon (Leptobramidae);
- Flathead (Platycephalidae);
- Grunter (Teraponidae);
- Herring (Clupeidae);
- Pufferfish (Tetraodontidae);
- Bream (Sparidae); and
- Red Legged Banana Prawn (*Peneaus indicus*).

The most abundant group caught was the Ponyfish (Leiognathidae), with 31 individuals being caught in a single cast. The site with the largest catch was the middle site within the Western Basin Project Area and the most diverse catch was recorded at the Graham Creek site (Figure 3-1). No fish were caught by the cast netting conducted at the Reference Area of Curtis Island.

4.3.2 Intertidal Surveys

From the intertidal surveys undertaken 52 different kinds of animals and plants were recorded within the Western Basin Project Area and Reference Area locations. Extensive crab burrows and mangrove prop roots were also noted. Observations and findings are comparable to those noted by URS (2009) during their recent intertidal field survey where 57 different taxa were observed. In this latest survey several dead individuals were observed and the origin of these cannot be determined. Lack of damage and erosion to the shells of these dead taxa indicate they are likely sourced locally from a nearby shallow subtidal environment. Records of these species are provided here with reference to describing the energy of beach environments from which the shells were recorded.

Laird Point represented a highly mobile environment with sands dominating the upper intertidal region and supporting the myrtle (*Osbornia octodonta*) and black (*Lumnitzera* sp.) mangroves. A few crab burrows were present in this location although no crabs or shells were able to be recovered, even from excavation of burrows, to enable identification of the potential species occupying these burrows. Mid-intertidally sandy muds were present overlayed with a high proportion of vegetation detritus. Extensive searching did not detect any live taxa within the mid-intertidal area although crab burrows were occasionally noted.

Dead bivalves from the Arciidae (*Trisidos tortuosa*), Pectinidae (*Chlamys* sp.) and Veneridae (*Venus* sp.) families were of high density on the lower intertidal region of this beach environment. Sandy muds were again overlaid by the shell and detritus matter. No crab burrows were observed in the lower intertidal region. *Cerithium* sp. and *Nerita chamaeleon* gastropods were, however, noted in low densities.

This was a depauperate beach environment likely reflecting the mobile nature of the sediments on this corner of Graham Creek. These observations were in accordance with findings by URS (2009).

The intertidal areas surveyed within the Western Basin Project Area presented a comparatively moderate diversity. In the upper intertidal reaches mangroves and sand banks were common. Mid-intertidal rocky outcrops were interspersed between mangrove stands. The rocky outcrops were heavily sedimented but supported a range of hard substrate taxa including bivalves (*Saccostrea cucculata, Parviperna* sp.), chitons (possibly *Acanthoplura gaimardi*) and gastropods (*Nerita costata and N. polita*). In the lower intertidal reaches mud flats were the dominant habitat with a fine mud/silt content to the sediment.

Mangroves present mid-intertidally on the seaward margin and were dominated by the red mangrove *Rhizophora stylosa.* Closer to the landward edge of the adjoining salt marsh other species were present including *Avicennia marina* and *Aegialitis annulata* (grey and club mangrove respectively). A full list of the mangroves present in the Project Area is available in the complementary Terrestrial Ecology report for this project. On the seaward margin macroinvertebrate species were supported on the trunks and leaves of the trees as well as on the mud around the base of the mangrove trees. *Euraphia withersi* (a barnacle) was common on the tree trunks and under side of leaves as were *Littoraria articulata* and *L. undulata* (periwinkle gastropods). Around the base of the trees *Telescopium telescopium* and *Terebralia semistratus* (mud creeper gastropods) and *Ulva* (a green algae) were common as were *Bembicium auratum* (a periwinkle). The tufts of green algae mid-intertidally were quite restricted in the are of shore on which they were present and this may indicate a regular input of nutrients and/or freshwater to this location.

Alpheidae snapping shrimp and mudskippers were noted between the mangroves and lower mud flat areas as were *Grapsid* crabs. The small baler like gastropod *Bulla* sp.1 was very common (present in hundreds) on the mid to lower intertidal mud flat as well as being interspersed around the base of the mangrove trees. *Cerithidea anticipata* (a mud creeper) was less common but also present. The lower shore was comprised of very soft silty muds and surveying beyond a few hundred meters towards the lowest tide mark was not considered safe. Some of these shallow intertidal habitats were sampled by sled during high tide.

As for Western Basin Project Area, the Curtis Island Reference Area also included a mix of rocky shore and sandy beach environments and, accordingly, included a similar habitat mix to that in Western Basin for comparative purposes. Being more seaward with coarser sands and cleaner waters there was a reduced component of silt/fine sands to the soft sediment environment and the rocky shore area was not as heavily sedimented as it was in Western Basin Project Area and extended across most of the intertidal zone. The red mangrove was, however, sparsely distributed through this sampling site and given the habitat similarities the Curtis Island Reference Area is considered appropriate for comparative purposes with the Project Area.

Given the extension of the rocky shore in the Reference Area across the entire intertidal zone and greater level of exposure it follows that it supported a greater mix of species than noted in Western Basin Project Area. In the upper intertidal regions in the Reference Area gastropods including *Nodilittorina pyramidalis, Bembicium auratum, Nerita costata* and *N. chamaeleon* were common (in the tens per square meter). *Littoria undulata* was also noted associated with the mangrove stands.

Mid intertidally in the Reference Area the rock oyster *Saccostrea cucculata* was common while *S. echinata, Isognomon* sp. and *Brachiodontes* sp. were also present but in lower numbers. Drilling predatory whelks (*Morula granulate* and *Thais* sp.) were sparsely distributed mid intertidally, however, other gastropods were numerous including *Cerithium* sp., *Planaxis sulcatus* and *Nerita* spp.

Grapsid rock crabs (*Grapsus* sp.), limpets (*Patelloidea cryptalirata*) and the barnacle *Chthalamus malayensis* were common in the mid and extended into the lower intertidal regions of this Reference Area. In the lower intertidal reaches the rocky shore graduated into a beach environment. At the point of transition between the rocky and sandy beach *Ralfsia* sp. (a red alga) was common and green turf algae was also observed.

Mud skippers and alpheid snapping shrimps were common on the lower intertidal sand banks of the Reference Area. Hermit crabs (Family Paguridae) and *Cerithidiea* sp. (F. Potamididae) were distributed in large numbers across both the lower and mid intertidal sandy habitats and evidence of stingrays was seen (resting scars) mid intertidally. Small swimming crabs (*Thalamita* sp.) were also infrequently observed in water pools but were too small to identify to species level *in situ*. Other species that were common across the intertidal sand flats included the following:

- Sipunculids (marine worms);
- Phyllodocida (a worm);
- *Polinices spp.* (moon snails);
- *Ocypode* sp. (ghost) crabs;
- *Mictyris* sp. (soldier) crabs;
- Leucosiidae crabs (too small to identify further);
- *Nassarius* sp. (scavenging gastropods);
- *Bulla* sp. (gastropods); and
- *Zostera capricornii* (seagrass, low density).

The upper and mid intertidal regions where rocky shore was absent were characterised by supporting coarse and fine sands and were relatively depauperate.

At this Reference Area Location small molluscs dominated both the rocky and sandy beach environments. Crustaceans, particularly small crabs, were also very common.

Across all sites the Reference Area had the highest diversity of intertidal animals supporting 38 of the 52 taxa recorded. The Western Basin Project Area was also quite diverse supporting 14 taxa. The Laird Point site was depauperate in comparison supporting only seven taxa.

Assemblages present in the Western Basin Project Area appear to be similar to those located elsewhere in the Gladstone region and were not observed to support any unique species.

4.4 Invasive Marine Pests

During all benthic ecology survey activities care was taken to examine species sampled to determine if they were potential marine pests. Of the taxa sampled only bivalves belonging to the familes Mytilidae and Corbulidae closely resembled potential marine pests of concern for the Gladstone region. These species were examined following the field work to enable further clarification of their status and all were

determined to not be introduced marine pest taxa. Accordingly, no introduced marine pest taxa were detected during any phase of the benthic ecology sampling across the Port Curtis area.

4.5 Listed Rare and Threatened Species and Incidental Observations

4.5.1 EPBC Act Protected Matters Online Search Tool results

A search using the EPBC Act Protected Matters Online Search Tool returned a number of marine threatened and migratory species of National Environmental Significance (NES) in the Study Area. This included nine NES, 13 migratory and 52 Other Protected Matter species.

- National Environmental Significance:
  - Whales – two species (endangered and vulnerable);
  - Turtles – five species (endangered and vulnerable); and
  - Sharks – two species (vulnerable).
- Migratory species:
  - Whales – four species;
  - Dugong – one species;
  - Dolphin – one species;
  - Turtles – five species;
  - Crocodiles – one species; and
  - Sharks – one species.
- Other protected matters:
  - Dugong – one species;
  - Pipehorse – three species
  - Pipefish – 21 species;
  - Seahorses – one species;
  - Seasnakes – 10 species;
  - Kraits – two species;
  - Turtles – five species;
  - Crocodiles – one species;
  - Whales – five species; and
  - Dolphins – three species.

The habitat requirements of the species identified in the searches and an assessment of the availability of that habitat in the Study Area is summarised in Table 4-3. The full EPBC Protected Matters Search Tool results are provided in Appendix C.

This survey was not designed to provide data on marine megafauna including turtles, rays, dugong and dolphins. Given the mobility and specific importance of these species a dedicated sampling program has been conducted to inform the EIS of the presence, prevalence and usage of the study area by these species. Findings from that study are described in the Marine Megafauna Assessment (Appendix R of the main EIS) to complement information provided here.

Matters relating to terrestrial ecology (including birds, terrestrial mammals, plants, etc.) are addressed in the complementary Terrestrial Ecology Assessment (Appendix P of the main EIS).

4.5.2 Wildlife Online search results

The Wildlife Online search results are presented in Appendix D. Twenty two species of fish and one stingray were listed in the search none of which are assigned Queensland conservation status under the Nature Conservation Act 1992.

4.5.3 Queensland Museum database search results

The Queensland Museum database search results on marine mammals and reptiles returned twelve species (Appendix E). The two turtle species (green turtle *Chelonia mydas* and flatback turtle *Nattator depressus*) and two mammal species (humpback whale *Megaptera novaeangliae* and dugong *Dugong dugong)* are of conservation significance under the NC Act. These species are listed in Table 4-3, with a brief habitat description and an assessment of the extent to which habitat requirements for that species are present in the Study Area. Of these only the green turtle was observed during this survey. The other reptiles were eight species of sea snake, three of which are listed marine species under Other Matters Protected by the EPBC Act (*Aipysurus eydouxii, Aipysurus laevis and Hydrophis elegans*; Appendix B). As described below a sea snake, possibly (*Aipysurus laevis*) was observed once during the survey.

The Queensland Museum database search results on fish returned 134 fish species, three seahorse and two sharks. One of the species of fish, the estuary cod *Epinephelus coioides*, is listed in a report of threatened and potentially threatened Australian marine and estuarine fishes. It is assigned the IUCN conservation category of Lower Risk and least concern. The three species of seahorse were *Filicampus tigris*, *Hippocampus hendriki* and *Hippocampus multispinus*, the first of which is a listed marine species under Other Matters Protected by the EPBC Act with the other two Listed Marine Species under the EPBC Act. None of these species of concern were observed during the survey. A seahorse was, however, observed and that finding is noted below.

4.5.4 Incidental observations

Marine Reptiles

Turtles, NES species, were sighted 14 times over four non-consecutive days of the survey at all locations surveyed, except the Channel (Figure 4-10). A number green turtles (*Chelonia mydas*), both adults and juveniles, were sighted as were a number of unidentifiable turtles. The following sightings were made:

- 2nd June, afternoon;
  - One adult at Laird Point;
  - One adult in the Western Basin Project Area;
- 4th June, midday;
  - One adult in Passage Islands;
- 5th June, morning;
  - One adult in the Western Basin Project Area;
- 5th June, midday;

- Between 9 – 11 juvenile and adult turtles were close together in the northern area of Western Basin Project Area;

- 5th June, afternoon;
  - One juvenile in The Narrows;
- 6th June, morning;
  - Up to 17 repeated sightings of at least six adult turtles in Fisherman's Landing Basin; and
  - One juvenile in the Reference Area.

Sea snakes are listed as other protected matter species and a sea snake was observed mid morning in the Western Basin Project Area (Figure 4-10). It was possibly an olive sea snake (*Aipysurus laevis*) although the identification is not certain. No other listed under the EPBC Act were observed during the surveys.

Marine Mammals

The EPBC Act lists IndoPacific Humpback Dolphin (*Sousa chinensis)* as a migratory marine species. The EPBC Act Protected Matters Online Search Tool did not report that this species is likely to occur in the area, however despite this, a number of individuals were sighted during the survey period (Figure 4-10), including:

- 3rd June there were four sightings in the morning;
  - One adult dolphin in the Gladstone Marina entrance;
  - One adult in the Channel location;
  - Eight adults and one juvenile feeding on bait fish in the Channel; and
  - Four adults feeding in the Western Basin Project Area;
- 4th June there were two sightings;
  - Six in the Western Basin Project Area in the morning; and
  - Two adults at the Passage Islands in the early afternoon;
- 5th June one sighting in the afternoon of a juvenile and adult at Passage Islands;
- 7th June there were two sightings;
  - Two adults and a juvenile in the morning near Diamantia Island; and
  - Two adults feeding in the Reference Area.

Another dolphin species, Bottlenose Dolphin (*Tursiops truncatus*), listed as a cetacean protected by the EPBC Act, was sighted in the Channel on the morning of the 3rd June feeding on baitfish.

Ray-finned Fishes

Seahorses and pipefish are listed marine species under the EPBC Act. One low-crown seahorse (*Hippocampus dahli*) was collected during the macroinvertebrate benthic survey. It was present at a Channel site located in front of the middle of the Bay to the south of Fisherman's Landing Basin at a depth of 10 m in coarse sand and shell substrate. This seahorse has an Indo-Pacific distribution and occurs in north-eastern Australia between Moreton Bay and Darwin in shallow waters on rubble substrates and is tolerant of brackish waters. The IUCN Red List Status for the low-crowned seahorse is Vulnerable (http://www.iucnredlist.org/search). Its' resilience or capacity to withstand exploitation is reported to be high though it is vulnerable to extinction (Froese and Pauly, 2009).

Table 4-3 Summary of Desktop Study Results for Species of National Environmental Significance

Scientific Name	Common Name	Source	EPBC Act status	NC Act status	Survey Status*	Habitat requirements of this species	Preferred habitat availability on site
Marine mammals							
Balaenoptera musculus	Blue Whale	EPBC Protected Matters Search	Endangered, Migratory (Bonn), Cetacean	Not Listed	Not detected	This species occurs in southern Australian and Antarctic waters during the summer months and migrates to unknown tropical breeding grounds during the winter months (Van Dyck and Strahan 2008).	Habitat suitable to this species was present within the study area although depth in immediate study area restrictive.
Megaptera novaeangliae	Humpback whale	EPBC Protected Matters Search	Vulnerable, Migratory (Bonn), Cetacean	Vulnerable	Not detected	Two out of seven recognised southern hemisphere populations spend winter in warm shallow northern Australian waters where species breeds (Van Dyck and Strahan 2008).	Habitat suitable to this species was present within the study area although depth in immediate study area restrictive.
Marine reptiles							
Natator depressus	Flatback turtle	EPBC Protected Matters Search	Vulnerable, Migratory (Bonn), Marine	Vulnerable	Not detected	Restricted distribution in Australia between the Kimberleys in Western Australia and Queensland's east coast where it feeds on soft corals, sea cucumbers, and jellyfish (Wilson and Swan 2003).	Habitat suitable to this species was present within the study area.

Scientific Name	Common Name	Source	EPBC Act status	NC Act status	Survey Status*	Habitat requirements of this species	Preferred habitat availability on site
Chelonia mydas	Green turtle	EPBC Protected Matters Search	Vulnerable, Migratory (Bonn), Marine	Vulnerable	36-38 animals observed during survey (refer to Figure 4-10 for locations).	Warm temperate to tropical marine areas. Juveniles carnivorous and adults graze sea grasses and seaweeds (Wilson and Swan 2003).	Habitat suitable to this species was present within the study area
Caretta caretta	Loggerhead turtle	EPBC Protected Matters Search	Endangered, Migratory (Bonn), Marine	Endangered	Not detected	Warm temperate to tropical marine areas world wide and Australian distribution. Eats mainly marine invertebrates (Wilson and Swan 2003).	Habitat suitable to this species was present within the study area.
Lepidochelys olivacea	Olive ridley turtle	EPBC Protected Matters Search	Endangered, Migratory (Bonn), Marine	Endangered	Not detected	Tropical oceans of Atlantic, Indian and Pacific. Australian distribution restricted to Northern Territory and Cape York Peninsula where it has limited breeding and can access prey such as shellfish (Wilson and Swan 2003).	Habitat suitable to this species was present within the study area but outside the range of distribution.

Scientific Name	Common Name	Source	EPBC Act status	NC Act status	Survey Status*	Habitat requirements of this species	Preferred habitat availability on site
Dermochelys coriacea	Leatherback turtle	EPBC Protected Matters Search	Endangered, Migratory (Bonn), Marine	Endangered	Not detected	Open ocean areas from temperate to tropical regions. Breeding occurs in mid-eastern Queensland, eastern Malaysia and Central America. Eats mainly gelatinous marine invertebrates (Wilson and Swan 2003).	Preferred habitat not available within the study area.
Eretmochelys imbricata	Hawksbill turtle	Not Detected[#]	Vulnerable, Migratory (Bonn), Marine	Not listed	Not detected	Open ocean areas around the world from temperate to tropical areas favouring rocks and reefs where it feeds on sponges, sea grasses, soft corals and mollusks (Wilson and Swan 2004).	Habitat suitable to this species was present within the study area although rocky subtidal substrate not recorded except for the breakwaters.
Acalyptophis peronii	Horned Seasnake	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Occurs in sandy areas near coral reefs from the north west coast of Western Australia to New Caledonia (Wilson and Swan 2003).	Preferred habitat not available within the study area.

Scientific Name	Common Name	Source	EPBC Act status	NC Act status	Survey Status*	Habitat requirements of this species	Preferred habitat availability on site
Aipysurus duboisii	Dubois' Seasnake	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Occurs at reef flats and coral reefs to depth of approximately 50 m in northern Australia, New Guinea and New Caledonia waters (Wilson and Swan 2003).	Preferred habitat not available within the study area.
Aipysurus eydouxii	Spine-tailed Seasnake	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Occurs in turbid waters in northern Australia, New Guinea and south east Asia, usually between depth of 30 m - 50 m (Wilson and Swan 2003).	Habitat suitable to this species was present in the study area.
Aipysurus laevis	Olive Seasnake	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Occurs on coral reefs in northern Australia, ranging from Exmouth in Western Australia to the central coast of New South Wales (Wilson and Swan 2003).	Preferred habitat not available within the study area.
Astrotia stokesii	Stokes' Seasnake	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Widespread in turbid coastal waters and coral reefs of northern Australia (Wilson and Swan 2003).	Habitat suitable to this species was present in the study area.

Scientific Name	Common Name	Source	EPBC Act status	NC Act status	Survey Status*	Habitat requirements of this species	Preferred habitat availability on site
Disteira major	Olive-headed Seasnake	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Occurs in turbid deep coastal waters of northern Australia and southern New Guinea (Wilson and Swan 2003).	Habitat suitable to this species was present in the study area.
Emydocephalus annulatus	Turtle-headed Seasnake	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Patchily distributed in shallow water on coral reefs in northern Australia (Wilson and Swan 2003).	Preferred habitat not available within the study area.
Hydrophis elegans	Elegant Seasnake	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Occurs in deep turbid waters and deep water between reefs from southern Western Australia to New South Wales (Wilson and Swan 2003).	Preferred habitat not available within the study area.
Lapemis hardwickii	Spine-bellied Seasnake	EPBC Protected Matters Search	Marine	Not Listed	Not detected	A widespread species, found in habitats ranging from clear reefs to turbid estuaries (Wilson and Swan 2003).	Habitat suitable to this species was present in the study area.
Laticauda colubrina	Sea krait	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Found in India and Sri Lanka to islands of the south west Pacific. This species rarely strays into Australian waters (Wilson and Swan 2003).	Preferred habitat not available within the study area. Study area outside the range of distribution of this species.

Scientific Name	Common Name	Source	EPBC Act status	NC Act status	Survey Status*	Habitat requirements of this species	Preferred habitat availability on site
Laticauda laticaudata	Sea krait	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Found in India and Sri Lanka to islands of the south west Pacific (Wilson and Swan 2003).	Preferred habitat not available within the study area. Study area outside the range of distribution of this species.
Pelamis platurus	Yellow-bellied Seasnake	EPBC Protected Matters Search	Marine	Not Listed	Not detected	This species of sea snake is the most widespread, occupying all tropical and subtropical seas except the Atlantic, primarily inhabiting open seas rather than continental shelves (Wilson and Swan 2003).	Preferred habitat not available within the study area.

Scientific Name	Common Name	Source	EPBC Act status	NC Act status	Survey Status*	Habitat requirements of this species	Preferred habitat availability on site
Threatened sharks							
Pristis zijsron	Green sawfish	EPBC Protected Matters Search	Vulnerable	Not Listed	Not detected	Australian distribution is from Broome in Western Australia and Jervis Bay in New South Wales. Currently the species is thought only to occur to the north of Cairns in estuarine and river mouths, embankments and beaches. Prey is hunted actively throughout the day on the bottom of the water in the mud and this species has been found in depths from 1m to 70m.	Habitat suitable to this species was present within the study area but outside the range of distribution.

Scientific Name	Common Name	Source	EPBC Act status	NC Act status	Survey Status*	Habitat requirements of this species	Preferred habitat availability on site
Rhincodon typus	Whale shark	EPBC Protected Matters Search	Vulnerable, Migratory (Bonn)	Not Listed	Not detected	Found in oceanic waters of 124 countries between latitudes 30°N and 35°S. Critical habitat in Australia includes Ningaloo Reef in Western Australia, the Coral Sea and Christmas Island. Areas with high nutrient levels and seasonal availability of tropical krill and baitfishes may form critical habitat (DEWHA 2007).	Preferred habitat not available within the study area.

Scientific Name	Common Name	Source	EPBC Act status	NC Act status	Survey Status*	Habitat requirements of this species	Preferred habitat availability on site
Migratory marine mammals							
Balaenoptera edeni	Bryde's whale	EPBC Protected Matters Search	Migratory (Bonn), Cetacean	Not Listed	Not detected	Coastal waters of much of Australia and southern Africa where it searches for baitfish (Van Dyck and Strahan 2008).	Habitat suitable to this species was present within the study area although depth in immediate study area restrictive.
Dugong dugon	Dugong	EPBC Protected Matters Search, Wildlife Online	Migratory (Bonn), Marine	Vulnerable	Not detected	Marine habitats with shallow nutrient rich water with silt allowing intact sea grass meadows to grow. Distributed from coastal Shark Bay in Western Australia to Moreton Bay in Queensland (Van Dyck and Strahan 2008).	Habitat suitable to this species was present within the study area.
Orcaella brevirostris / Orcaella heinsohni	Irrawaddy dolphin/ Australian snubfin dolphin	EPBC Protected Matters Search	Migratory (Bonn), Cetacean	Rare	Not detected	Not exclusively Australian this genus is also represented in New Guinea. In Australia this species occurs in shallow coastal areas often near estuary and river mouths from southern Queensland to mid to northern Western Australia (Van Dyck and Strahan 2008).	Habitat suitable to this species was present within the study area.

Scientific Name	Common Name	Source	EPBC Act status	NC Act status	Survey Status*	Habitat requirements of this species	Preferred habitat availability on site
Sousa chinensis	Indo-Pacific humpback dolphin	Not Detected[#]	Migratory (Bonn), Cetacean	Rare	Detected	Occurs in coastal and estuarine areas in association with rocky reef areas. Food is comprised of fish and the range of this species in Australia is shrinking (Van Dyck and Strahan 2008).	Habitat suitable to this species was present within the study area.
Orcinus orca	Killer whale	EPBC Protected Matters Search	Migratory (Bonn), Cetacean	Not Listed	Not detected	Occurs throughout the worlds oceans. Marine mammals provide much of the food required by the Killer Whale (Van Dyck and Strahan 2008).	Preferred habitat not available within the study area.
Migratory Marine Reptiles							
Crocodylus porosus	Estuarine crocodile	EPBC Protected Matters Search	Migratory (Bonn), Marine	Vulnerable	Not detected	Coastal rivers, swamps, inland rivers, open sea (Wilson and Swan, 2003).	Habitat suitable to this species was present within the study area.

Scientific Name	Common Name	Source	EPBC Act status	NC Act status	Survey Status*	Habitat requirements of this species	Preferred habitat availability on site
Listed Cetaceans							
Balaenoptera acutorostrata	Minke whale	EPBC Protected Matters Search	Cetacean	Not Listed	Not detected	This species has been recorded throughout Australian waters excluding the Northern Territory. Although tropical waters are generally avoided by this species, the dwarf form is often encountered in the Great Barrier Reef.	Preferred habitat not available within the study area.
Delphinus delphus	Common dolphin	EPBC Protected Matters Search	Cetacean	Not Listed	Not detected	This species occurs in the Indian, Pacific and Atlantic Oceans where they inhabit coastal and oceanic environments (Van Dyck and Strahan 2008)	Habitat suitable to this species was present within the study area.
Grampus griseus	Risso's dolphin	EPBC Protected Matters Search	Cetacean	Not Listed	Not detected	This species is primarily a deepwater species and is patchily distributed worldwide in tropical to temperate seas (Van Dyck and Strahan 2008).	Preferred habitat not available within the study area.
Stenella attenuata	Spotted dolphin	EPBC Protected Matters Search	Cetacean	Not Listed	Not detected	This species occupies outer shelf and continental slope areas of tropical and subtropical waters (Van Dyck and Strahan 2008).	Preferred habitat not available within the study area.

Scientific Name	Common Name	Source	EPBC Act status	NC Act status	Survey Status*	Habitat requirements of this species	Preferred habitat availability on site
Tursiops aduncus	Indian Ocean bottlenose dolphin	EPBC Protected Matters Search	Cetacean	Not Listed	Not detected	This species occupies shallow inshore habitats in tropical and temperate waters of the Pacific and Indian Ocean (Van Dyck and Strahan 2008).	Habitat suitable to this species was present within the study area.
Tursiops truncatus	Bottlenose dolphin	EPBC Protected Matters Search, Wildlife Online	Cetacean	Common	One individual observed during survey (refer to Figure 4-10 for location).	This species is distributed worldwide in deep coastal waters of tropical and temperate regions. It is only rarely sighted in shallow coastal waters and estuaries (Van Dyck and Strahan 2008).	Preferred habitat not available within the study area.
Ray-finned Fishes							
Acentronura tentaculata	Hairy Pygmy Pipehorse	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.
Campichthys tryoni	Tryon's Pipefish	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.

Scientific Name	Common Name	Source	EPBC Act status	NC Act status	Survey Status*	Habitat requirements of this species	Preferred habitat availability on site
Choeroichthys brachysoma	Pacific Short-bodied Pipefish	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.
Corythoichthys amplexus	Fijian Banded Pipefish	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.
Corythoichthys flavofasciatus	Yellow-banded Pipefish	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.
Corythoichthys intestinalis	Australian Messmate Pipefish	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.
Corythoichthys paxtoni	Paxton's Pipefish	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.

Scientific Name	Common Name	Source	EPBC Act status	NC Act status	Survey Status*	Habitat requirements of this species	Preferred habitat availability on site
Corythoichthys schultzi	Schultz's Pipefish	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.
Doryrhamphus excisus	Indian Blue-stripe Pipefish	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.
Filicampus tigris	Tiger Pipefish	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.
Halicampus dunckeri	Red-hair Pipefish	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.
Halicampus grayi	Mud Pipefish	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.

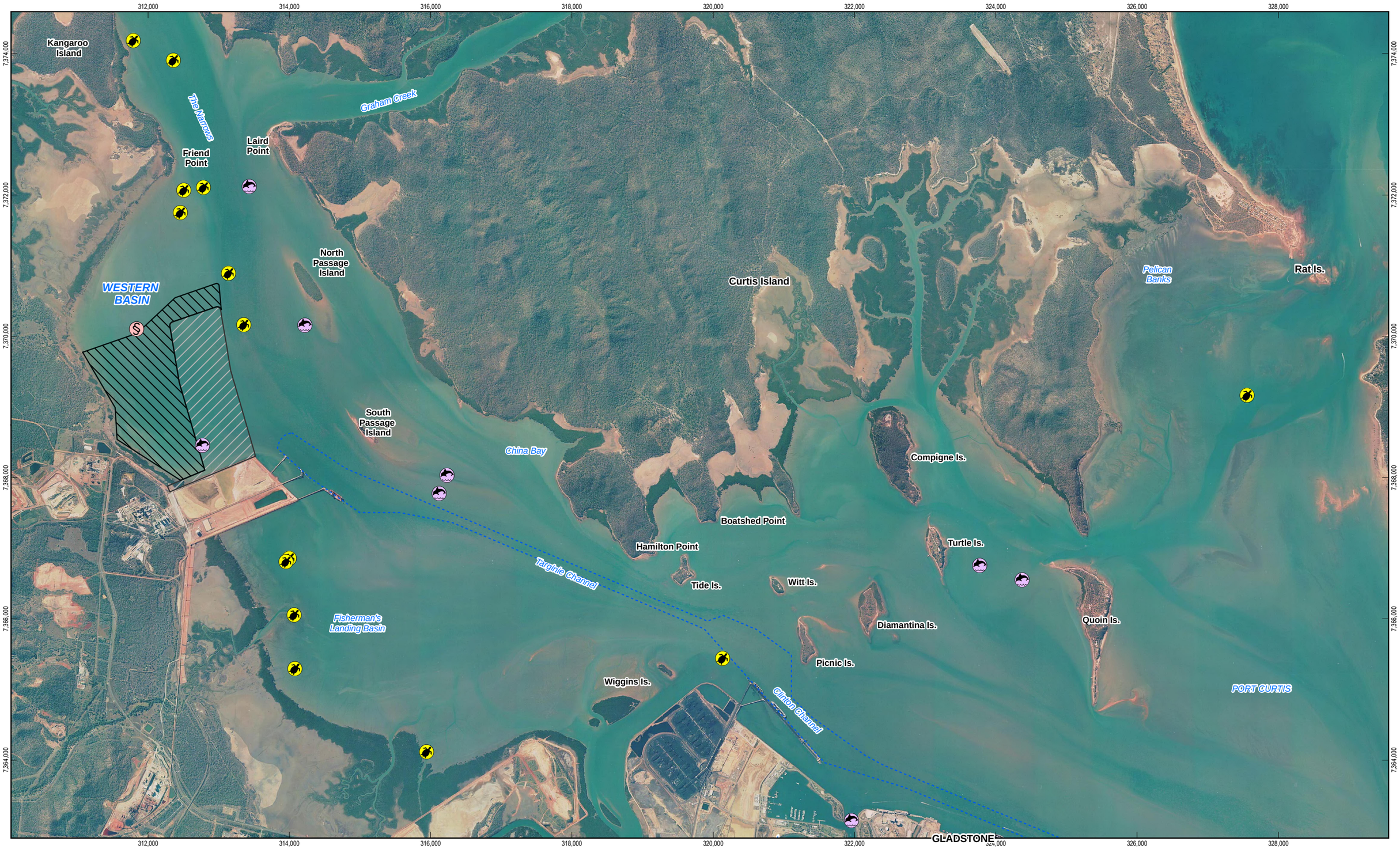
Scientific Name	Common Name	Source	EPBC Act status	NC Act status	Survey Status*	Habitat requirements of this species	Preferred habitat availability on site
Halicampus nitidus	Glittering Pipefish	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.
Halicampus spinirostris	Spiny-snout Pipefish	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.
Hippichthys heptagonus	Madura Pipefish	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.
Hippichthys penicillus	Beady Pipefish	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.
Hippocampus kuda	Spotted Seahorse	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.

Scientific Name	Common Name	Source	EPBC Act status	NC Act status	Survey Status*	Habitat requirements of this species	Preferred habitat availability on site
Lissocampus runa	Javelin Pipefish	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.
Micrognathus andersonii	Anderson's Pipefish	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.
Micrognathus brevirostris	Thorn-tailed Pipefish	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.
Nannocampus pictus	Painted Pipefish	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.
Solegnathus hardwickii	Pipehorse	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.

Scientific Name	Common Name	Source	EPBC Act status	NC Act status	Survey Status*	Habitat requirements of this species	Preferred habitat availability on site
Solenostomus paradoxus	Harlequin Ghost Pipefish	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.
Syngnathoides biaculeatus	Double-ended Pipehorse	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.
Trachyrhamphus bicoarctatus	Bend Stick Pipefish	EPBC Protected Matters Search	Marine	Not Listed	Not detected	Little is known about this species' habitat requirements, however coral and weedy habitats are recognised as important.	Habitat suitable to this species was present within the study area.

* Incidental sightings during benthic marine ecology survey. For detailed megafauna sightings refer to Marine Megafauna Assessment (Appendix R of the main EIS).

Species not detected during EPBC Protected Matters Search for this project but detected by previous searches and included as they are recognised to be of importance to the study area.



1:50,000 (at A3)

0 0.5 1 1.5 2

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

Incidental Sightings

- Dolphin
- Seasnake
- Turtle

- Western Basin Reclamation Area
- Fisherman's Landing Northern Expansion
- Existing Channels, Swing Basins and Berths

Port of Gladstone
Western Basin Dredging and Disposal Project

Incidental Sightings of Marine Megafauna

Job Number	42-15386
Revision	A
Date	30 Aug 2009

Figure 4-10

G:\42\15386\GIS\WesternBasinProjects\MXDs\42-15386_WB_309_rev_a.mxd

Level 4 201 Charlotte Street Brisbane QLD 4000 Australia **T** +61 7 3316 3000 **F** +61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

4.6 Results Summary

The Project Area supports a number of key marine benthic habitats, some of which are unique within the Study Area with regard to the species compositional mix they support. The majority of which are, however, well represented within the Study Area. The assemblages sampled reflected the variety of benthic habitats observed during the survey.

The Western Basin and Fisherman's Landing sites were dominated by soft silty, muddy benthic habitats supporting communities that were similar in their composition. The Reference Area, The Narrows and the Passage Islands sites all supported a mixture of sediment types across the sites but typically any individual site was characterised by a dominant type of sediment, such as sand or shell and the community composition at each site was reflective of this. The Channel sites, however, had the most diverse sediments on a site by site basis with no silty sediments and a dominance of coarse sand, rubble and some rock.

Benthic macroinvertebrate communities across the Project Area were characterised by a moderate species richness and abundance compared with the previous long-term nine year benthic survey of Port Curtis (Alquezar and Small, 2006); with a total of 2,710 individuals from 244 taxa collected from the six sampling locations. Across all the locations molluscs were the dominant group accounting for 28% of the taxa, followed by crustaceans (18%); polychaetes, echinoderms and algae (each at 9%); corals and anemones (8%); ascidians (6%); sponges (5%); bryozoans (4%); and seagrass and fish (each at 2%).

The taxonomic composition of the macroinvertebrate benthic communities were fairly similar to one another at Western Basin, Fisherman's Landing and the Reference Area where around half of all the organisms present were molluscs and crustaceans with seagrass and algae also very prevalent. These communities differed from those at The Narrows, Channel and Passage Islands, where a greater diversity and different type of assemblage was observed. These other locations supported less seagrass and algae and more echinoderms, corals and anemones, bryozoans, ascidians and sponges. Western Basin and Fisherman's Landing had the least diverse communities of all locations surveyed.

During the study seagrasses were noted from 33 sites. A total of four species of seagrass were sampled including *Zostera capricorni*, *Halodule uninervis* (wide and narrow), *Halophila spinulosa*, and *Halophila ovalis*. *Zostera capricorni* was the most prevalent species, whilst the least prevalent species was *H. uninervis*. Twenty-three algal taxa, comprised of seven Chlorophyta (green algae), seven Phaeophyta (brown algae) and eight Rhodophyta (red algae), were recorded and these were in mixed composition across 47 sites.

The highest diversity of seagrass occurred in the Western Basin Project Area, while the highest diversity of algae occurred at the Reference Area. The Western Basin Project Area was observed to contain seven algal taxa (four red and three green alga). While these species were generally also found elsewhere within the Study Area, the seagrass complex sampled within Western Basin was unique to that site in its composition and relative abundance.

The Study Area supported healthy populations of fishery and recreationally targeted species of blue swimmer and mud crabs as well as supporting a range of fish taxa. Although widely distributed, these taxa were more prevalent within the Project Area.

The intertidal areas surveyed within the Western Basin Project Area were characterised in upper intertidal reaches by mangroves and sand banks. Mid-intertidal rocky outcrops were interspersed between mangrove stands. The rocky outcrops were heavily sedimented but supported a range of hard

substrate taxa including oysters, chitons and gastropods. In the lower intertidal reaches mud flats dominated with a fine mud/silt content to the sediment. All communities observed intertidally were well represented elsewhere within the Study Area.

No introduced marine pest taxa were detected during any phase of the marine ecology sampling across the Port Curtis area.

A number of species of conservation significance were observed as incidental sightings during the marine benthic ecology survey. A targeted Marine Megafauna Assessment details these communities for the Study Area and should be referred to for complete understanding of the presence of these species (Appendix R of the main EIS). However, during the benthic study humpback and bottlenose dolphins, green turtles, a tawny shark, a sea snake and a seahorse were observed from a range of sites, including those proposed for direct impact by the Project.

The green turtles and dolphins were highly prevalent within the direct footprint of the Project Area, which is also where the shark was noted. The seahorse was adjacent to the shipping channel and associated with coral and sponge communities. This area will also be directly impacted by dredging works during channel widening.

Habitat for a number of other listed species of conservation significance, marine mammals and reptiles, present in the Study Area will also be directly impacted by the Project. Although not detected during this study, a number of these species may use the area from time to time. Reference should be made to the complementary Marine Megafauna Assessment (Appendix R of the main EIS) for full understanding of the relative importance of these habitats for these species.

The Project is expected to impact on the marine communities described within the Project Area as a result of direct habitat removal from dredging and reclamation works and as indirectly as a result of offsite impacts including declines in water and sediment quality. Expected impacts from the Project activities are described in the following Section. In order to appropriately address the potential impacts and any relevant mitigation measures an impact risk assessment has been undertaken and is discussed in detail in Section 5.

5. Potential Impacts and Risk Assessment

5.1 Project Activities

The Western Basin Dredging and Disposal Project is expected to require the following works:

- Construction of a rock revetment bund;
- Reclamation of land;
- Dredging to deepen and widen existing channels;
- Dredging of new channels, swing basins, berth pockets;
- Installation of navigational aids; and
- Rehandling of dredge materials into the reclamation.

Construction of the reclamation will commence with the building of a bund wall. This bund will be lined with geofabric material to reduce the potential for leaching of fine sediments back into the marine environment through the bund wall during reclamation and dewatering works. Rehandling of some dredged material (i.e. that collected by a trailer suction hopper dredger), is expected to be required. Dredged material will be deposited adjacent to the eastern face of the bund before being rehandled into the Reclamation Area.

The positioning of the reclamation works will create a tidally influenced channel on the western side of the reclamation works adjacent to the existing soft sediment, mangrove fringed, shoreline. The channel is proposed to be 40 m in width from the edge of the mangroves to the revetment.

To assist with navigation through the newly created shipping channels, additional channel markers will be established. For the purposes of this Project a number of new navigational aids will be installed. These are described in the main body of the EIS under Table 2-10. Each pile marker is to be pile driven (not to refusal) at an anticipated rate of one per day and to an approximate depth of 6 – 8 m and each marker buoy positioned using a concrete mass to provide anchorage.

Dredging activities for the channels are expected to occur in three phases. These are identified on Figure 5-1. Stages 1A and 1B are expected to be dredged from late 2010 to 2012 (over a period of two years). Stage 2 is expected to commence in 2014 and require a period of 12 months to complete. Stages 3 and 4 will be dredged as required to meet market demand. It is expected that cutter suction dredging plant will be used for the majority of works with a trailer suction hopper dredger required for some works in Stage 1A in the Clinton Bypass channel area and Stage 1B.

As noted in the complementary Water Quality Report for this EIS (Appendix K of the main EIS), limited offsite water quality impacts are expected from cutter suction dredger operation. However, the trailer suction dredge plant will likely produce extensive plumes which will, depending on the tide, extend up to The Narrows and out to Barney Point. The Numerical Modelling Report and Water Quality Report (Appendices J and K of the main EIS) provide further information on the sediment loads expected and plume dispersion that may potentially be experienced in Port Curtis under different dredging scenarios associated with this project. Hydrodynamic modelling of the Western Basin Project dredging works was assessed against a range of dredging scenarios, which included:

- Scenario 1 – Stage 1A and part of 1B: Clinton bypass channel to -13 m LAT; Spur channel to China Bay, China Bay Swing Basins; Targinie Channel to -10.6 LAT; Fisherman's Landing Swing Basins to -10.6m LAT;
- Scenario 2 – remainder Stage 1B and Stage 2: all of Scenario 1; Targinie Channel to -13m LAT, Fisherman's Landing Swing Basins to -13m LAT; channel extension to Laird Point and Laird Point Swing Basin to -13m LAT;
- Scenario 3 – all dredging required for full development: Scenario 2; increased width past Fisherman's Landing to Laird Point and China Bay and Hamilton Point additional swing basins and departure areas.

Modelling assessments indicate that affects on the hydrodynamics within the Study Area are not consistent across sites or tides and will include:

- Changes in water velocity;
- Changes in water levels;
- Changes in bed shear stresses; and
- Changes in tidal flows.

These are described in detail in the complementary Numerical Modelling Report for this Project (Appendix J of the main EIS). Information provided in the Coastal Processes Assessment (Appendix M of the main EIS) also provides understanding of potential impacts on the study area from the Project. In brief it is expected that:

- Areas to the north of the reclamation footprint and around the toe of the rock revetment walls will be subject to both increased bed shear stresses as well as increased deposition. The bed shear stresses are not expected to be significant enough to remobilise sediments except against the toe of the bund. There will also be a tendency for siltation, varying across parts of the Western Basin area, being greatest at the western shoreline and channel area;
- Areas to the west of the proposed reclamation footprint in the landward channel will be subject to decreased water flows, some pooling, decreased flushing on neap tidal cycles and, as noted above, will have an increased sedimentation potential;
- Where channels are deepened and swing basins are established tidal flows are expected to be marginally less than existing flow rates;
- Where water will move from the channels into shallower habitats there may be a small increase in flow rates compared to existing conditions. This is not expected to alter bed shear stresses to the point of having consequential effects on sedimentation rates / scouring potential;
- Within the Western Basin Project Area and upstream in The Narrows there is expected to be a very slight phase shift (minutes) in the tidal cycle;
- The northern side of the Reclamation Area will experience a slight increase in water levels (millimeters) while the south western corner will experience a phase change; and
- Within the landward channel and areas to the immediate north of the channel and reclamation there is expected to be a tens of minutes phase shift in the tidal cycle and a potential increase in water retention within the channel during low tide with fewer periods of drying.

Table 5-1 identifies the areas expected to be directly and indirectly impacted by works associated with this Project. This includes areas predicted from modelling studies to be impacted by dredge plumes, which is expected to have the largest impact on water quality in the region. This is illustrated on Figure 5-2. Figure 5-3 identifies the habitats and benthic areas expected to be directly impacted. Known seagrass meadows within the impacted footprint are also identified from comparison of data collected in this study with information available through DEEDI.

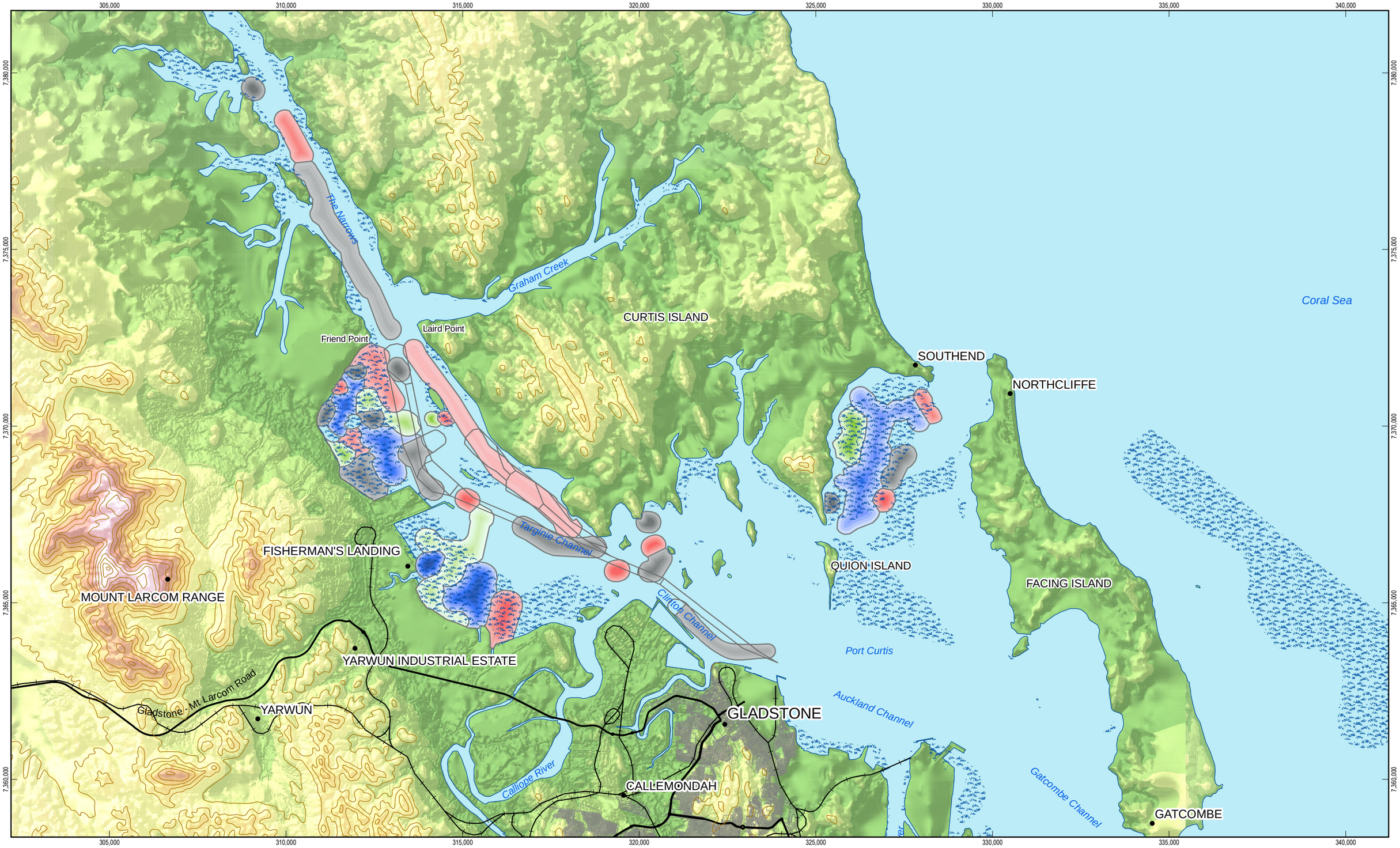
Table 5-1 Areas of Benthic Habitat Expected to be Directly and Indirectly Impacted by Construction and Operation Works

Location	Expected Impact*	Habitat type	Total Benthic Area (ha)	Known Seagrass Area**
Reclamation area + bund wall	Direct – habitat removal (not including Fisherman's Landing)	Intertidal and subtidal soft substrate	235.9	221.6
Channel to west of reclamation	Indirect – water quality	Intertidal soft substrate	8.7	3.4
Western Basin residual area (area to the north of the Western Basin Reclamation Area)	Indirect – water quality + habitat removal	Intertidal and subtidal soft substrate	299.1	274.6
Channel to be dredged (all stages, already dredged)	Direct – habitat removal	Subtidal soft and hard substrates	146.4	3.4
Channel to be dredged (all stages, not already dredged)	Direct – habitat removal	Subtidal soft and hard substrates	520.0	33.8
All other areas within Gladstone Harbour predicted as potentially impacted by dredge plume modelling	Potential Indirect Impacts – water quality	Subtidal soft and hard substrates	5,108.0	1,128.0
		Total Direct Impact	902	258.8
		Total Indirect Impact	5,416	1,406
		Total Potential Impact	6,318	1,665

* Refer to Section 5.2 for discussion of potential impacts

*Areas based on merged data from all DEEDI studies from 2002 to 2008 AND GHD field survey data.

The various construction and operation activities for the Project are expected to result in a range of impacts on the marine systems within the Study Area, including smothering of benthos, reduction in photosynthetic activities, scouring and mobilisation of contaminants. Given the understanding of the potential impacts that may occur as a result of dredging and reclamation works, expected direct and indirect impacts from the Project (both within the immediate footprint of works and offsite) have been determined. These are described in the following sections.



1:100,000 (at A3)

0 1 2 3 4 5

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

- Proposed Dredge Footprint
- Seagrass Distribution (DPI 2002 to 2008)

Seagrass, Algae and Other Benthic Fauna (GHD 2009)

- Seagrass
- Algae
- Seagrass and Algae
- No Seagrass or Algae. Other Benthic Taxa Present
- No Seagrass or Algae

Port of Gladstone
Western Basin Dredging and Disposal Project

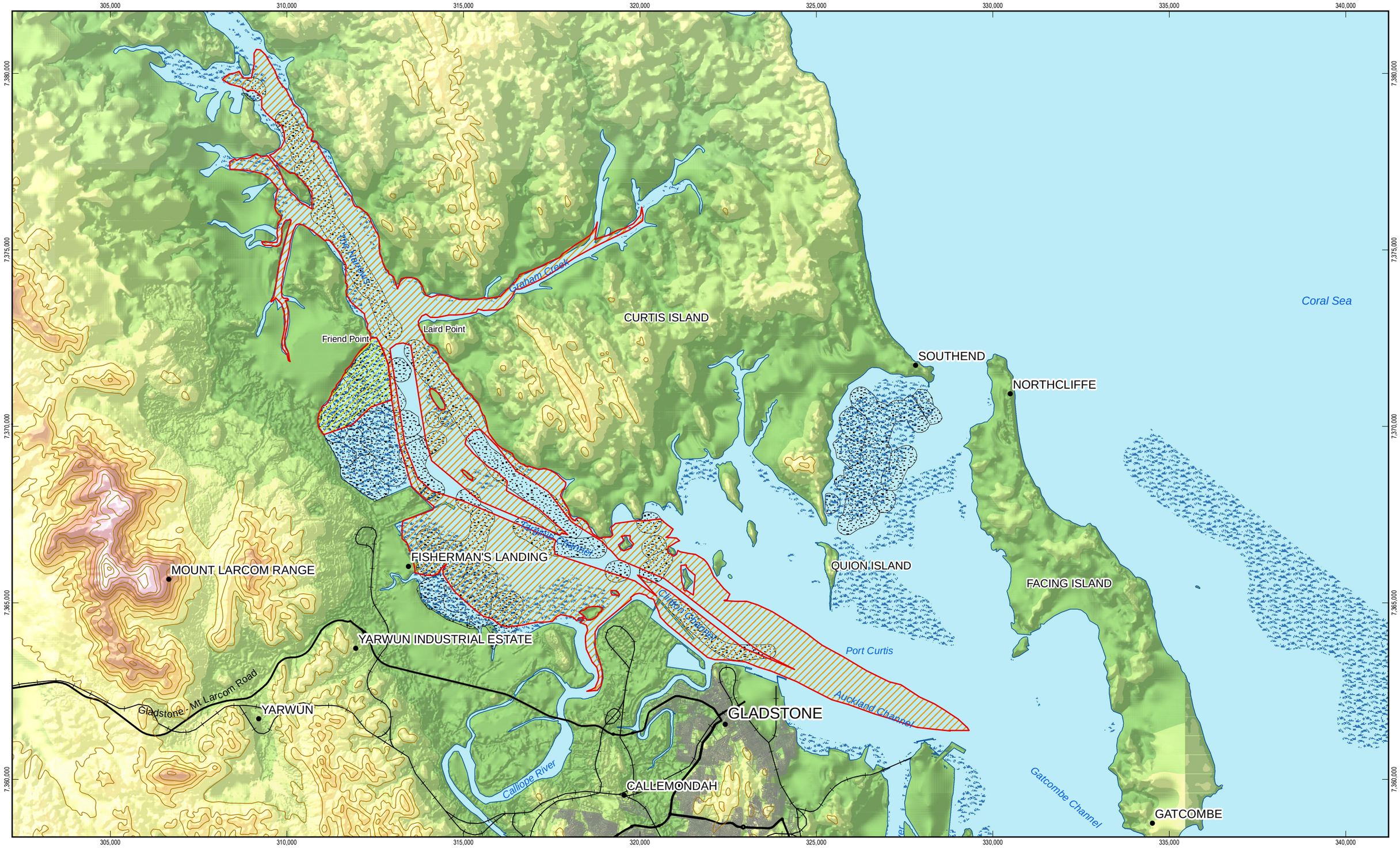
Seagrass (DPI&F 2002-2008) and Benthic Fauna Habitat (GHD 2009)

Job Number	42-15386
Revision	A
Date	30 Aug 2009

Figure 5-1

G:\42\15386\GIS\WesternBasinProjects\MXDs\42-15386_WB_330_re_a.mxd

Level 4 201 Charlotte Street Brisbane QLD 4000 Australia T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com



1:100,000 (at A3)

0 1 2 3 4 5

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

- Seagrass Distribution (DPI 2002 to 2008)
- Seagrass, Algae and Other Benthic Habitat (GHD 2009)

Indirect Impact

- Area of habitat north of Western Basin
- Residual area

Port of Gladstone
Western Basin Dredging and Disposal Project

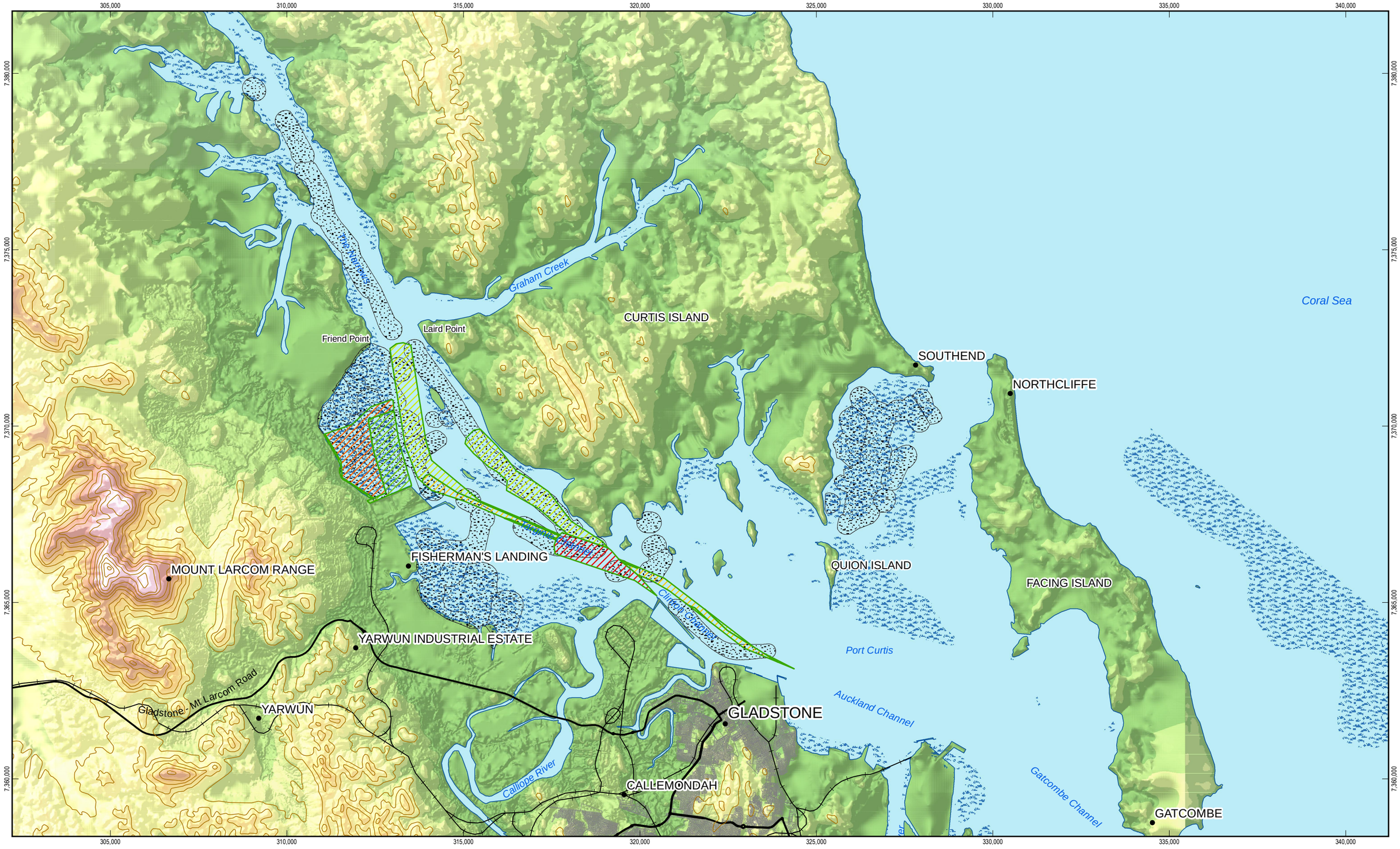
Job Number 42-15386
Revision A
Date 30 Aug 2009

Estimated Indirect Impact Footprint

Figure 5-2

G:\42\15386\GIS\WesternBasinProjects\MXDs\42-15386_WB_332_re_a.mxd

Level 4 201 Charlotte Street Brisbane QLD 4000 Australia **T** +61 7 3316 3000 **F** +61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com



1:100,000 (at A3)

0 1 2 3 4 5

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

- Seagrass Distribution (DPI 2002 to 2008)
- Seagrass, Algae and Other Benthic Habitat (GHD 2009)

Direct Impact

- Channel to West of Reclamation (approx 40m wide)
- Fisherman's Landing with Storm Toe
- Proposed Channel - New to be dredged
- Proposed Channel - Previously dredged
- Western Basin Reclamation with Storm Toe
- Wiggins Island Dredge Area

Port of Gladstone
Western Basin Dredging and Disposal Project

Job Number 42-15386
Revision A
Date 30 Aug 2009

Estimated Direct Impact Footprint

Figure 5-3

G:\42\15386\GIS\WesternBasinProjects\MXDs\42-15386_WB_331_re_a.mxd

Level 4 201 Charlotte Street Brisbane QLD 4000 Australia T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

5.2 Potential Impacts

5.2.1 Predicted Direct and Indirect Impacts

The Western Basin Dredging and Disposal Project will have a number of permanent impacts on the marine ecological values of the area in which it is located. The majority of the impacts involve the permanent direct removal of an area (approximately 275 ha) of intertidal and subtidal habitat within the Western Basin Reclamation Area. An additional 9 ha of benthic habitat within the channel to the west of the reclamation will also be permanently changed. The entire 284 ha area supports known seagrass habitats of demonstrated importance to dugong, marine turtles and of indirect importance to coastal dolphin species. In addition, a range of temporary impacts are expected as a result of construction activities, including dredge plume impacts and noise impacts.

The impacts on marine ecological values expected to result from the Project, either during construction and/or operation, include:

- Direct impacts (both potential and probable):
  - Removal or damage to the benthos and individual organisms from bund construction, dredging and pile driving works, including smothering of benthos;
  - Alteration of benthic habitat type from soft sediment to coarse/clay/hard substrate;
  - Alteration of benthic habitat type from intertidal to subtidal substrate;
  - Damage to individual organisms from direct contact related to construction activities, including trapping within bund when bund is closed;
  - Impact to fauna by boat strike from dredge and/or construction vessels;
  - Decreases in water quality from dredging, construction, spills of fuel or other hydrocarbons or other pollutants;
  - Introduction of marine pests to the Port and/or adjacent marine environment, including the GBRMP;
  - Alteration of sediment and water quality at the reclamation site by the introduction of contaminants or PASS;
  - Land use change resulting in loss of benthic primary producer habitat and fisheries resources; and
  - Interruption of recreational and other vessel traffic movement patterns.
- Indirect impacts (both potential and probable):
  - Decreased water quality from altered siltation/sedimentation regimes, alteration of stormwater input, and tailwater management, and an increase in pollutants as a result of construction waste or land use changes;
  - Conflict between commercial and recreational activities as a result of land use change leading to additive pressures on the adjacent marine systems;
  - Impact on subtidal and intertidal benthos (including mangrove communities) from changes in the hydrodynamic regime resulting in sedimentation, scouring, longer durations of wetting, increased/decreased flow rates; and

– Noise, vibration and light impacts to marine reptiles and mammals from in-water construction or ongoing operational activities.

5.2.2 Potential Impacts on Marine Communities

Annual maintenance dredging within the Study Area already occurs and the marine communities identified during this program persist under that dredging regime. Maintenance material is typically relocated to the offshore deepwater disposal ground. While the communities present may be able to adapt to existing short term dredging related impacts, they may experience chronic impacts given the duration and magnitude of the proposed dredging program.

The area adjacent to Curtis Island (including the Passage Islands) supports a diverse assemblage of soft corals, sponges, bryozoans, hydrozoans and crinoids among scallop beds. These assemblages were also identified during the 2002 survey by Rasheed *et al.* (2003), demonstrating their persistence over time. These assemblages were also common within the channel samples, primarily located on the batter slopes. The removal of these species from the proposed dredging projects to create new, deeper channels, will likely have an immediate impact resulting in a reduction in the diversity of these taxa within Port Curtis. Given these taxa currently occupy the existing channels, batter slopes and habitats adjacent to existing facilities, it is likely this will be a temporary disturbance and that any affected areas will be recolonised over time. However, within the deeper water in the bed of the channel, fewer species occur with less diversity (fewer corals, crinoids and bivalves) and widening these areas for multiple projects will likely reduce the overall habitat available across Port Curtis for these taxa.

An overall loss of soft sediment intertidal species is expected from this Project as currently soft sediment environs will be redeveloped into hard substrate environments. However, this is not expected to have a net negative effect on the diversity of the intertidal systems within the Study Area and may provide a net benefit as provision of three dimensional habitat intertidally and subtidally may promote species settlement. Three dimensional habitats, such as rock revetment walls, are also preferred structures compared to two or one dimensional structures in regards to fishery values, as three dimensional structures provide a greater colonisation area for juvenile fish and crab taxa, increasing available niche refuges. Use of rock revetments for reclamation works are, therefore, in accordance with the principles of the Queensland Government Fish Habitat Guidelines (FHG 006). This creation of interstitial habitat may partially offset some of the habitat losses associated with direct removal as these areas will be rapidly colonised and may support a greater diversity of species than currently persist intertidally. The rocky shore areas surveyed typically supported a higher diversity or an equivalent diversity than the soft sediment habitats. Rock revetment walls are also known to support algal assemblages, which may offset some direct losses of benthic primary producer (seagrass) habitat.

Proposed dredging works (inclusive of several dredgers operating simultaneously) have been predicted to generate an impact upon water quality within the Study Area. This in turn, will add to the direct impact of removal of diversity from the marine systems in the Study Area as a result of shading and sediment deposition through elevated turbidity/suspended solids concentrations. The relative impact of different numbers of dredges operating simultaneously has been demonstrated through the modelling of several different scenarios. The scenario predicted to have the largest impact on water quality in the region, is that for Stages 1A and 1B, where simultaneous dredging activities could include rehandling and decant from the reclamation.

For this situation (model scenario 1b), it is estimated that approximately 5,108 ha of benthic habitat outside the Project footprint has the potential to be impacted in terms of being touched by the dredge plume at least once (refer Figure 5-2 for the overlay of maximum plume extent with habitat areas). This includes approximately 1,128 ha of seagrass areas, based on the maximum understood footprint of seagrass in this area as mapped by DEEDI during their monitoring program and GHD during the field survey for this EIS.

Seagrass communities are recognised as important ecosystems for maintenance of seabed stability, water quality and biodiversity (Collier and Waycott, 2009). In addition to their intrinsic value, seagrasses are known to act as nursery grounds for juvenile fish, which may be targeted by commercial and recreational fishers, or be an important food source for other fish and megafauna species. Seagrasses are also an integral food for marine megafauna including turtles and dugongs. As such, the seagrass meadows, and the associated benthic macroinvertebrate communities that will be directly affected by construction should be considered to be of high ecological value.

Seagrass meadows are recognised to be ephemeral in their distribution and meadows within the Study Area have varied in size and biomass over the last few years (refer Chartrand *et al.* 2009). The soft sediment habitat adjacent to the existing seagrass meadows that has previously been occupied by seagrasses, may contain seagrass seeds and act as a seed bank for any plant losses and should, therefore, also be considered as suitable habitat for seagrasses. The soft sediment habitats within the Project Area also support a number of benthic macroinvertebrates, algal taxa as well as recreationally and commercially targeted fish and crab taxa. These soft sediment habitats not currently supporting seagrass should also, therefore, be considered to be of high ecological value.

The seagrass meadow complex within the direct footprint of the Project was noted to be unique within the Study Area (refer Chartrand *et al.* 2009), however, there are extensive seagrass beds supporting the same or similar seagrass (if in different proportions) and benthic assemblages throughout the wider region (including locations within Port Curtis, The Narrows, Rodds Bay, Ince Bay, Clairview and Shoalwater Bay). Therefore, the loss of some or all of the affected seagrass meadows should not result in the loss of specific seagrass species from the Gladstone region. While the presence of specific species may not be impacted, the compounded loss of coastal meadows is, however, expected to have an impact upon the overall availability of benthic resources both within and beyond the Study Area.

The permanent loss of coastal meadows and the soft sediment habitats that connect these meadows will have the potential to affect the remaining meadows and benthic resources both within the region and potentially beyond the region via a shift in resource availability and, hence, utilisation by key species. Any mobile species that currently use the meadows and connecting habitats in the Project Area will be displaced to other areas. This will put increased pressure on remaining habitats of similar composition (mixed seagrass, algal and soft sediment) and if these areas are currently fully utilised, species would be displaced from the area. The Western Basin Dredging and Disposal Project represents a further extension of the Fisherman's Landing Northern Expansion, increasing the impacts on the seagrass and benthic macroinvertebrates in the immediate Project Area and having the potential to impact on the broader region through further loss of habitat and feeding/nursery grounds.

The minimum carrying capacity for meadows within the Study Area for fishery species and megafauna is not well understood. Given the high utilisation of the existing meadows it is probable that a reduction in the presence and prevalence of these species within the Study Area will occur as a result of proposed developments and subsequent increase in commercial vessel traffic utilising these coastal areas.

Table 5-1 outlines the areas of benthic habitat that will be directly and indirectly impacted as a result of this project and also highlights the area within the benthic habitat to be impacted that has been known to support seagrass at any point during the 2002 – 2008 DEEDI seagrass mapping and as identified in the GHD survey undertaken for this EIS. This totals approximately 6,318.1 ha of benthic habitat, including 1,664.8 ha of known seagrass habitat, which could be directly or indirectly impacted under the worst case scenario of development and dredging works. In addition to expected permanent losses of high value ecological habitats, temporary losses from indirect impacts related to reduced water quality from dredge plume footprints are also expected. However, temporary losses would be expected to return to the Study Area over time (within 2-5 years) following cessation of construction and dredging.

Permanent losses of seagrasses, as mapped by DEEDI, as a direct consequence of this Project equate to 258.8 ha, which includes the reclamation footprint and channels to be dredged. This represents approximately 11.2% of seagrass within the port environment of the Fitzroy region and approximately 2.6% of the seagrasses across all environments of the Fitzroy region. If all recognised seagrasses are lost (even temporarily) through direct and indirect impacts this equates to approximately 34.8% of the port environment seagrasses and 8.2% of the wider Fitzroy region seagrasses. These values are based on comparison of areas expected to be impacted by this study with areas of seagrass mapped in the Fitzroy region (Gladstone Harbour, Shoalwater Bay but not Rodds Bay) as reported by Coles *et al.* (2007).

A conservative assessment of the potential offsite impacts from concurrent dredging activities, in the absence of carrying capacity knowledge, is that species tied to habitats that will be directly impacted by this Project (284 ha of habitat) would be permanently lost from Port Curtis versus displaced to other habitats within Port Curtis. That is, seagrasses and other soft sediment community assemblages, fishes, crabs and megafauna (green turtles, dugongs and dolphins) noted within the Western Basin and channel areas are likely to be permanently lost from Port Curtis under the proposed development scenarios. Given the prevalence of seagrass communities throughout the wider region, a loss of local seagrass meadows may result in a local-level loss of highly mobile fauna species (turtles, dugongs and dolphins) that have a strong affiliation with these meadows as following loss of the meadows these species will move to other areas of similar habitat in the region. Potential mitigation of these losses could be achieved by reducing the footprint of dredging to reduce the displacement pressure on remaining habitats or through application of the offsets policy.

The assessment of impacts arising from having multiple dredgers operating simultaneously has been addressed through the various modelled dredging scenarios. These assume up to 4 dredgers operating at any one time, with the most significant impact arising from the use of TSHDs operating by dumping material adjacent to the reclamation, and CSDs then being used to collect and pump the material into the reclamation. To reduce the impacts associated with dredging, it would be necessary to operate the dredgers in different modes to those that have been assessed, which may have the disadvantage of increasing the duration of dredging campaigns.

The potential measures could include periods where the TSHD pump directly into the reclamation (subject to material type), programming of dredgers so that times of peak plume transport are avoided (e.g. selected large spring tides during the flood phase of the tide) or increased use of CSDs.

Monitoring of water quality within sensitive habitats for the duration of construction works and for a period (no less than 12 months) before the completion of works should be undertaken across the Study Area to inform development of a reactive dredge management program. Typically, management intervention during dredging and construction activities is undertaken if trigger levels relevant to background water

quality levels are exceeded (refer Appendix K of the main EIS). Trigger levels have been determined by comparing the measured median and 90th percentile values of TSS, with the difference between the two nominated for consideration. Warning levels can also be adopted, whereby exceedance triggers a monitoring action, whilst exceedance of the trigger value can require a more stringent action. In setting and applying these values, it is critical that natural/background values of TSS are considered, and that the values are applied to areas of sensitivity, rather than at the point of dredging.

Management measures under this scenario would need to be in accordance with the DMP, which might dictate the alteration of dredging mode, location, or duration. The aim of such measures is typically to provide respite or the prevention of damage to areas where damage was not predicted to occur. This will mitigate against impacts prior to those impacts having an irreversible affect on seagrasses and other sensitive ecosystem receptors.

The water quality and sediment quality assessments conducted as part of this EIS provide information on the baseline turbidity and total suspended solid loads for a range of locations within the Study Area. Through their long term monitoring programs, DEEDI and PCIMP host data that describe natural temporal variability of sensitive ecosystem receptors within the Study Area that should be used in combination with long term water quality datasets to assist in developing ecologically relevant values for turbidity monitoring during construction activities. This could be coupled with preliminary work to understand resilience of seagrass assemblages to changes in light availability. In addition, it may be appropriate to include shading and stressing experiments for seagrasses. These will then assist in developing appropriate dredge management trigger levels and ecologically relevant water quality thresholds.

Given the ecological importance of seagrasses within this region, continued monitoring of seagrass and algal meadow health within the Study Area should also be undertaken in conjunction with any shading experiments or water quality monitoring works. Water quality triggers should provide early warning to any potential impacts upon these systems, however, monitoring of these meadows will provide opportunity to determine the effectiveness of these management measures at an ecologically relevant scale. Monitoring of the meadows should be undertaken during the construction period and for at least 12 months beyond the construction works. The duration of monitoring should be appropriate to detect recovery in communities post completion of construction. The duration may be influenced by external influences upon ecosystem health, including rainfall inputs to the region, effecting seasonal variability in communities but may need to be three years in order to show continued improvement in assemblages. This duration may be informed by experimental work.

5.3 Risk Assessment

To assess the risk posed to the marine environment by activities undertaken as part of the proposed project a risk assessment has been undertaken. This risk assessment addresses the construction and operational aspects of the Western Basin Dredging and Disposal Project and, therefore, takes into consideration potential compounded impacts from multiple dredging programs. The assessment identifies aspects of the works that pose an environmental risk, and classes these risked into one of four categories (High, Medium, Low and Very Low). The classification then allows priorities to be set for addressing and mitigating these risks.

5.3.1 The Risk Assessment Process

No international standard exists for risk management and as a result the risk assessment methodology employed here is based on the Australian Standard AS/NZS 4360: 1999 *Risk Management* (the Standard), HB 203: 2000 *Environmental Risk Management – Principles and Process* (the Guidelines), and the GPC Environment Procedure for Risk Assessment. The Standard and Guidelines set out a generic framework for establishing the context, identifying, analysing, evaluating, treating, monitoring and communicating risks. The Best Practice Environmental Management in Mining, Environmental Risk Assessment (EA, 1999) also adopts this standard though different definitions have been adopted by EA. The GPC Environment Procedure for Risk Assessment provides a whole of business risk matrix to assist in calculating the level of consequence and likelihood for identified risks.

Risk Assessment Methodology

The objective of a risk assessment is to filter the minor acceptable risks from the major non-acceptable risks. It involves consideration of the sources of risk, the consequences and the likelihood that those consequences may occur.

Risk analysis may be undertaken to various degrees of refinement depending upon the risk information and data available. Analysis techniques include:

- Qualitative assessment;
- Semi-Quantitative assessment; and
- Quantitative assessment.

In practice, a qualitative analysis is often used to first obtain a general indication of the level of risk and then a more quantitative analysis is applied to refine the risk.

A quantitative risk assessment can be undertaken based on statistical analysis for various consequences and probabilities. In the absence of statistical data, an estimate may be made of the degree of the consequence and frequency (refer to Section 4.3 of the Standard).

The risk assessment methodology for this EIS uses a semi-quantitative process for determining risk. The semi-quantitative process estimates the degree of the consequence and probability and assigns a score to each. The score allocated “does not have to bear an accurate relationship to the actual magnitude of consequences or likelihood” (refer to Section 4.3.4 of the Standard). The risk and impact assessment process used here to assess and weight potential project risks was undertaken using an Environmental Risk and Likely Impact (“ERLI”) approach. For each possible impact aspect, two key areas were addressed:

Environmental Risk

This essentially considers the risk of irreversible change to natural ecological processes and community interaction. Assessment addresses:

- Conservation significance of environmental, social and cultural values and regional context of these values;
- Current level of integrity of natural ecosystem processes;
- Known sensitivity of ecosystem processes/natural values to human induced change;
- Natural change and resilience of relevant ecosystem processes/natural values;

- Potential for cumulative social and environmental impacts; and
- Level of scientific certainty of the above factors.

Likely Impact

This considered the likely impact of the project, as modified and undertaken in accordance with mitigation strategies (including any environmental management plans or conditions from licensing/approval agencies) and includes:

- Geographic extent of the activities;
- Duration of the activities;
- Magnitude of potential environmental change;
- Confidence in prediction of impact;
- Confidence in mitigation strategies to minimise ecological and social risks; and
- Ability to monitor the impacts and detect change before irreversible change to system processes occurs.

The approach considered direct and indirect impacts, short and long term, cumulative, temporary and irreversible, and adverse and beneficial impacts.

The significance of the impacts was placed in an appropriate context in which to justifiably determine the impact's significance. In particular, the duration of the impact (temporary vs. permanent) and reversibility were considered. The ability of natural systems (including population, communities and ecosystems) to accept or assimilate impacts was also considered.

The above approach is used to provide the essential information that is used in the formal Risk Assessment as based on the Australian/New Zealand Standard 4360:2004. This methodology is outlined below.

Stage 1: Identification of Risk

This included identification of all relevant risks, addresses all known activities and related environmental aspects of the Project.

Stage 2: Risk Analysis

An important feature is recognition of the fact that an event's consequence extends beyond the immediate impact. This methodology ensures that the full consequences of events are visible to risk owners and managers and that the effects on the Project are all understood and treated. Each class of consequence is rated a score of 1 - 5, where "1" is minor consequence to "5" is critical.

An analysis of each risk is undertaken to determine an environmental event's likelihood of occurrence and its consequences. A five-level qualitative description of the likelihood and consequences for each risk enables a semi-quantitative method to be used to calculate a 'score' for each risk.

Definitions and scales for Consequences that are in accordance with the GPC Environment Procedure for Risk Assessment are shown in Table 5-2 and definitions and scales for Likelihood are shown in Table 5-3.

Stage 3: Calculation of Risk Level

Two levels of risk are used:

The **Primary Risk Level (PRL)** is a conservative measure of risk, based on the most severe consequences across all the relevant criteria. PRL is calculated according to the equation:

Primary Risk Level (PRL) = Likelihood Rating X Maximum Consequence Rating

The **Secondary Risk Level (SRL)** is a less conservative measure of risk, which incorporates all relevant criteria, not just the most severe ones. SRL is calculated according to the equation:

Secondary Risk Level (SRL) = Likelihood Rating X Average Consequence Rating

In most circumstances PRL should be the preferred measure, as it is more conservative. Risk scores are banded into risk levels which provide a "plain English" view of the risk. Scores will always be visible to enable prioritisation within bands.

Table 5-4 and Table 5-5 show the bands, their threshold values and indicative management action.

Stage 4: Determination of Options for Treatment of Risks

Following the analysis of a risk it is necessary to investigate the options available for risk treatment and then determine the option or options that provide the greatest cost benefit.

Risks may be treated in one or a combination of ways[2]:

- Avoiding a risk by preventing the activity that leads to the risk eventuating;
- Reducing the likelihood of the risk eventuating;
- Reducing the consequences if the risk does eventuate;
- Transfer the risk; and
- Retaining the risk.

Table 5-2 Threat Criteria and Consequence Scales

Category	Workplace Health & Safety	Environment	Financial Impact on Earnings before Interest and Tax	Community or Customer Reputation	Legal	Process Interruption
1 Minor	Near miss/no injury	On site release of pollutant contained without external assistance	Losses less than $100,000	Isolated complaint	Court action with small fine – less than $10,000	Less than 1 hour
2 Moderate	First Aid Treatment	On site release of pollutants contained with external assistance	Losses of $100,000 to $1 million	Multiple community or customer complaints	Court action with moderate fine - $10,000 to $75,000	1 hour to 1 shift

[2] After AS/NZS 4360:2004

Category	Workplace Health & Safety	Environment	Financial Impact on Earnings before Interest and Tax	Community or Customer Reputation	Legal	Process Interruption
3 Significant	Medical treatment	Significant on or off site release and detrimental impacts	Losses of $1 million to $2.5 million	Community action with possible delays to project	Court action with significant fine - $75,000 to $250,000	1 shift to 1 day
4 Major	Serious injury/lost time injury	Major offsite release and detrimental impacts	Losses of $2.5 million to $5 million	Community action severely delays project	Court action with major fine - Greater than $250,000	1 day to 1 week
5 Critical	Major extensive injury (permanent disablement) or fatality	EPA ordered shutdown of major part of process	Losses of greater than $5 million	Community or customer outrage prevents projects or results in severe damage to Corporate image which limits future options	Court action with jail sentence	More than 1 week

Table 5-3 Likelihood Rating

Likelihood	Rating	Likelihood Calculator
Rare	1	The risk may occur only in exceptional circumstances (The risk is not likely to occur in the next 25 years)
Unlikely	2	The risk could occur at some time (The risk is likely to occur once in the next 5-25 years)
Possible	3	The risk might occur at some time (This risk is likely to occur in the next 2-5 years)
Likely	4	The risk will probably occur in most circumstances (The risk is likely to occur in 1-2 years)
Almost Certain	5	The risk is expected to occur in most circumstances (The risk is likely to occur within the next 12 months)

Table 5-4 Risk Assessment Matrix

	Consequence				
Likelihood	**Critical (5)**	**Major (4)**	**Significant (3)**	**Moderate (2)**	**Minor (1)**
Almost Certain (5)	High	High	High	Medium	Medium
Likely (4)	High	High	Medium	Medium	Low
Possible (3)	High	Medium	Medium	Low	Low
Unlikely (2)	Medium	Medium	Low	Low	Very Low
Rare (1)	Medium	Low	Low	Very Low	Very Low

Table 5-5 Risk Levels and Management Action (example)

Risk Level (PRL or SRL)	Descriptor	Indicative management action
1-4	Low	Manage by routine procedures, unlikely to need specific application of resources
5-10	Medium	Manage by specific monitoring or response procedures, develop more detailed actions as resources allow
10-16	High	Senior management attention needed and management responsibilities specified for further action
17-25	Extreme	Immediate action required, senior management will be involved

Limitations

As with any model, the relevance and applicability of the risk model revolves around a number of basic assumptions and limitations. The application of the risk model has been based on subjective ranges of consequences and probabilities.

Limitations of the application of the risk methodology for this study include:

- The assessment is based on the professional judgement of a limited number of experienced GHD staff and does not incorporate the collective experience of all parties involved with the Project. The full range of risks and the most appropriate consequence and likelihood rating would be best completed in a workshop involving key stakeholders;
- The assessment has been limited to a selected number of primary risks and the assessment of cumulative risk to the environment from multiple pollution sources or sources of environmental degradation has not been addressed. Cumulative risks are approached for this study in a qualitatively manner only.

Although a semi-quantitative methodology was used to conduct the risk assessment, the resultant risk estimation is purely relative. The risk estimations do not imply an absolute scale of risk that can be applied to any other situation or assessment.

5.3.2 Applying the Process to Expected Impacts

Table 5-4 adopts the process described above to provide an assessment of ecological risk for the Project. Marine megafauna based on understanding from incidental sightings has been included here for completeness; however, it is further addressed in greater detail in the Marine Megafauna Assessment (Appendix R of the main EIS). Reference should be made to that assessment for detailed understanding of the full impacts and mitigation measures associated with this Project for marine megafauna. Similarly, water quality and sediment quality impacts as they relate to marine ecological values are included, however, the full potential range of impacts are described in detail in the Water and Sediment Quality Reports (Appendix K and L respectively of the main EIS), which should be referred to for completeness.

Table 5-6 Marine Ecology Risk Assessment

Activity Description	Potential Impacts and their Consequences	Preliminary Risk Assessment (C, L) Score	Additional Control Strategy	Residual Risk with Additional Control Strategies Adopted (C, L) Score
Construction Phase				
Building of Bund	Removal or damage to benthos. Seagrass species, algae, macrobenthos including fish and crab species. Reduction in biodiversity.	(2, 5) Medium	No ability to control impact. Habitat and communities represented elsewhere in region except for seagrass complex. Consider implementation of offsets.	(2, 5) Medium
	Water quality impacts (including from altered siltation/sedimentation regimes) that may have potential follow on effects for trophic groups including seagrasses and their associated species.	(1, 5) Medium	No ability to control impact. Silt curtains inappropriate given high flow environment. Habitat and communities represented elsewhere in region except for seagrass complex. Implement offsets for habitat losses. Expected to be minimal impacts. Monitor adjacent sensitive ecosystem receptors according to Dredge Management Program (DMP) and implement trigger levels for seagrass mortality on surrounding habitats.	(1, 5) Medium
	Alteration of benthic habitat from soft sediment to hard substrate. Altering environment from supporting soft to hard substrate species. Juvenile crab and fish habitat to be created. Seagrass habitat to be lost.	(1, 5) Medium	Not expected to be a net negative effect.	(1, 5) Medium
	Impacts to fauna trapped in bund when closed.	(4, 5) High	Manually remove marine fauna prior to reclamation works closing bund. Relocate species to adjacent open marine system. Adopt a strategy to decrease potential trapping of fauna during bund construction such as use of nets to deter entry into bunded area.	(4, 3) Medium

Activity Description	Potential Impacts and their Consequences	Preliminary Risk Assessment (C, L) Score	Additional Control Strategy	Residual Risk with Additional Control Strategies Adopted (C, L) Score
	Impact upon flushing regime and health of the marine ecosystem and potentially on the sedimentation/scouring of the benthic habitat (subtidal/intertidal) and mangroves associated with the channel.	(3,3) Medium	Design bund to reduce any long-term scouring potential. Monitor mangrove and benthic habitat for detrimental change in health and undertake remediation activities in accordance with EMP.	(3, 2) Low
	Noise and vibration effects associated with construction works. Displacement of marine fauna from immediate area.	(1, 4) Low	No ability to control impact. Fauna known to occur in area where there are existing port and in-water operations and impacts expected to be temporary.	(1, 4) Low
	Potential release of waste materials or pollutants associated with the construction of bund.	(4, 3) Medium	Adherence to waste management controls identified in the EMP for this Project.	(4, 2) Medium

Activity Description	Potential Impacts and their Consequences	Preliminary Risk Assessment (C, L) Score	Additional Control Strategy	Residual Risk with Additional Control Strategies Adopted (C, L) Score
Dredging of Material	Removal or damage to benthos. Seagrass species, algae, macrobenthos and associated taxa.	(3, 5) High	Assessment of risk based on dredge footprint identified for the Project. Impact considered to be direct removal of species within dredge path. To minimise this impact dredge activities are to be restricted to agreed footprint of channel works to minimise impact to critical habitats. Where alteration of dredging footprint is desired, dredging activities should avoid highly sensitive ecological habitats including additional seagrass meadow impacts or fragmentation. Dredge activities to be managed under a Dredge Management Program (DMP). To minimise impacts to areas immediately adjacent to dredging works identified under this Project dredging activities should be programmed under the DMP (particularly for TSHD) such that wherever practicable, habitats are rested periodically. This might include one or more of the following: ◗ Periods of pumping from TSHD directly into reclamation. ◗ Where breaks in dredging are programmed (e.g. for maintenance, provisioning, crew change over) or where it is possible to cycle between more than one location, attempting to coordinate these with the flood phase of a large spring tide. This will increase opportunity for communities to be resilient within affected areas. Refer also to offset requirements for Project to address habitat losses.	(2, 5) Medium

Activity Description	Potential Impacts and their Consequences	Preliminary Risk Assessment (C, L) Score	Additional Control Strategy	Residual Risk with Additional Control Strategies Adopted (C, L) Score
	Noise and vibration effects associated with dredging works.	(1, 5) Medium	Dredgers already operate in this environment so taxa currently co-exist. Commence dredging operations when dredge head on sea bed. Impacts to be temporary and expected to be minimal.	(1, 4) Low
	Potential release of waste materials or pollutants associated with the dredger into the marine environment resulting in reduction in biodiversity.	(4, 3) Medium	Adherence to waste management controls for vessel operations.	(4, 2) Medium
	Introduction of marine pests to port and or GBRMP on construction equipment, flow on effects to native marine communities/impact on fishing industries, financial loss, time delay.	(5, 3) High	Adhere to Commonwealth and State biofouling and ballast water management requirements. Vessels, particularly dredgers, to be of low risk of introducing marine pest to area via construction works. This may require a pre-entry inspection of vessel, particularly dredger, to demonstrate not carrying pest species.	(5, 2) Medium
	Creation of habitat by changing seabed surface structure to a deeper surface. Possibly change of type of sediment (eg fine silts to coarse material) which will effect re-colonisation of the area.	Positive Benefit	Not considered to be net negative impact given that deeper water likely to provide opportunities for different taxa to colonise, including sponge gardens. Seagrasses able to persist in deeper waters as well.	Positive Benefit
Dredging of Material – cutter suction dredger or backhoe dredger - clays / hard sediments	Water quality impacts at dredge head (including increased sediment loads) that may have potential follow on effects for trophic groups including seagrasses and their associated species.	(1, 3) Low	Where possible target appropriate sediments with appropriate dredger to reduce release of fine material from dredge head. Expected to be minor impacts.	(1, 2) Very Low
	Spill from dredger during relocation to disposal ground. Relates to backhoe dredger if used. Cutter suction dredger will pump sediments into reclamation and this impact not applicable.	(2, 3) Low	Operate within safe weather conditions for maintenance of load.	(2, 2) Low

Activity Description	Potential Impacts and their Consequences	Preliminary Risk Assessment (C, L) Score	Additional Control Strategy	Residual Risk with Additional Control Strategies Adopted (C, L) Score
	Potential harm or interaction from dredging process with marine fauna.	(4, 2) Medium	Fauna spotting to reduce likelihood of impact prior to deployment of dredge head. Do not commence dredging if fauna within 50m of dredge head. Wait until fauna moves away from dredge head.	(4, 2) Medium
Dredging of Material – trailer suction dredger - soft sediments	Water quality impacts at dredge head (including increased sediment loads) that may have potential follow on effects for trophic groups including seagrasses and their associated species.	(4, 4) High	Monitoring and control of dredge regime to be in accordance with DMP. Monitor water quality turbidity levels against site specific objectives within relevant sensitive ecosystem receptors and adjacent habitats and respond as required by DMP. Objectives and monitoring sites to be determined during development of DMP. Processes to respond to exceedance of trigger levels to be defined and should include potential options for alteration of dredging program.	(4, 3) Medium
	Spill from dredger during relocation to disposal ground.	(2, 2) Low	Operate within safe weather conditions.	(2, 2) Low

Activity Description	Potential Impacts and their Consequences	Preliminary Risk Assessment (C, L) Score	Additional Control Strategy	Residual Risk with Additional Control Strategies Adopted (C, L) Score
	Water quality impacts from overflow (including increased sediment loads leading to overburial of benthic communities) that may have potential follow on effects for trophic groups including seagrasses and their associated species.	(4, 4) High	Adopt appropriate overflow management for dredge to reduce water quality impacts in identified sensitive areas, if trigger values exceeded. Management provisions to be documented in DMP. Monitoring and control of dredge regime to be in accordance with DMP. Program dredge activity to avoid or minimise, where practicable, use of TSHD with rehandling in northern extents of dredging footprint during flood phase of large spring tides. Monitor water quality turbidity levels against site specific objectives within relevant sensitive ecosystem receptors and adjacent habitats and respond as required by DMP. Objectives and monitoring sites to be determined during development of DMP. Processes to respond to trigger level exceedance to be defined in DMP and may include options for alteration of dredging program, temporary alternative to rehandling, or programmed movement of dredge between areas, in order to minimise sustained plume creation at any one area. Dredge activity alteration under DMP may include reducing duration of dredging at particular locations during spring tide, relocating dredge to different areas in accordance with dredge program, planned increase in period between dredging activity at any one location to reduce seabed impacts at that site.	(4, 3) Medium

Activity Description	Potential Impacts and their Consequences	Preliminary Risk Assessment (C, L) Score	Additional Control Strategy	Residual Risk with Additional Control Strategies Adopted (C, L) Score
	Direct impacts by dredge plant on marine megafauna leading to capture / reduction in diversity.	(4, 4) High	Use a tickler chain or deflector head to avoid interaction with turtles resting on seabed. Maintain a fauna spotter and manage dredging operations to minimise interaction with megafauna. Do not commence dredging if megafauna noted within 50m of dredge head. Wait until megafauna moves out of immediate area.	(4, 2) Medium
Reclamation of Land	Removal or damage to benthos. Seagrass species, algae, macrobenthos including fish and crab species. Reduction in biodiversity. Both within the reclamation and within the dredge material rehandling area.	(3, 5) High	No ability to control impact. Habitat and communities represented elsewhere in region except for seagrass complex. Offsets to be implemented.	(3, 5) High
	Land use change resulting in increased potential for fuel, hydrocarbon, etc spill during construction activities leading to degradation of water quality and loss of biodiversity.	(3, 4) Medium	Identify hazardous material handling requirements and implement waste management and emergency response procedures. Adhere to waste management requirements for the Project under the EMP.	(3, 2) Low
	Alteration of sediment quality at the reclamation site by introduction of contaminants or PASS from dredged marine sediments leading to loss of biodiversity.	(3, 4) Medium	Sediments to be used for reclamation works to be tested for contamination and Reclamation Area to be constructed to reduce/remove potential impacts from any contaminants, including PASS. Flow on effects to future land use opportunities to be assessed and appropriate management to mitigate any contamination concerns to be implemented.	(3, 3) Medium

Activity Description	Potential Impacts and their Consequences	Preliminary Risk Assessment (C, L) Score	Additional Control Strategy	Residual Risk with Additional Control Strategies Adopted (C, L) Score
	Alteration of water quality arising from decant might generate in increase in sediment load. Potential reduction in biodiversity could result. Potential alteration of water quality arising from stormwater run-off and potential follow on reduction in biodiversity.	(3, 3) Medium	Appropriate design and construction of bund, including lining bund with geotextile fabric and installing internal bunding, to reduce potential for fines to be moved back into marine environment through the bund wall or via the decant waters. Consider use of floating booms within internal bunds to reduce potential for wind disturbance within retention ponds stirring up settling material. Manage movement of decant waters between bunds through installation of adjustable weir boxes and control rate of flow to increase sedimentation potential and reduce carriage of fines back to marine environment. Adjust decant regime if turbidity within sensitive ecosystem receptors exceed trigger levels defined under DMP. Capping and revegetation of finished land surface to minimise erosion and sedimentation for management of stormwater run-off. Design stormwater management system to manage quality of water entering marine environment from run-off. Manage stormwater pond discharge to maintain water quality to stated objectives.	(3, 2) Low
Pile Driving	Noise and vibration effects associated with pile driving works leading to avoidance of area by marine fauna. Likely to be temporary impact. Small risk of direct injury to fauna.	(4, 4) High	Use warning strikes or similar prior to commencement of pile driving (if found to be effective). Avoid activity if breeding of megafauna noted in Project Area. Use a megafauna spotter on vessel to manage conduct of activity to avoid interaction with megafauna when animals within close (50 m) proximity to vessel.	(4, 3) Medium
	Increased sediment loads in water column at base of piles being driven leading to decreased water quality. Very limited impact expected that will decay rapidly in space and time having little effect.	(1, 2) Very Low	No management measure possible - impact expected to be greater in softer sediments but expected to decay rapidly and have very localised effect. No mitigation measure deemed required.	(1, 2) Very Low

Activity Description	Potential Impacts and their Consequences	Preliminary Risk Assessment (C, L) Score	Additional Control Strategy	Residual Risk with Additional Control Strategies Adopted (C, L) Score
Other	Light spill from construction works leading to disorientation of marine fauna leading to inappropriate clustering of fauna at the site and potential reduction in biodiversity.	(1, 1) Very Low	No night time bund construction. Marine fauna currently co-exist with extensive lighting of construction and operational sites within Gladstone with no detrimental effects noted.	(1, 1) Very Low
	Increased vessel traffic - potential strike of marine fauna leading to death or maiming.	(4, 3) Medium	Use speed restriction areas for construction works to minimise risk of strike. Educate construction workforce regarding risks to marine megafauna and requirement to avoid interaction with those species.	(4, 2) Medium
	Interruption of recreational and other vessel traffic movement patterns.		To be addressed under social impact assessment and through discussion with harbour master. Refer relevant sections of the EIS.	
Operational Phase				
Water Quality Impacts	Change in water quality in habitats adjacent to decant pond arising from increased sediment loads. Potential reduction in biodiversity. Decant waters expected to be managed in accordance with water quality conditions. Limited impact potential. Potential alteration of water quality in adjacent habitats from land run-off and potential follow on reduction in biodiversity.	(1, 2) Very Low	Appropriate design of bund, including lining bund with geotextile fabric to reduce potential for fines to be moved back into marine environment through the bund wall. Capping and revegetation of finished land surface to minimise erosion and sedimentation for management of stormwater run-off. Design stormwater management system to manage quality of water entering marine environment from run-off. Manage stormwater pond discharge to maintain water quality to stated objectives.	(1, 1) Very Low

Activity Description	Potential Impacts and their Consequences	Preliminary Risk Assessment (C, L) Score	Additional Control Strategy	Residual Risk with Additional Control Strategies Adopted (C, L) Score
	Impacts to marine water quality from alteration of stormwater runoff characteristics, including increased potential for erosion during storm events. Potential to mobilise contaminants into the marine environment and reduce biodiversity.	(2, 3) Low	Implement appropriate topside waste and stormwater management. Design stormwater drainage systems to avoid increased scouring potential at release points in adjacent marine environment. Capping and revegetation of finished land surface to minimise erosion and sedimentation. Design stormwater management system to manage quality of water entering marine environment from run-off. Manage stormwater pond discharge to maintain water quality to stated objectives.	(2, 2) Low
Light Spill from Western Basin Facilities	Light spill from channel markers and reclamation lighting leading to disorientation of marine fauna leading to inappropriate clustering of fauna at the site and potential reduction in biodiversity.	(1, 1) Very Low	No management measure considered necessary. Marine fauna currently co-exist with extensive lighting of construction and operational sites within Gladstone with no detrimental effects noted. If any detrimental impacts detected management measures appropriate to mitigate impacts to be assessed in consultation and implemented.	(1, 1) Very Low
Land Use Change	Introduction of pests (both terrestrial and marine) to Project Area via increased vector visitation and increased habitat for potential colonisation. Flow on effects to native communities reducing biodiversity.	(5, 3) High	Western Basin area not established as first port of call for quarantine clearance of incoming vessels. Adhere to Commonwealth and State biofouling and ballast water management requirements. Terrestrial vehicles traversing reclaimed land to adhere to processes to minimise translocation of a terrestrial weed/pest species including wash down of at risk vehicles.	(5, 2) Medium
	Land use change - potential provision of public access facilities within or adjacent to the Reclamation Area	Positive Benefit	Provides opportunity to increase public access to coast.	Positive Benefit

Activity Description	Potential Impacts and their Consequences	Preliminary Risk Assessment (C, L) Score	Additional Control Strategy	Residual Risk with Additional Control Strategies Adopted (C, L) Score
Habitat Creation	Creation of interstitial habitat and provision of additional hard substrate.	Positive Benefit	Provides benthic habitat that can be recolonised by taxa. Counteracts removal of existing rocky shore area that bounds Fisherman's Landing. Provides niche habitat for juvenile fishery species protection.	Positive Benefit

6. Cumulative Impacts and Mitigation Strategies

6.1 Background

Any proposed development has the potential to impact upon the environmental, social or economic values of a region as a result of its development. It also has the potential to produce a cumulative impact upon those values when the proposed activity is conducted in combination with other developments. The typical effect is a compounded impact resulting from the interaction of multiple stressors from different projects. To have complete understanding of the full impact potential of a proposed development, it is necessary to assess the potential cumulative impacts that may result from the Project in combination with other projects. In addition, assessing the direct and indirect impacts attributable only to the project of interest must be carried out.

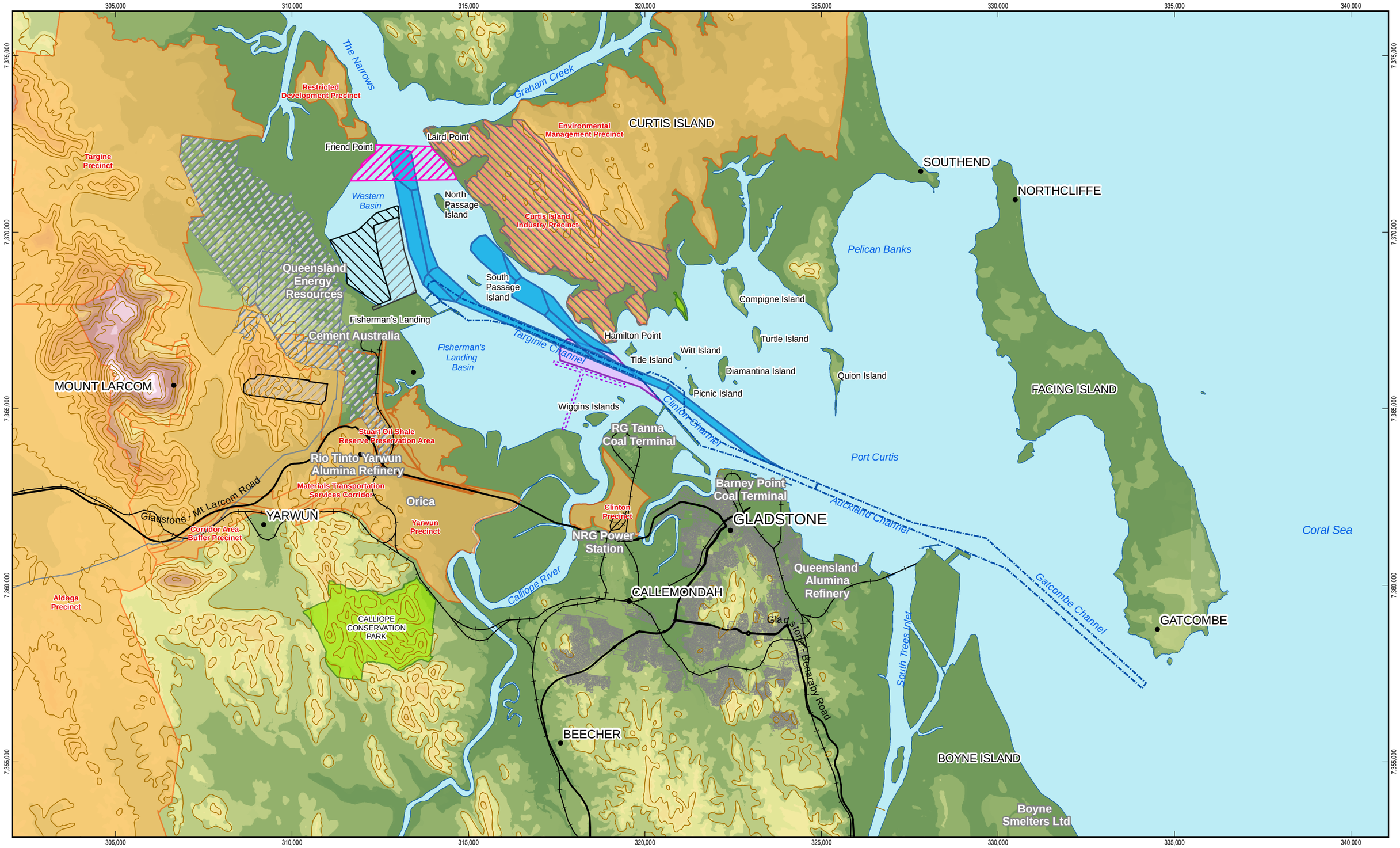
An assessment of cumulative environmental impacts considers the potential impact of a proposed development in the context of:

- Previous developments to provide context to environmental resilience;
- Existing developments to understand direct potential confounding impacts; and
- Future developments to consider all potential and indirect environmental impacts.

The assessment enables all potential impacts of a project to be understood in relative context and not in isolation from other projects. Assessment of previous developments should be conducted in context of the current baseline conditions of the environment. In this regard the existing environment has been characterised through studies conducted to complete the EIS and is reported in the main body of the EIS. Economic and social impacts from the Project are also presented in the body of the EIS, and, in accordance with the ToR, the cumulative impacts of relevance to these sections are noted here and detailed in the following sections.

A number of coastal developments are being undertaken in the Gladstone region in addition to the Western Basin Dredging and Disposal Project (Figure 6-1). These include:

- Annual maintenance dredging of the shipping channels, swing basins and berth pockets of various Port of Gladstone facilities by the '*Brisbane'* trailer hopper suction dredger;
- Development of the Wiggins Island Coal Terminal (approved);
- LNG Ltd Stage 1 dredging at the existing Fisherman's Landing reclamation Bulk Liquids Wharf; and
- Fisherman's Landing Northern Expansion – 153 ha reclamation, dredging of Targinie Channel and Fisherman's Landing Swing Basin (draft EIS submitted to the Co-ordinator General's office for review).



1:100,000 (at A3)

0 1 2 3 4 5

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

- Town and Locality
- Contour (50m interval)
- Railway
- Major Road
- Built Up Area
- Conservation Estate
- Western Basin Reclamation
- Fisherman's Landing Northern Expansion
- Mining Lease
- Quarry Lot Boundary
- Gladstone State Development Area
- Proposed Dredging
- Bridge & Road Marine Investigation Area
- LNG Facility Investigation Area
- Proposed Wiggin's Island Wharf
- Existing Channels, Swing Basins and Berths
- Wiggins Island Coal Terminal (Approved)

Port of Gladstone
Western Basin Dredging and Disposal Project

Job Number 42-15386
Revision A
Date 30 Aug 2009

Existing and Proposed Industries

Figure 6-1

G:\42\15386\GIS\WesternBasinProjects\MXDs\42-15386_WB_310_rev_a.mxd

Level 4 201 Charlotte Street Brisbane QLD 4000 Australia T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

The Western Basin Dredging and Disposal Project is required by GPC to provide access channels, swing basins and berths and to provide additional capacity for land based disposal of material from capital and maintenance dredging works in the Port of Gladstone. A comparative assessment of opportunities to disposal of the dredged material in other locations has been undertaken as part of this EIS and determined that placement of material within the Western Basin footprint provides the least impactive approach. This assessment is detailed under Section 1 of the main EIS document.

If one or more of the projects listed previously proceed in parallel with this project, there is potential for cumulative environmental impacts to the region, particularly with regard to compounding impacts from multiple dredging activities. Impacts from future developments are not able to be quantified and, accordingly, it is appropriate to examine cumulative impacts across all developments from a qualitative perspective. In this regard the methodological approach to assessment of cumulative impacts for the proposed Western Basin Dredging and Disposal Project has been to:

- Describe the existing baseline conditions of relevance to the Project Area;
- Ascertain potential direct and indirect impacts from the Western Basin Dredging and Disposal Project;
- Identify mitigation and management measures for each identified impact;
- Ascertain which of the identified impacts may be compounded by concurrent or successive other developments within the local region;
- Qualitatively describe how identified impacts are compounded; and
- Identify mitigation and management measures against the compounded impact potential.

In accordance with the ToR, the following describes identified cumulative impacts and mitigation measures for the marine ecology considerations of the Western Basin Dredging and Disposal Project. This section focuses on the impacts identified in Section 5 that may be compounded by other projects occurring in the Port.

6.2 Cumulative Impacts

6.2.1 Project Context

The Port of Gladstone has experienced ongoing development since the beginning of the twentieth century. Surveys in recent years have identified healthy seagrass and benthic assemblages existing in close proximity to port facilities demonstrating these assemblages persist under existing port operational conditions. However, as dredging and reclamation have both direct and indirect impacts on seagrass and benthic assemblages it follows that the implementation of this project will have a cumulative impact on these communities.

Effectively all proposed LNG plants and port facilities will require dredging of new channels, as defined in the project description (Figure 6-1) , with disposal of dredged material proposed for the Western Basin reclamation site. Rather than consider these in isolation, the potential cumulative impact associated with the proposed dredging program (which may involve multiple dredgers operating simultaneously) has been considered by including all envisaged future dredging works in the Western Basin Dredging and Disposal EIS. Works proposed for Fisherman's Landing, LNG Limited and Wiggins Island Coal Terminal have not been included in the impact assessment for this project. Wiggins Island Coal Terminal has

already achieved approval and the dredging works to be undertaken for Fisherman's Landing and LNG Limited are being assessed under separate approvals processes.

In accordance with the Terms of Reference, cumulative impacts associated with the construction and operation of land based works (i.e. beyond the proposed dredging works), have not been addressed under this project. However, it is appropriate to also explore potential cumulative impacts that may result from concurrent marine construction activities within the Study Area as these could compound and amplify the impacts identified by this Project. In particular, increased turbidity and additive declines in water quality could conceivably be generated by concurrent in-water construction activity, such as building of wharves or jetties. This could have a relatively small but compounded, additive, impact upon marine flora and fauna.

6.2.2 Approaches to Reduce Cumulative Impact Potential within Gladstone

By locating the Western Basin Dredging and Disposal Project adjacent to the Fisherman's Landing Northern Expansion, the potential impacts of these projects are amalgamated in one area. This amalgamation of impact areas has allowed for the avoidance of potential fragmentation of other seagrass meadows in the port. It should be also noted that the approved Wiggins Island Coal Terminal has been designed such that it will result in the removal of minimal seagrass communities.

The development of marine offloading facilities to the west of Curtis Island will also not result in extensive fragmentation of existing seagrass meadows as the seagrasses within this area are patchy except for immediately around North Passage Island, which supports mainly filamentous green algae but where *Halophila ovalis* and *H spinulosa* also occur sporadically.

6.2.3 Expected Cumulative Impacts in Addition to Dredging Activities

Hydrodynamic modelling, water and sediment quality assessments and coastal process studies undertaken to support this EIS have been used in conjunction with marine biodiversity studies to inform what potential impacts may occur as a direct or indirect result of all (proposed) reclamation and dredging works. This includes scenarios with multiple dredgers operating. However, the risk assessment for this project also identified a range of in-water construction impacts, which are likely to be applicable across all projects and have been considered here for the qualitative assessment of cumulative impacts. This includes pile driving for wharf construction and installation of channel markers and an increase in vessel traffic in the port during both construction and operation.

On this basis, potential cumulative impacts from the concurrent dredging and wharf construction projects in Gladstone are expected to result in a decrease in biodiversity and are likely to include:

- Alteration and removal of benthic habitat, including seagrass meadows, algal beds and macroinvertebrates. Areas to be affected by concurrent construction works are expected to have the greatest influence on macroinvertebrate and algal communities. Light, isolated patches of *Zostera capricorni* and potentially *Halophila ovalis* may occur within the vicinity of a few proposed jetty/wharf developments of proposed LNG plants (Rasheed *et al.* 2003) while, given their patchy nature and small footprint, pile driving activities to construct jetty/wharf facilities are expected to have minimal impact. The majority of impact from construction works is expected within deeper waters where algal beds and macroinvertebrates are more prevalent and seagrasses have not been recorded (by this study). Direct impacts to these communities may include from wharf/jetty structures shading the seabed and altering hydrodynamic regimes of the seabed and are also likely to relate to a shift in the

community resulting from deepening of waters from dredging, as described in Section 5. This is expected to have subsequent flow on effects to the epibenthic communities supported by these habitats; and

- Potential impacts to marine megafauna from construction and vessel operations. Expected impacts from these activities have been discussed in the Marine Megafauna Report (Appendix R of the main EIS).

The main potential operational impacts include:

- Impacts to water quality from stormwater and other site related discharges (particularly if not managed appropriately) and subsequent flow on effects to marine communities;
- Ongoing impacts to habitat and the supported communities from altered conditions. This may include alteration of ability to utilise habitat if structures are placed in the transitory pathway of fishes or other mobile species; and
- Impacts to marine megafauna from light spill, increased frequency of underwater noise (with increased vessel traffic) and altered hydrodynamic regimes (Appendix R of the main EIS).

6.2.4 Expected Effects on Marine Communities from Identified Cumulative Impact Activities

Mitigation strategies for each impact for the proposed Western Basin Dredging and Disposal Project were identified in Section 5.3.2 in Table 5-6. These mitigation measures took into consideration the potential impacts from multiple dredging projects occurring concurrently. These are considered to be the biggest concern with regard to cumulative impact potential relating to the multiple project development that may occur within the Gladstone region. Offsite impacts are likely to be temporary with recolonisation of any denuded areas occurring rapidly (within 2 years) post completion of dredging.

Accordingly, indirectly impacted areas are not expected to be permanently impacted from declines in water quality or altered hydrodynamic regimes, as assessed by this Project.

Beyond dredging works, some additional loss of soft sediment intertidal and subtidal species is expected from marine construction works associated with the land based facilities. Potential cumulative impacts to benthic habitats from this will likely occur within the direct area of each construction activity and may include a reduction in light under created structures leading to greater reduction in photosynthetic activities, additive removal of benthos, alteration to hydrodynamic regimes from provision of in-water structures and potentially increased mobilisation of contaminants.

Direct Removal of Benthic Habitat

Many of these potential impacts will principally be under the direct footprint of pylons driven to support wharf and jetty structures. However, the area of direct permanent impact from seabed removal, compared to reclamation works that could be undertaken to support the same wharf or jetty structures, is comparatively small.

Declines in Sediment or Water Quality

The offsite water quality impacts from pylon driving are minor and do not persist over time. Typically only small puffs of sediment are mobilised directly adjacent to the base of the pylon as it is being driven into the sediment. These are known to settle rapidly and not distribute far or create plumes. There is also little risk of pile driving mobilising contaminants bound within sediments as it usually only disturbs surface sediments and sediments in Port Curtis have not been assessed as contaminated. Removal of piles from

the seabed carries a greater risk of contaminant mobilisation but that is not an expected activity under cumulative construction scenarios. The activity of driving pylons is, therefore, expected to have only a small impact in regards to permanent loss or impact upon seabed habitat.

Social impacts and potential increases in waste related pollutions, which could affect water or sediment quality, may also occur in a cumulative manner. The relevant sections of the EIS should be referred to for discussion of those matters.

Noise and Vibration Impacts

Pile driving noise and vibration is expected to impact upon marine megafauna and other taxa resulting in temporary displacement from the construction area. Potential for direct damage to animals is also possible and use of warning noises or partial strikes should be adopted to promote avoidance of construction areas by animals prior to undertaking pile driving works. This is addressed further under the marine megafauna report (Appendix R of the main EIS) which should be referred to for a discussion of all potential cumulative impacts to marine megafauna.

Shading and Hydrodynamic Impacts

Development of overwater structures (jetties or wharves) may reduce light penetration to the seabed and could have flow on affects to the benthic assemblages, however, seagrasses may also persist in these environments. The expanse of the overwater structure and height off the water will have an influence on the shading impact the structure may have. Seagrasses are known to currently persist under existing over water structures in Port Curtis, including under the Queensland Alumina Limited causeway and the shading effects may not be significant for all proposed structures. A greater concern is the potential impact on species habitat utilisation, including movement between Port Curtis and The Narrows. This is likely to be affected by the proposed installation of wharf and jetty structures from Curtis Island into the channels and from the western banks of Port Curtis into the channels. Movement between these habitats may greatly reduce or cease for species sensitive to shipping activities or in-water barriers. This includes marine megafauna species. This should be taken into consideration during the design of any new facilities such that they minimise or avoid the restriction of species movements and water flow between northern and southern habitats in Port Curtis. Without providing for connectivity between The Narrows and areas within Port Curtis and to the south of Port Curtis, the ability of this region to continue to support the extensive marine megafaunal communities that currently persist is at significant risk.

6.2.5 Offsets For, and Mitigation Of, Potential Cumulative Impacts

Installation of in-water structures are not expected to have a net negative effect on the diversity of the benthic systems within the Study Area and may provide a net benefit as provision of three dimensional habitat intertidally and subtidally may promote species settlement. The rocky shore areas and rubble substrate areas surveyed typically supported a higher diversity or an equivalent diversity compared with the soft sediment habitats. Accordingly, creation of three dimensional hard substrate habitats in deeper water will likely improve the diversity of communities in these areas.

Three dimensional habitats, such as rock bunds and wharf pylons, are also preferred structures to place in-water compared to two or one dimensional structures in regards to fishery habitat values as three dimensional structures provide a greater niche refuges and hence colonisation area for benthic communities, juvenile fish and crab taxa. Use of rock walls for reclamation works or pylons for wharf or jetty construction are, therefore, in accordance with the principals of the Queensland Government Fish Habitat Guidelines (FHG 006). This creation of interstitial habitat will partially, and may completely, offset

some of the habitat losses associated with direct removal as these areas will be rapidly colonised and may support a greater diversity of species than currently persist in these locations.

Consistency in application of mitigation measures identified for this project should be considered for all other projects to reduce potential for cumulative impacts. In particular development of reactive management plans for dredging, construction, waste management and hazardous material risks should be undertaken for this Project such that the potential for cumulative effects, from adjacent works are considered and accounted for.

For recognised permanent habitat losses occurring as a result of this project and as a consequence of cumulative impacts, offsets should be implemented in accordance with the EPBC Act and Queensland Government's Environmental Offset Policy. Understanding of potential cumulative impacts from all possible dredging projects is achieved in a coordinated manner by accounting for all future dredging requirements in Gladstone under this project.

7. Conclusion

The Project Area supports a number of key marine benthic habitats, some of which are unique to those areas with regard to the species compositional mix they support, the majority of which are, however, well represented within the Study Area. The communities sampled reflected the variety of benthic habitats observed during the survey.

The Western Basin and Fisherman's Landing sites were dominated by soft silty, muddy benthic habitats supporting communities that were similar in their composition. The Reference Area, The Narrows and the Passage Islands sites all supported a mixture of sediment types across the sites but typically any individual site was characterised by a dominant type of sediment, such as sand or shell and the community composition at each site was reflective of this. The Channel sites, however, had the most diverse sediments on a site by site basis with no silty sediments and a dominance of coarse sand, rubble and some rock.

The taxonomic composition of the macroinvertebrate benthic communities were fairly similar to one another at Western Basin, Fisherman's Landing and the Reference Area where around half of all the organisms present were molluscs and crustaceans with seagrass and algae the other dominant benthos. These communities differed from those at The Narrows, Channel and Passage Islands where a more diverse, greater proportion of different types of animals were observed, specifically, there were more echinoderms, corals and anemones, bryozoans, ascidians and sponges. Western Basin and Fisherman's Landing had the least diverse communities of all locations surveyed.

As the Project involves reclamation of approximately 235 ha of seabed within the Western Basin footprint the marine benthic habitats in this area will be directly impacted. Areas to be dredged in the channels and proposed channels will also be directly impacted. The primary direct impact will involve removal of all seabed environment under the direct footprint of the Reclamation Area and channel dredging areas, which totals approximately 902 ha including habitat that is already dredged. Areas within the channel are expected to be recolonised post dredging within two to five years.

The major indirect impacts expected include degradation of water quality during dredging and disposal activities resulting in displacement of mobile fauna and potential die back of benthic fauna and alteration of the hydrodynamic regime in the Project Area. This is expected to increase sedimentation in some locations, such as along the eastern face of the reclamation footprint, but is also expected to increase scouring potential around the bund.

Within the Port Curtis / Gladstone wider region there is significant development occurring and concurrent development of coastal habitats has the potential to compound any affects directly related to this Project's development.

The main potential construction impacts, including potential cumulative impacts, which may result during the reclamation and channel dredging works are, therefore:

- Removal of benthic habitat, particularly benthic primary producer communities that support fisheries taxa and protected and threatened marine megafauna;
- Declines in water quality associated with construction events, particularly from the combined effect of dredge plumes; and
- Potential impacts to fauna, particularly turtles and dugongs, from vessel operations.

The main potential operational impacts include:

- Continuous disturbance to benthic systems or mobile species transit routes from in water marine structures;
- Ongoing impacts to water quality from reclamation stormwater runoff;
- Increased potential of pollution to the marine environment as a result of land use change.

In addressing the potential risks to the marine system from the Project proposed mitigation measures were examined, where opportunities to mitigate impacts are available. These were detailed above and, in brief, include:

- Development and implementation of a reactive dredge management plan to mitigate against impacts on water quality from dredging activities;
- Development and implementation of a reactive sensitive habitat monitoring program to inform dredging activities and mitigate against potential impacts to these systems from declines in water or sediment quality. This may include development of tolerance limits of sensitive systems prior to dredging commencing;
- Implementation of waste management plans;
- Appropriate design of the reclamation facility to reduce water quality impacts from leaching of material through the bund wall, decant waters and storm-water run-off and with respect to reducing benthic habitat scouring potential around the bund;
- Removal of marine fauna from the Reclamation Area prior to bund closure to avoid fatalities of the animals that previously occupied this footprint;
- Dredge management strategies to avoid impacts upon marine megafauna including use of spotters and turtle exclusion devices;
- Use of soft starts during pile driving activities to minimise potential impacts upon nearby marine fauna; and
- Considered use of speed restricted areas and eduction of workforce regarding potential for vessel impacts upon marine megafauna to reduce potential for damaging or fatal interactions.

A number of direct impacts are not able to be mitigated. These primarily relate to loss of habitat as a consequence of the Project activities. Offsets will have to be implemented for these habitat losses. Some benthic marine habitat will be created by the Project and an estimate of the areas to be lost and gained as a result of the Project activities has been provided above.

The seabed environs to be lost are represented elsewhere within the Gladstone region, however, these habitats are continually being lost within this region and elsewhere to ongoing coastal developments. The primary benthic producer habitats being affected are critically important for protected and threatened species, especially turtles and dugongs, as well as being highly supportive of commercially and recreationally important fishery species. The carrying capacity of the residual (post development) benthic systems to support the robust populations of these taxa within the Gladstone region is unknown and, under cumulative impact scenarios, it is likely that any taxa temporarily displaced by this project will not return to the area. Consideration should be given to the ongoing protection of remaining benthic habitats within the Gladstone region in parallel with developing a greater understanding of the required habitat needs for communities within the area. This information should be developed within a regional framework

to contextualise the mobility and migratory nature of many of these species. In particular, consideration must be given to protecting the transitory and migratory pathways within the Gladstone Harbour as construction of marine structures and increased shipping may result in restriction of access to The Narrows and this pathway may be lost for species sensitive to shipping activities.

8. References

Alquezar R. and Small K. (2006). *Port Curtis Macrobenthic Monitoring Programme* (Final Report).Gladstone Port Authority November 1995- November 2003. Centre for Environmental Management, Central Queensland University. Australia. pp.50.

Chartrand K.M., Rasheed M.A., and Unsworth R.K.F (2009). *Port Curtis long term seagrass monitoring.* QPI&F Publication PR09-4407 (QPI&F, Cairns), 33 pp

Clarke K.R and Gorley R.N. (2006). *Primer v6 User Manual/Tutorial.* Primer –E: Plymouth.

Clarke K.R and Warwick R.M. (2001). *Changes in marine communities: an approach to statistical analyses and interpretation*, 2nd edition. Primer-E: Plymouth.

Coles R.G., McKenzie L.J., Rasheed M.A., Mellors J.E., Taylor H., Dew K., McKenna S., Sankey T.L., Carter A.B. and Grech A. (2007). *Status and Trends of Seagrass Habitats in the Great Barrier Reef World Heritage Area.* Report to the Marine and Tropical Sciences Research Facility. Reef and Rainforest Research Centre Limited, Cairns.

Collier, C. and Waycott, M. (2009). Drivers of change to seagrass distributions and communities on the Great Barrier Reef: Literature Review and Gaps Analysis. Report to the Marine and Tropical Sciences Research Facility. Reef and Rainforest Research Centre Limited, Cairns (55pp.).

Currie, D.R. and Small, K.J. (2005). Macrobenthic community responses to long-term environmental change in an east Australian sub-tropical estuary. *Estuarine, Coastal and Shelf Science* 63: 315-331

Cruz Motta J.J. (2000). Effects of dumping of dredged material of Townsville Port on the soft-bottom *benthic community of Cleveland Bay*. James Cook University report to the Townsville Port Authority.

DEEDI (formerly DPIF) – Department of Primary Industries and Fisheries (2009a). *Declared Fish Habitat Areas.* http://www.dpi.qld.gov.au/cps/rde/xchg/dpi/hs.xsl/28_1238_ENA_HTML.htm. Accessed 14 January 2009.

DERM (formerly) Environmental Protection Agency (2009a). *Great Barrier Reef Coast Marine Park.* http://www.epa.qld.gov.au/parks_and_forests/marine_parks/gbr_coast_marine_park/ Accessed 14 January 2009.

DEWHA – Department of the Environment, Water, Heritage and the Arts (2007). Whale Shark *Rhincodon typus* in Marine Species Information, Department of the Environment, Water, Heritage and the Arts Canberra. Available from: http://www.environment.gov.au/coasts/species/sharks/whaleshark/index.html. Accessed October 1 2008

DEWHA – Department of the Environment, Water, Heritage and the Arts (2008a). *Australian Heritage Database – Great Barrier Reef*. http://www.environment.gov.au/cgi-bin/ahdb/search.pl Date Accessed: 12th August 2008.

DEWHA – Department of the Environment, Water, Heritage and the Arts (2009b). *Australian Heritage Database – Balaclava Island and The Narrows, Curtis Island, QLD, Australia.*

Fourqurean JW, Boyer JN, Durako MJ, Hefty LN and Peterson BJ (2003). Forecasting responses of seagrass distributions to changing water quality using monitoring data. *Ecological Applications* 13(2): 474-489.

Froese R. and Pauly, D. (2009). FishBase. World Wide Web electronic publication. www.fishbase.org, version (06/2009).

Ellis D. (1985). *Taxonomic sufficiency in pollution assessment. Marine Pollution Bulletin*, Vol. 16: 459

EA (1999). The Sustainable Minerals programme (previously known as the Best Practice Environmental Management in Mining Programme) http://www.ea.gov.au/industry/sustainable/mining/index.html Accessed March 2009

GHD (2009) *Fisherman's Landing Northern Expansion Draft Environmental Impact Statement.* GHD Pty Ltd.

GBRMPA (2009). *Dugong Protection Areas – Mesh Netting Restrictions.* http://www.gbrmpa.gov.au/corp_site/key_issues/conservation/natural_values/dugongs/dugong_protection_areas. Accessed 14 January 2009.

Hewitt C.L. and Martin R.B. (1996). Port surveys for introduced marine pests. CRIMP Technical Report No. 4, CSIRO Marine Research, Hobart, 40pp.

Kuiter R.H. (2001) *Revision of the Australian Seahorses of the Genus Hippocampus (Sygnahtiformes:Sygnathidae) with descriptions of nine new species*. Records of the Australian Museum 53, 293-340.

Neil K.M., Stafford H., Rose C. and Thomas R. (2003). *Flora and Fauna Survey: Cairns Port Authority Ocean Disposal Site*. CRC Reef Research Centre and Queensland Department of Primary Industries and Fisheries, report to Cairns Port Authority.

Olsgard R., Somerfield R.J., and Carr M.R. (1997). *Relationship between taxonomic resolution and data transformation in analyses of a macrobenthic community along an established pollution gradient. Marine Ecology Progress Series* Vol 149: 173-181

Peterson, B.J. and Heck Jr., P.L. (1999). The potential for suspension feeding bivalves to increase seagrass productivity. *Journal of Experimental Marine Biology and Ecology*. 240: 37-52.

Platten J. R. (2004). Historical trends in recreational fishing catches in the Gladstone region. *Cooperative Research Centre of Coastal Zone, Estuary and Waterway Management.*

PCIMP (2008) Port Curtis Integrated Monitoring Program Monitoring Approach and Methodology. Vision Environment (QLD)

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*. DPI Information Series QI03058 Marine Ecology Group, Northern Fisheries Centre, Department of Primary Industries and Fisheries.

Rasheed M.A., McKenna S.A., and Thomas R. (2005). *Long term seagrass monitoring in Port Curtis and Rodds Bay, Gladstone – October/November 2004.* DPI&F Information Series Q105032 (DPI&F, Cairns) 27pp.

Rasheed M.A., Taylor H.A, and Thomas R. (2006). *Long term seagrass monitoring in Port Curtis and Rodds Bay, Gladstone – October 2006.* DPI&F Information Series Q106030 (DPI&F, Cairns) 30pp.

Rasheed M.A., McKenna S.A., Taylor H.A. and Sankey T.L. (2008). *Long term seagrass monitoring in Port Curtis and Rodds Bay, Gladstone – October 2007.* DPI&F Publication PR07-3271 (DPI&F, Cairns) 32pp.

Roberts R.D., Gregory M.R. and Foster M.A. (1998). *Developing an efficient macrofauna monitoring index from an impact study a dredge spoil example. Marine Pollution Bulletin* Vol. 36: 231-235.

Seibold, E. and Berger, W.H. (1996). The Seafloor – An introduction to Marine Geology. Third Edition. *Springer, Heildelberg (Berlin, Heildelberg, New York)* 356 pp.

Skagen, S.K. and Oman, H.D. (1996). Dietary flexibility of shorebirds in the Western Hemisphere. *Canadian Field-Naturalist*. 110: 419-444.

Smith S.D.A. and Rule M.J. (2001). *The effects of dredge-spoil dumping on a shallow water soft-sediment community in the Solitary Islands Marine Park, N.S.W, Australia. Marine Pollution Bulletin,* Vol. 42, No. 11, pp 1040-1048.

Taylor H.A., Rasheed M.A., Dew K. and Sankey T.L. (2007) *Long Term seagrass monitoring in Port Curtis and Rodds Bay, Gladstone – November 2006.* DPI&F Publication PR07-2774 (DPI&F, Cairns)

URS (2009). GLNG Marine Ecology Technical Report. Prepared for Santos Ltd, 152pp.

Vanderklift M.A., Ward T.J. and Jacoby C.A. (1996). *Effect of reducing taxonomic resolution* Marine Ecology Progress Series, vol. 136: 137-145. Wildish, 985. Effects of dredging and dumping on benthos of Saint John Harbor. Canadian Marine Environmental Research, vol. 15: 45-57

Van Dyck, S. and Strahan, R. (2008). The Mammals of Australia. 3rd Edition. New Holland Publishers.

Warwick R.M. (1998). *The level of taxonomic discrimination required to detect pollution effects on marine benthic communities. Marine Pollution Bulletin*, Vol. 19: 259-268.

WBM (2009). Draft. Gladstone Western Basin EIS – Numerical Modelling Studies. R.B. 17382.002.00.Impact_Assessment.doc. August 2009. Prepared for Gladstone Ports Corporation.

Wilson, S. K. and G. Swan (2003). A Complete Guide to Reptiles of Australia. Reed New Holland, French's Forest, NSW.

Appendix A

Taxa list and presence/absence at each location

Taxa	Common Name	Western Basin	Fisherman's Landing	The Narrows	Channel	Passsage Islands	Reference Area
Ampharetidae sp. 1	Polychaete			X			
Ampharetidae sp. 2	Polychaete	X					
Ampharetidae unidentified	Polychaete					X	
Capitellidae sp. 1	Polychaete	X					
Eunicidae sp. 1	Polychaete	X					
Eunicidae sp. 2	Polychaete				X		X
Eunicidae sp. 3	Polychaete				X		
Nereididae sp. 1	Polychaete			X			X
Nereididae sp. 2	Polychaete						X
Serpulidae sp. 1	Polychaete			X	X	X	X
Sigalionidae sp. 1	Polychaete	X		X			
Terebellidae sp. 1	Polychaete			X			
Terebellidae sp. 2	Polychaete					X	
Trichobranchidae sp. 1	Polychaete	X					
Trichobranchidae sp. 2	Polychaete		X				
Onuphidae sp. 1	Polychaete	X				X	
Polynoidae sp. 1	Polychaete				X		
Polynoidae sp. 2	Polychaete				X		
Polynoidae sp. 3	Polychaete				X		
Maladanidae sp. 1	Polychaete	X		X			
Polychaete unidentified	Polychaete	X	X	X	X	X	
Nematode unidentified	Round worm				X		X
Zostera capricorni	Seagrass	X	X		X		X
Halodule uninervis (wide)	Seagrass						X
Halodule uninervis (narrow)	Seagrass						X
Halophila spinulosa	Seagrass	X	X			X	
Halophila ovalis	Seagrass	X	X				X
Gammaridean Amphipod	Amphipod crustacean			X	X	X	X
Isopod	Isopod crustacean			X	X		X
Alpheidae sp. 1	Snapping shrimp				X	X	
Dorippidae sp. 1	Carrier crab					X	
Hexapodidae sp. 1	Six-legged crab			X	X		
Nursia sp. 1	Pebble crab				X	X	
Leucosidae sp. 1	Pebble crab		X		X		X
Leucosidae sp. 2	Pebble crab						X
Leucosia sp. 1	Pebble crab						X
Portunidae	Swimming crab	X		X			
Portunus sp. 1	Swimming crab	X		X			X
Portunus sp. 2	Swimming crab		X				X
Portunus sp. 3	Swimming crab						X
Portunus sp. 4	Swimming crab						X
Thalamita sp. 1	Swimming crab		X			X	X
Charybdis sp. 1	Swimming crab				X		
Phalangipus sp. 1	Spider crab			X	X	X	X
Majidae sp. 1	Spider crab			X	X	X	
Majidae sp. 2	Spider crab						X
Majidae sp. 3	Spider crab				X		
Majidae sp. 4	Spider crab				X		
Pilumnidae sp. 1	Spider crab				X		
Trachypeneaus anchoralis	Hardback prawn	X	X				
Peneaus marginatus	Aloha prawn	X	X				
Parapenaeopsis sp. 1	Prawn	X					
Parapenaeus sp. 1	Prawn			X			
Peneaus plebejus	Eastern king prawn		X				
Caridae sp. 1	Shrimp			X		X	
Caridae	Shrimp				X		
Diogenidae	Hermit crab	X	X			X	X
Paguridae	Hermit crab	X			X	X	X

Taxa	Common Name	Western Basin	Fisherman's Landing	The Narrows	Channel	Passsage Islands	Reference Area
Hermit Crab unidentifiable	Hermit crab		X				
Grapsidae sp. 1	Shore crab						X
Ocypodidae sp. 1	Stalk-eyed crab						X
Ocypodidae sp. 2	Stalk-eyed crab						X
Hymenosomatidae sp. 1	Spider crab				X		
Hymenosomatidae sp. 2	Spider crab						X
Palaemonidae sp. 1	Shrimp				X		
Palaemonidae sp. 2	Shrimp				X		
Scyllarides sp. 1	Flat lobster				X		
Xanthidae sp. 1	Dark fingered crab						X
Stomatopod	Mantis shrimp			X			
Austromegabalanus sp.	Barnacle			X	X		X
Bugula sp.	Bryozoan	X	X	X	X	X	X
Watersipora sp.	Bryozoan			X			
Erect Branching Bryozoan sp. 1	Bryozoan			X	X	X	X
Erect Branching Bryozoan sp. 2	Bryozoan			X			
Erect Foliose Bryozoan	Bryozoan				X	X	
Encrusting Bryozoan sp. 1	Bryozoan			X	X	X	X
Encrusting Bryozoan sp. 2	Bryozoan				X		
Spiral Bryozoan	Bryozoan			X	X	X	X
Coral Bryozoan	Bryozoan			X	X	X	
Orange Bryozoan	Bryozoan				X		X
Burrowing Anemone sp. 1	Burrowing anemone			X		X	X
Burrowing Anemone sp. 2	Burrowing anemone					X	X
Anemone	Sea anemone				X		
Orange/Red Anemone	Sea anemone						X
Dendronephthya sp. 1	Soft Coral	X	X	X	X	X	X
Soft Coral sp. 1	Soft Coral				X	X	
Soft Coral sp. 2	Soft Coral				X		
Gorgonian sp. 1	Gorgonian coral			X	X	X	
Gorgonian sp. 2	Gorgonian coral				X		
Gorgonian sp. 3	Gorgonian coral				X		
White Sea Whip	Sea whip				X		
Sea Pen sp. 1	Sea pen				X		
Hydrozoan sp. 1	Hydrozoan	X	X	X	X	X	
Hydrozoan sp. 2	Hydrozoan			X	X	X	X
Hydrozoan sp. 3	Hydrozoan				X	X	
Hard Coral sp. 1	Hard coral				X		
Encrusting Coral sp. 1	Encrusting coral			X	X		
Solitary Coral sp.1	Hard coral				X		
Ctenophore	Comb jelly	X		X			
Asteroidea sp. 1	Sea stars			X			
Asteroidea sp. 2	Sea stars				X		
Asteroidea sp. 3	Sea stars				X		
Astropecten sp. 1	Sea stars				X	X	X
Astropecten sp. 2	Sea stars					X	
Asteroidea	Sea stars				X		
Echinoidea sp.1	Sea urchin			X	X		
Echinoidea sp.2	Sea urchin						X
Crinoidea sp. 1	Feather stars				X	X	
Crinoidea sp. 2	Feather stars				X	X	
Crinoidea sp. 3	Feather stars				X		
Crinoidea sp. 4	Feather stars				X		
Crinoidea sp. 5	Feather stars				X		
Crinoidea sp. 6	Feather stars				X		
Crinoidea sp. 7	Feather stars				X	X	
Crinoidea sp. 8	Feather stars				X	X	
Crinoidea sp. 9	Feather stars				X		

Taxa	Common Name	Western Basin	Fisherman's Landing	The Narrows	Channel	Passsage Islands	Reference Area
Lovenidae sp. 1	Heart urchin			X			
Stichopodidae sp. 1	Sea cucumber				X		
Ophiuroidea sp. 1	Brittle star				X		
Ophiuroidea sp. 2	Brittle star						X
Arcidae sp. 1	Ark shell bivalve	X		X	X		X
Arcidae sp. 2	Ark shell bivalve				X		
Barbatia sp. 1	Ark shell bivalve			X			
Corbulidae sp. 1	Cockle bivalve	X	X	X	X		X
Laternulidae sp. 1	Lantern clam bivalve	X					
Laternulidae sp. 2	Lantern clam bivalve	X	X		X		
Anomiidae sp. 1	Jingle shell bivalve	X		X		X	
Chlamys sp. 1	Scallop bivalve			X	X	X	
Chlamys sp. 2	Scallop bivalve				X		
Chlamys sp. 3	Scallop bivalve				X		
Pectinidae	Scallop bivalve				X		X
Ostreidae sp. 1	Oyster bivalve				X		
Ostreidae sp. 2	Oyster bivalve					X	
Isognomonidae sp.1	Toothed oyster bivalve				X		X
Isognomonidae sp.2	Toothed oyster bivalve				X		
Malleidae sp. 1	Hammer oyster bivalve				X	X	
Pteriidae	Wing oyster bivalve				X		
Mactra sp. 1	Mactra bivalve	X	X				X
Mactra sp. 2	Mactra bivalve	X	X				X
Mactra sp. 3	Mactra bivalve	X	X				X
Mactra sp. 4	Mactra bivalve	X					
Cardiidae sp. 1	Heart cockle bivalve						X
Modiolus sp.1	Mussel bivalve	X		X			X
Modiolus sp.?	Mussel bivalve						X
Cioboticola lunata	Mussel bivalve						X
Mytilidae sp. 1	Mussel bivalve	X					
Mytilidae	Mussel bivalve		X		X		
Xenostrobus sp. 1	Mussel bivalve				X		
Pinnidae	Razor clam bivalve				X		
Venus sp. 1	Venus clam bivalve	X	X	X	X	X	X
Venus sp. 2	Venus clam bivalve			X			
Venus sp. 3	Venus clam bivalve				X	X	
Veneridae sp. 1	Venus clam bivalve	X	X	X		X	X
Veneridae sp. 2	Venus clam bivalve				X	X	
Paphia sp. 1	Venus clam bivalve	X		X			
Tellinidae sp. 1	Tellen bivalve	X	X	X			
Nerita costata	Nerite gastropod				X		X
Naticidae sp. 1	Moon snail gastropod						X
Strombus sp. 1	Stromb gastropod					X	
Ranellidae sp. 1	Trumpet gastropod						X
Ranellidae sp. 2	Trumpet gastropod						X
Cominella sp. 1	Whelk gastropod			X			
Cancellariidae	Nutmeg shell gastropod			X	X		X
Latirus sp. 1	Spindle gastropod	X		X			
Nassaridae sp. 1	Dog whelk gastropod	X		X			
Nassaridae sp. 2	Dog whelk gastropod	X					
Muricidae sp. 1	Murex gastropod					X	
Morula granulata	Granulated drupe gastropod						X
Olividae sp. 1	Olive gastropod			X		X	
Terebra sp. 1	Auger gastropod						X
Terebra sp. 2	Auger gastropod						X
Inquisitor sp. 1	Turrid shell gastropod		X		X	X	X
Inquisitor sp. 2	Turrid shell gastropod						X
Fissurellidae	Keyhole limpet gastropod				X		

Taxa	Common Name	Western Basin	Fisherman's Landing	The Narrows	Channel	Passsage Islands	Reference Area
Scutus antipodes	Shield limpet gastropod				X		
Cerithiidae sp. 1	Creeper gastropod	X	X				X
Pyrazus ebeninus	Hercules mud whelk gastropod						X
Turbo sp. 1	Turban shell gastropod	X		X	X		X
Turbo sp. 2	Turban shell gastropod						X
Turbo sp. 3	Turban shell gastropod				X		
Turbinidae sp. 1	Turban shell gastropod						X
Turbinidae sp. 2	Turban shell gastropod						X
Turbinidae sp. 3	Turban shell gastropod						X
Astralium sp. 1	Turban shell gastropod						X
Trochidae sp. 1	Top shell gastropod				X	X	X
Trochidae sp. 2	Top shell gastropod				X		X
Aplysia sp.	Sea hare gastropod			X			
Haminoeidae sp.	Bubble shell gastropod			X			
Chiton sp. 1	Chiton				X		
Brown Sponge	Sponge			X		X	X
Green Sponge	Sponge				X		X
Orange Sponge	Sponge				X		X
Pink Sponge	Sponge				X		
Purple Sponge	Sponge						X
Red Sponge	Sponge	X		X	X		X
Red Encrusting Sponge	Sponge						X
White Sponge	Sponge			X	X		X
Spikey Ball Sponge	Sponge					X	
Yellow Sponge	Sponge				X		X
Grey Sponge	Sponge				X		
Sponge	Sponge			X		X	
Udotea sp. 1	Algae	X					
Halimeda sp.	Algae						X
Codium geppi	Algae						X
Caulerpa sp.	Algae						X
Acerabularia calyculus	Algae						X
Green Filamentous Algae	Algae	X	X		X	X	X
Green Algae	Algae	X					
Dictyota sp.	Algae				X		X
Lobophora variegata	Algae						X
Padina sp.	Algae						X
Sargassum sp.	Algae						X
Hydroclathrus clathratus	Algae						X
Brown Filamentous Algae	Algae						X
Brown Algae	Algae						X
Champia parvula	Algae						X
Dasya sp. 1	Algae	X		X			
Martensia fragilis	Algae						X
Chondria succulenta	Algae	X					X
Asparagopsis taxiformis	Algae				X		X
Red Filamentous Algae	Algae	X		X		X	X
Calcareous Algae	Algae			X			
Red Algae	Algae	X	X				
Sipunculid	Peanut worm		X	X			
Clear Ascidian sp. 1	Ascidian sea squirt	X			X		
Clear Ascidian sp. 2	Ascidian sea squirt				X		X
Ascidean sp. 1	Ascidian sea squirt			X	X	X	X
Ascidean sp. 2	Ascidian sea squirt					X	
Ascidean sp. 3	Ascidian sea squirt				X	X	
Ascidean sp. 4	Ascidian sea squirt				X		X
Ascidean sp. 5	Ascidian sea squirt				X		
Ascidean sp. 6	Ascidian sea squirt						X

Taxa	Common Name	Western Basin	Fisherman's Landing	The Narrows	Channel	Passsage Islands	Reference Area
Colonial Ascidian sp. 1	Ascidian sea squirt				X		
Colonial Ascidian sp. 2	Ascidian sea squirt					X	
Colonial Ascidian	Ascidian sea squirt			X			
White Colonial Ascidian	Ascidian sea squirt			X	X	X	X
Yellow Colonial Ascidian	Ascidian sea squirt			X			X
Blue Colonial Ascidian	Ascidian sea squirt						X
Ciona sp. 1	Ascidian sea squirt					X	
Callionymidae sp. 1	Dragonet fish						X
Platycephalus sp. 1	Flathead fish						X
Platycephalus sp. 2	Flathead fish						X
Hippocampus dahli	Low crown seahorse				X		
Fish Egg	Fish egg			X	X		

Crustacean spider or decorator crab

Gastropod Olividae shell

Low crown seahorse

Cnidarian Soft coral

Appendix B

Locations, sites and dominant sediment type

Location	Site	Dominant Sediment Type	Depth
Western Basin	WB 1	Silt	
Western Basin	WB 2	Silt	
Western Basin	WB 3	Silt	
Western Basin	WB 4	Silt	
Western Basin	WB 5	Silt	
Western Basin	WB 10	Silt	
Western Basin	WB 11	Silt	
Western Basin	WB 17	Silt	
Western Basin	WB 18	Silt	
Western Basin	WB 20	Silt	
Western Basin	WB 21	Silt	
Western Basin	WB 22	Silt	
Western Basin	WB 23	Silt	
Western Basin	WB 6	Mud	
Western Basin	WB 7	Mud	
Western Basin	WB 8	Mud	
Western Basin	WB 9	Mud	
Western Basin	WB 12	Mud	
Western Basin	WB 13	Mud	
Western Basin	WB 14	Mud	
Western Basin	WB 15	Mud	
Western Basin	WB 16	Mud	
Western Basin	WB 19	Mud	
Western Basin	WB 24	Mud	
Western Basin	WB 25	Mud	
Fisherman's Landing	FL 1	Silt	
Fisherman's Landing	FL 2	Silt	
Fisherman's Landing	FL 4	Silt	
Fisherman's Landing	FL 5	Silt	
Fisherman's Landing	FL 6	Silt	
Fisherman's Landing	FL 7	Silt	
Fisherman's Landing	FL 9	Silt	
Fisherman's Landing	FL 10	Silt	
Fisherman's Landing	FL 3	Mud	
Fisherman's Landing	FL 8	Mud	
The Narrows	N 9	Silt	
The Narrows	N 6	Mud	
The Narrows	N 7	Mud	
The Narrows	N 8	Mud	
The Narrows	N 10	Mud	
The Narrows	N 1	Shell	
The Narrows	N 2	Shell	
The Narrows	N 3	Shell	
The Narrows	N 5	Shell	
The Narrows	N 4	Sand	
Channel	C 2	Mud	
Channel	C 8	Mud	
Channel	C 9	Mud	
Channel	C 11	Shell	
Channel	C 13	Shell	
Channel	C 3	Sand	
Channel	C 4	Sand	

Channel	C 5	Sand	
Channel	C 6	Sand	
Channel	C 7	Sand	
Channel	C 10	Sand	
Channel	C 14	Sand	
Channel	C 20	Sand	
Channel	C 1	Clay	
Channel	C 12	Rubble	
Channel	C 15	Rubble	
Channel	C 16	Rubble	
Channel	C 17	Rubble	
Channel	C 18	Rubble	
Channel	C 19	Rock	
Passage Islands	P 5	Silt	
Passage Islands	P 10	Silt	
Passage Islands	P 6	Mud	
Passage Islands	P 7	Mud	
Passage Islands	P 8	Mud	
Passage Islands	P 9	Mud	
Passage Islands	P 11	Mud	
Passage Islands	P 3	Shell	
Passage Islands	P 1	Clay	
Passage Islands	P 2	Clay	
Passage Islands	P 4	Clay	
Reference Area	R 11	Silt	
Reference Area	R 13	Silt	
Reference Area	R 15	Silt	
Reference Area	R 1	Mud	
Reference Area	R 5	Mud	
Reference Area	R 6	Mud	
Reference Area	R 7	Mud	
Reference Area	R 9	Mud	
Reference Area	R 17	Mud	
Reference Area	R 3	Shell	
Reference Area	R 2	Sand	
Reference Area	R 4	Sand	
Reference Area	R 8	Sand	
Reference Area	R 10	Sand	
Reference Area	R 12	Sand	
Reference Area	R 14	Sand	
Reference Area	R 16	Sand	
Reference Area	R 18	Sand	

Appendix C

EPBC Protected Matters online search tool

Australian Government
Department of the Environment, Water, Heritage and the Arts

Protected Matters Search Tool

You are here: Environment Home > EPBC Act > Search

29 July 2009 09:07

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

You may wish to print this report for reference before moving to other pages or websites.

The Australian Natural Resources Atlas at http://www.environment.gov.au/atlas may provide further environmental information relevant to your selected area. Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html

Search Type: Line

Buffer: 10 km

Coordinates: -23.7640,151.1528, -23.8891,151.3730

Report Contents:

This map may contain data which are
© Commonwealth of Australia
(Geoscience Australia)
© 2007 MapData Sciences Pty Ltd, PSMA

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are

proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html.

World Heritage Properties:	1
National Heritage Places:	1
Wetlands of International Significance: (Ramsar Sites)	None
Commonwealth Marine Areas:	None
Threatened Ecological Communities:	3
Threatened Species:	24
Migratory Species:	32

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html.

Please note that the current dataset on Commonwealth land is not complete. Further information on Commonwealth land would need to be obtained from relevant sources including Commonwealth agencies, local agencies, and land tenure maps.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.au/epbc/permits/index.html.

Commonwealth Lands:	1
Commonwealth Heritage Places:	None
Places on the RNE:	5
Listed Marine Species:	75
Whales and Other Cetaceans:	8
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

nominated.

State and Territory Reserves:	6
Other Commonwealth Reserves:	1
Regional Forest Agreements:	1

Details

Matters of National Environmental Significance

World Heritage Properties [Dataset Information]

Great Barrier Reef QLD

National Heritage Places [Dataset Information]

Great Barrier Reef QLD

Threatened Ecological Communities [Dataset Information]	Status	Type of Presence
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	Critically Endangered	Community likely to occur within area
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Community likely to occur within area
Weeping Myall Woodlands	Endangered	Community may occur within area
Threatened Species [Dataset Information]	Status	Type of Presence
Birds		
Geophaps scripta scripta Squatter Pigeon (southern)	Vulnerable	Species or species habitat likely to occur within area
Pterodroma neglecta neglecta Kermadec Petrel (western)	Vulnerable	Species or species habitat may occur within area
Turnix melanogaster Black-breasted Button-quail	Vulnerable	Species or species habitat likely to occur within area
Mammals		
Balaenoptera musculus Blue Whale	Endangered	Species or species habitat may occur within area
Dasyurus hallucatus Northern Quoll	Endangered	Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale	Vulnerable	Breeding known to occur within area
Xeromys myoides Water Mouse, False Water Rat	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea	Endangered	Species or species habitat may

Leatherback Turtle, Leathery Turtle, Luth		occur within area
Egernia rugosa Yakka Skink	Vulnerable	Species or species habitat likely to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle	Endangered	Species or species habitat may occur within area
Natator depressus Flatback Turtle	Vulnerable	Breeding likely to occur within area
Paradelma orientalis Brigalow Scaly-foot	Vulnerable	Species or species habitat likely to occur within area
Sharks		
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish	Vulnerable	Species or species habitat may occur within area
Rhincodon typus Whale Shark	Vulnerable	Species or species habitat may occur within area
Plants		
Bosistoa selwynii Heart-leaved Bosistoa	Vulnerable	Species or species habitat likely to occur within area
Bosistoa transversa Three-leaved Bosistoa	Vulnerable	Species or species habitat likely to occur within area
Bulbophyllum globuliforme Miniature Moss-orchid	Vulnerable	Species or species habitat likely to occur within area
Cupaniopsis shirleyana Wedge-leaf Tuckeroo	Vulnerable	Species or species habitat likely to occur within area
Cycas megacarpa	Endangered	Species or species habitat known to occur within area
Parsonsia larcomensis	Vulnerable	Species or species habitat likely to occur within area
Quassia bidwillii Quassia	Vulnerable	Species or species habitat likely to occur within area
Taeniophyllum muelleri Minute Orchid, Ribbon-root Orchid	Vulnerable	Species or species habitat may occur within area
Migratory Species [Dataset Information]	Status	Type of Presence
Migratory Terrestrial Species		
Birds		
Haliaeetus leucogaster White-bellied Sea-Eagle	Migratory	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail	Migratory	Species or species habitat may occur within area
Hirundo rustica Barn Swallow	Migratory	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch	Migratory	Breeding may occur within area
Myiagra cyanoleuca	Migratory	Species or species habitat likely to

Satin Flycatcher		occur within area
Rhipidura rufifrons Rufous Fantail	Migratory	Breeding may occur within area

Migratory Wetland Species

Birds

Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe	Migratory	Species or species habitat may occur within area
Limicola falcinellus Broad-billed Sandpiper	Migratory	Roosting likely to occur within area
Limosa limosa Black-tailed Godwit	Migratory	Roosting likely to occur within area
Nettapus coromandelianus albipennis Australian Cotton Pygmy-goose	Migratory	Species or species habitat may occur within area
Numenius minutus Little Curlew, Little Whimbrel	Migratory	Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank	Migratory	Roosting known to occur within area

Migratory Marine Birds

Apus pacificus Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area
Sterna albifrons Little Tern	Migratory	Species or species habitat may occur within area

Migratory Marine Species

Mammals

Balaenoptera edeni Bryde's Whale	Migratory	Species or species habitat may occur within area
Balaenoptera musculus Blue Whale	Migratory	Species or species habitat may occur within area
Dugong dugon Dugong	Migratory	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale	Migratory	Breeding known to occur within area
Orcaella brevirostris Irrawaddy Dolphin	Migratory	Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca	Migratory	Species or species habitat may occur within area

Reptiles

Caretta caretta	Migratory	Breeding known to occur within area

Loggerhead Turtle		
Chelonia mydas Green Turtle	Migratory	Species or species habitat may occur within area
Crocodylus porosus Estuarine Crocodile, Salt-water Crocodile	Migratory	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth	Migratory	Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle	Migratory	Species or species habitat may occur within area
Natator depressus Flatback Turtle	Migratory	Breeding likely to occur within area
Sharks		
Rhincodon typus Whale Shark	Migratory	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Dataset Information]	Status	Type of Presence
Birds		
Anseranas semipalmata Magpie Goose	Listed - overfly marine area	Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Listed - overfly marine area	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper	Listed - overfly marine area	Roosting likely to occur within area
Calidris subminuta Long-toed Stint	Listed - overfly marine area	Roosting likely to occur within area
Charadrius dubius Little Ringed Plover	Listed - overfly marine area	Roosting likely to occur within area
Charadrius ruficapillus Red-capped Plover	Listed - overfly marine area	Roosting known to occur within area

Gallinago hardwickii Latham's Snipe, Japanese Snipe	Listed - overfly marine area	Species or species habitat may occur within area
Gallinago stenura Pin-tailed Snipe	Listed - overfly marine area	Roosting likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle	Listed	Species or species habitat likely to occur within area
Himantopus himantopus Black-winged Stilt	Listed - overfly marine area	Roosting known to occur within area
Hirundapus caudacutus White-throated Needletail	Listed - overfly marine area	Species or species habitat may occur within area
Hirundo rustica Barn Swallow	Listed - overfly marine area	Species or species habitat may occur within area
Limicola falcinellus Broad-billed Sandpiper	Listed - overfly marine area	Roosting likely to occur within area
Limnodromus semipalmatus Asian Dowitcher	Listed - overfly marine area	Roosting likely to occur within area
Limosa limosa Black-tailed Godwit	Listed - overfly marine area	Roosting likely to occur within area
Merops ornatus Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch	Listed - overfly marine area	Breeding may occur within area
Myiagra cyanoleuca Satin Flycatcher	Listed - overfly marine area	Species or species habitat likely to occur within area
Nettapus coromandelianus albipennis Australian Cotton Pygmy-goose	Listed - overfly marine area	Species or species habitat may occur within area
Numenius minutus Little Curlew, Little Whimbrel	Listed - overfly	Species or species habitat may occur within area

	marine area	
Phalaropus lobatus Red-necked Phalarope	Listed	Roosting likely to occur within area
Philomachus pugnax Ruff (Reeve)	Listed - overfly marine area	Roosting likely to occur within area
Recurvirostra novaehollandiae Red-necked Avocet	Listed - overfly marine area	Roosting likely to occur within area
Rhipidura rufifrons Rufous Fantail	Listed - overfly marine area	Breeding may occur within area
Sterna albifrons Little Tern	Listed	Species or species habitat may occur within area
Stiltia isabella Australian Pratincole	Listed - overfly marine area	Roosting likely to occur within area
Thinornis rubricollis Hooded Plover	Listed - overfly marine area	Roosting likely to occur within area
Tringa nebularia Common Greenshank, Greenshank	Listed - overfly marine area	Roosting known to occur within area
Tringa totanus Common Redshank, Redshank	Listed - overfly marine area	Roosting likely to occur within area
Mammals		
Dugong dugon Dugong	Listed	Species or species habitat likely to occur within area
Ray-finned fishes		
Acentronura tentaculata Hairy Pygmy Pipehorse	Listed	Species or species habitat may occur within area
Campichthys tryoni Tryon's Pipefish	Listed	Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish	Listed	Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish	Listed	Species or species habitat may occur within area
Corythoichthys flavofasciatus Yellow-banded Pipefish, Network Pipefish	Listed	Species or species habitat may occur within area
Corythoichthys intestinalis	Listed	Species or species habitat may occur

Australian Messmate Pipefish, Banded Pipefish		within area
Corythoichthys paxtoni Paxton's Pipefish	Listed	Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish	Listed	Species or species habitat may occur within area
Doryrhamphus excisus Indian Blue-stripe Pipefish, Blue-stripe Pipefish	Listed	Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish	Listed	Species or species habitat may occur within area
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish	Listed	Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish	Listed	Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish	Listed	Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish	Listed	Species or species habitat may occur within area
Hippichthys heptagonus Madura Pipefish, Reticulated Freshwater Pipefish	Listed	Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish	Listed	Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse	Listed	Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish	Listed	Species or species habitat may occur within area
Micrognathus andersonii Anderson's Pipefish, Shortnose Pipefish	Listed	Species or species habitat may occur within area
Micrognathus brevirostris Thorn-tailed Pipefish	Listed	Species or species habitat may occur within area
Nannocampus pictus Painted Pipefish, Reef Pipefish	Listed	Species or species habitat may occur within area
Solegnathus hardwickii Pipehorse	Listed	Species or species habitat may occur within area
Solenostomus paradoxus Harlequin Ghost Pipefish, Ornate Ghost Pipefish	Listed	Species or species habitat may occur within area
Syngnathoides biaculeatus Double-ended Pipehorse, Alligator Pipefish	Listed	Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bend Stick Pipefish, Short-tailed Pipefish	Listed	Species or species habitat may occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake	Listed	Species or species habitat may occur within area
Aipysurus duboisii Dubois' Seasnake	Listed	Species or species habitat may occur within area
Aipysurus eydouxii	Listed	Species or species habitat may occur

Spine-tailed Seasnake		within area
Aipysurus laevis Olive Seasnake	Listed	Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake	Listed	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle	Listed	Breeding known to occur within area
Chelonia mydas Green Turtle	Listed	Species or species habitat may occur within area
Crocodylus porosus Estuarine Crocodile, Salt-water Crocodile	Listed	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth	Listed	Species or species habitat may occur within area
Disteira major Olive-headed Seasnake	Listed	Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake	Listed	Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake	Listed	Species or species habitat may occur within area
Lapemis hardwickii Spine-bellied Seasnake	Listed	Species or species habitat may occur within area
Laticauda colubrina a sea krait	Listed	Species or species habitat may occur within area
Laticauda laticaudata a sea krait	Listed	Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle	Listed	Species or species habitat may occur within area
Natator depressus Flatback Turtle	Listed	Breeding likely to occur within area
Pelamis platurus Yellow-bellied Seasnake	Listed	Species or species habitat may occur within area
Whales and Other Cetaceans [Dataset Information]	Status	Type of Presence
Balaenoptera acutorostrata Minke Whale	Cetacean	Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale	Cetacean	Species or species habitat may occur within area
Balaenoptera musculus Blue Whale	Cetacean	Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale	Cetacean	Breeding known to occur within area
Orcaella brevirostris Irrawaddy Dolphin	Cetacean	Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca	Cetacean	Species or species habitat may occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin	Cetacean	Species or species habitat may occur within area

Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin	Cetacean	Species or species habitat likely to occur within area

Commonwealth Lands [Dataset Information]

Defence

Places on the RNE [Dataset Information]
Note that not all Indigenous sites may be listed.

Historic

St Lukes Anglican Church QLD

Natural

Balaclava Island and The Narrows QLD

Curtis Island (part) QLD

Garden Island Environmental Park QLD

Great Barrier Reef Region QLD

Extra Information

State and Territory Reserves [Dataset Information]

Boyne Island Conservation Park, QLD

Garden Island Conservation Park, QLD

Mackay/Capricorn Marine Park, QLD

Rodds Bay Dugong Protection Area, QLD

Wild Cattle Fish Habitat Area, QLD

Wild Cattle Island National Park, QLD

Other Commonwealth Reserves [Dataset Information]

Great Barrier Reef Marine Park, COM

Regional Forest Agreements [Dataset Information]
Note that all RFA areas including those still under consideration have been included.

South East Queensland RFA, Queensland

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the *Environment Protection and Biodiversity Conservation Act 1999*. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under "type of presence". For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the migratory and marine provisions of the Act have been mapped.

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites;
- seals which have only been mapped for breeding sites near the Australian continent.

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgments

This database has been compiled from a range of data sources. The Department acknowledges the following custodians who have contributed valuable data and advice:

- New South Wales National Parks and Wildlife Service
- Department of Sustainability and Environment, Victoria
- Department of Primary Industries, Water and Environment, Tasmania
- Department of Environment and Heritage, South Australia Planning SA
- Parks and Wildlife Commission of the Northern Territory
- Environmental Protection Agency, Queensland
- Birds Australia
- Australian Bird and Bat Banding Scheme
- Australian National Wildlife Collection
- Natural history museums of Australia
- Queensland Herbarium
- National Herbarium of NSW
- Royal Botanic Gardens and National Herbarium of Victoria

- Tasmanian Herbarium
- State Herbarium of South Australia
- Northern Territory Herbarium
- Western Australian Herbarium
- Australian National Herbarium, Atherton and Canberra
- University of New England
- Other groups and individuals

ANUCliM Version 1.8, Centre for Resource and Environmental Studies, Australian National University was used extensively for the production of draft maps of species distribution. Environment Australia is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Last updated: Thursday, 20-Nov-2008 14:17:56 EST

Department of the Environment, Water, Heritage and the Arts
GPO Box 787 Canberra ACT 2601 Australia
Telephone: +61 (0)2 6274 1111

Appendix D

Wildlife Online search results

Queensland Government
Environmental Protection Agency
Queensland Parks and Wildlife Service

Wildlife Online Extract

Search Criteria: Species List for a Specified Point
Species: All
Type: All
Status: All
Records: All
Date: All
Latitude: 23.77007
Longitude: 151.142021
Distance: 5
Email: jeremy.simmonds@ghd.com.au
Date submitted: Thursday 14 May 2009 11:03:16
Date extracted: Thursday 14 May 2009 11:08:18

The number of records retrieved = 658

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	amphibians	Bufonidae	*Rhinella marina*	cane toad	Y			52
animals	amphibians	Hylidae	*Litoria fallax*	eastern sedgefrog		C		7
animals	amphibians	Hylidae	*Litoria nasuta*	striped rocketfrog		C		5
animals	amphibians	Hylidae	*Litoria rothii*	northern laughing treefrog		C		4
animals	amphibians	Hylidae	*Litoria dentata*	bleating treefrog		C		3
animals	amphibians	Hylidae	*Litoria wilcoxii*	eastern stony creek frog		C		2
animals	amphibians	Hylidae	*Litoria latopalmata*	broad palmed rocketfrog		C		5
animals	amphibians	Hylidae	*Cyclorana alboguttata*	greenstripe frog		C		2
animals	amphibians	Hylidae	*Litoria gracilenta*	graceful treefrog		C		3
animals	amphibians	Hylidae	*Litoria caerulea*	common green treefrog		C		12
animals	amphibians	Hylidae	*Litoria rubella*	ruddy treefrog		C		6
animals	amphibians	Hylidae	*Litoria inermis*	bumpy rocketfrog		C		4
animals	amphibians	Limnodynastidae	*Limnodynastes peronii*	striped marshfrog		C		6
animals	amphibians	Limnodynastidae	*Limnodynastes fletcheri*	barking frog		C		1
animals	amphibians	Limnodynastidae	*Limnodynastes terraereginae*	scarlet sided pobblebonk		C		12
animals	amphibians	Limnodynastidae	*Limnodynastes tasmaniensis*	spotted grassfrog		C		9
animals	amphibians	Limnodynastidae	*Platyplectrum ornatum*	ornate burrowing frog		C		10
animals	amphibians	Limnodynastidae	*Limnodynastes salmini*	salmon striped frog		C		1
animals	amphibians	Myobatrachidae	*Uperoleia rugosa*	chubby gungan		C		3
animals	amphibians	Myobatrachidae	*Pseudophryne major*	great brown broodfrog		C		6
animals	birds	Acanthizidae	*Acanthiza pusilla*	brown thornbill		C		1
animals	birds	Acanthizidae	*Smicrornis brevirostris*	weebill		C		8
animals	birds	Acanthizidae	*Gerygone levigaster*	mangrove gerygone		C		1
animals	birds	Acanthizidae	*Gerygone palpebrosa*	fairy gerygone		C		4
animals	birds	Accipitridae	*Aquila audax*	wedge-tailed eagle		C		4
animals	birds	Accipitridae	*Haliaeetus leucogaster*	white-bellied sea-eagle		C		1
animals	birds	Accipitridae	*Haliastur indus*	brahminy kite		C		5
animals	birds	Accipitridae	*Pandion cristatus*	eastern osprey		C		2
animals	birds	Accipitridae	*Lophoictinia isura*	square-tailed kite		R		1
animals	birds	Accipitridae	*Haliastur sphenurus*	whistling kite		C		6
animals	birds	Accipitridae	*Aviceda subcristata*	Pacific baza		C		4
animals	birds	Accipitridae	*Milvus migrans*	black kite		C		2
animals	birds	Aegothelidae	*Aegotheles cristatus*	Australian owlet-nightjar		C		12
animals	birds	Anatidae	*Aythya australis*	hardhead		C		2
animals	birds	Anatidae	*Chenonetta jubata*	Australian wood duck		C		1
animals	birds	Anatidae	*Dendrocygna arcuata*	wandering whistling-duck		C		4
animals	birds	Anatidae	*Anas superciliosa*	Pacific black duck		C		5
animals	birds	Anhingidae	*Anhinga novaehollandiae*	Australasian darter		C		2
animals	birds	Anseranatidae	*Anseranas semipalmata*	magpie goose		C		1
animals	birds	Ardeidae	*Ardea modesta*	eastern great egret		C		3
animals	birds	Ardeidae	*Egretta sacra*	eastern reef egret		C		1
animals	birds	Ardeidae	*Nycticorax caledonicus*	Nankeen night-heron		C		2
animals	birds	Ardeidae	*Egretta novaehollandiae*	white-faced heron		C		3
animals	birds	Ardeidae	*Butorides striata*	striated heron		C		1
animals	birds	Artamidae	*Artamus cinereus*	black-faced woodswallow		C		2
animals	birds	Artamidae	*Cracticus tibicen*	Australian magpie		C		27

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Artamidae	*Strepera graculina*	pied currawong		C		3
animals	birds	Artamidae	*Cracticus nigrogularis*	pied butcherbird		C		10
animals	birds	Artamidae	*Artamus leucorynchus*	white-breasted woodswallow		C		1
animals	birds	Artamidae	*Cracticus torquatus*	grey butcherbird		C		8
animals	birds	Burhinidae	*Burhinus grallarius*	bush stone-curlew		C		2
animals	birds	Cacatuidae	*Cacatua galerita*	sulphur-crested cockatoo		C		9
animals	birds	Cacatuidae	*Eolophus roseicapillus*	galah		C		1
animals	birds	Cacatuidae	*Calyptorhynchus banksii*	red-tailed black-cockatoo		C		5
animals	birds	Campephagidae	*Lalage leucomela*	varied triller		C		3
animals	birds	Campephagidae	*Coracina papuensis*	white-bellied cuckoo-shrike		C		7
animals	birds	Campephagidae	*Coracina tenuirostris*	cicadabird		C		12
animals	birds	Campephagidae	*Coracina novaehollandiae*	black-faced cuckoo-shrike		C		14
animals	birds	Caprimulgidae	*Caprimulgus macrurus*	large-tailed nightjar		C		1
animals	birds	Charadriidae	*Vanellus miles*	masked lapwing		C		1
animals	birds	Charadriidae	*Vanellus miles novaehollandiae*	masked lapwing (southern subspecies)		C		2
animals	birds	Charadriidae	*Charadrius ruficapillus*	red-capped plover		C		2
animals	birds	Cisticolidae	*Cisticola exilis*	golden-headed cisticola		C		7
animals	birds	Climacteridae	*Cormobates leucophaea metastasis*	white-throated treecreeper (southern)		C		3
animals	birds	Columbidae	*Geopelia placida*					13
animals	birds	Columbidae	*Geopelia striata*	peaceful dove		C		6
animals	birds	Columbidae	*Ocyphaps lophotes*	crested pigeon		C		5
animals	birds	Columbidae	*Geopelia humeralis*	bar-shouldered dove		C		15
animals	birds	Columbidae	*Geophaps scripta scripta*	squatter pigeon (southern subspecies)		V	V	7
animals	birds	Columbidae	*Phaps chalcoptera*	common bronzewing		C		2
animals	birds	Coraciidae	*Eurystomus orientalis*	dollarbird		C		8
animals	birds	Corcoracidae	*Corcorax melanorhamphos*	white-winged chough		C		5
animals	birds	Corvidae	*Corvus orru*	Torresian crow		C		21
animals	birds	Cuculidae	*Cuculus optatus*	oriental cuckoo		C		1
animals	birds	Cuculidae	*Chalcites lucidus*	shining bronze-cuckoo		C		1
animals	birds	Cuculidae	*Eudynamys orientalis*	eastern koel		C		5
animals	birds	Cuculidae	*Cacomantis variolosus*	brush cuckoo		C		4
animals	birds	Cuculidae	*Cacomantis flabelliformis*	fan-tailed cuckoo		C		1
animals	birds	Cuculidae	*Scythrops novaehollandiae*	channel-billed cuckoo		C		9
animals	birds	Cuculidae	*Centropus phasianinus*	pheasant coucal		C		6
animals	birds	Dicruridae	*Dicrurus bracteatus*	spangled drongo		C		16
animals	birds	Estrildidae	*Taeniopygia bichenovii*	double-barred finch		C		7
animals	birds	Estrildidae	*Lonchura castaneothorax*	chestnut-breasted mannikin		C		1
animals	birds	Eurostopodidae	*Eurostopodus mystacalis*	white-throated nightjar		C		3
animals	birds	Falconidae	*Falco berigora*	brown falcon		C		2
animals	birds	Falconidae	*Falco cenchroides*	nankeen kestrel		C		1
animals	birds	Haematopodidae	*Haematopus longirostris*	Australian pied oystercatcher		C		1
animals	birds	Halcyonidae	*Dacelo leachii*	blue-winged kookaburra		C		4
animals	birds	Halcyonidae	*Dacelo novaeguineae*	laughing kookaburra		C		24
animals	birds	Halcyonidae	*Todiramphus chloris*	collared kingfisher		C		1
animals	birds	Halcyonidae	*Todiramphus macleayii*	forest kingfisher		C		10
animals	birds	Halcyonidae	*Todiramphus sanctus*	sacred kingfisher		C		1

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Hirundinidae	*Hirundo neoxena*	welcome swallow		C		4
animals	birds	Jacanidae	*Irediparra gallinacea*	comb-crested jacana		C		4
animals	birds	Laridae	*Hydroprogne caspia*	Caspian tern		C		1
animals	birds	Laridae	*Gelochelidon nilotica*	gull-billed tern		C		2
animals	birds	Maluridae	*Malurus melanocephalus*	red-backed fairy-wren		C		15
animals	birds	Megaluridae	*Megalurus timoriensis*	tawny grassbird		C		1
animals	birds	Meliphagidae	*Myzomela obscura*	dusky honeyeater		C		1
animals	birds	Meliphagidae	*Lichenostomus fasciogularis*	mangrove honeyeater		C		3
animals	birds	Meliphagidae	*Melithreptus albogularis*	white-throated honeyeater		C		29
animals	birds	Meliphagidae	*Philemon citreogularis*	little friarbird		C		4
animals	birds	Meliphagidae	*Myzomela sanguinolenta*	scarlet honeyeater		C		2
animals	birds	Meliphagidae	*Manorina melanocephala*	noisy miner		C		15
animals	birds	Meliphagidae	*Philemon corniculatus*	noisy friarbird		C		23
animals	birds	Meliphagidae	*Melithreptus gularis*	black-chinned honeyeater		R		1
animals	birds	Meliphagidae	*Lichmera indistincta*	brown honeyeater		C		13
animals	birds	Meliphagidae	*Entomyzon cyanotis*	blue-faced honeyeater		C		16
animals	birds	Meliphagidae	*Meliphaga lewinii*	Lewin's honeyeater		C		1
animals	birds	Meropidae	*Merops ornatus*	rainbow bee-eater		C		20
animals	birds	Monarchidae	*Myiagra rubecula*	leaden flycatcher		C		9
animals	birds	Monarchidae	*Grallina cyanoleuca*	magpie-lark		C		4
animals	birds	Monarchidae	*Symposiarchus trivirgatus*	spectacled monarch		C		1
animals	birds	Motacillidae	*Anthus novaeseelandiae*	Australasian pipit		C		1
animals	birds	Nectariniidae	*Dicaeum hirundinaceum*	mistletoebird		C		11
animals	birds	Neosittidae	*Daphoenositta chrysoptera*	varied sittella		C		1
animals	birds	Oriolidae	*Oriolus sagittatus*	olive-backed oriole		C		5
animals	birds	Oriolidae	*Sphecotheres vieilloti*	Australasian figbird		C		8
animals	birds	Pachycephalidae	*Colluricincla harmonica*	grey shrike-thrush		C		10
animals	birds	Pachycephalidae	*Pachycephala rufiventris*	rufous whistler		C		6
animals	birds	Pachycephalidae	*Colluricincla megarhyncha*	little shrike-thrush		C		1
animals	birds	Pardalotidae	*Pardalotus striatus*	striated pardalote		C		16
animals	birds	Pelecanidae	*Pelecanus conspicillatus*	Australian pelican		C		1
animals	birds	Phalacrocoracidae	*Microcarbo melanoleucos*	little pied cormorant		C		2
animals	birds	Phasianidae	*Coturnix ypsilophora*	brown quail		C		3
animals	birds	Podargidae	*Podargus strigoides*	tawny frogmouth		C		14
animals	birds	Podicipedidae	*Tachybaptus novaehollandiae*	Australasian grebe		C		2
animals	birds	Pomatostomidae	*Pomatostomus temporalis*	grey-crowned babbler		C		11
animals	birds	Psittacidae	*Alisterus scapularis*	Australian king-parrot		C		2
animals	birds	Psittacidae	*Trichoglossus haematodus moluccanus*	rainbow lorikeet		C		23
animals	birds	Psittacidae	*Platycercus adscitus palliceps*	pale-headed rosella (southern form)		C		1
animals	birds	Psittacidae	*Trichoglossus chlorolepidotus*	scaly-breasted lorikeet		C		17
animals	birds	Psittacidae	*Aprosmictus erythropterus*	red-winged parrot		C		5
animals	birds	Psittacidae	*Glossopsitta pusilla*	little lorikeet		C		7
animals	birds	Psittacidae	*Platycercus adscitus*	pale-headed rosella		C		21
animals	birds	Rallidae	*Gallinula tenebrosa*	dusky moorhen		C		2
animals	birds	Rhipiduridae	*Rhipidura albiscapa*	grey fantail		C		2
animals	birds	Rhipiduridae	*Rhipidura leucophrys*	willie wagtail		C		4

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Rhipiduridae	*Rhipidura rufifrons*	rufous fantail		C		2
animals	birds	Scolopacidae	*Numenius madagascariensis*	eastern curlew		R		3
animals	birds	Scolopacidae	*Tringa nebularia*	common greenshank		C		1
animals	birds	Scolopacidae	*Limosa lapponica*	bar-tailed godwit		C		2
animals	birds	Scolopacidae	*Numenius phaeopus*	whimbrel		C		2
animals	birds	Scolopacidae	*Calidris ruficollis*	red-necked stint		C		1
animals	birds	Scolopacidae	*Actitis hypoleucos*	common sandpiper		C		1
animals	birds	Strigidae	*Ninox boobook*	southern boobook		C		16
animals	birds	Threskiornithidae	*Platalea regia*	royal spoonbill		C		1
animals	birds	Threskiornithidae	*Threskiornis molucca*	Australian white ibis		C		1
animals	birds	Timaliidae	*Zosterops lateralis*	silvereye		C		2
animals	birds	Turnicidae	*Turnix varius*	painted button-quail		C		3
animals	bony fish	Ambassidae	*Ambassis agassizii*	Agassiz's glassfish				14
animals	bony fish	Anguillidae	*Anguilla reinhardtii*	longfin eel				1
animals	bony fish	Apogonidae	*Glossamia aprion*	mouth almighty				2
animals	bony fish	Atherinidae	*Craterocephalus stercusmuscarum*	flyspecked hardyhead				4
animals	bony fish	Centropomidae	*Lates calcarifer*	barramundi				1
animals	bony fish	Clupeidae	*Nematalosa erebi*	bony bream				3
animals	bony fish	Eleotridae	*Gobiomorphus australis*	striped gudgeon				2
animals	bony fish	Eleotridae	*Hypseleotris species 1*	Midgley's carp gudgeon				2
animals	bony fish	Eleotridae	*Hypseleotris compressa*	empire gudgeon				4
animals	bony fish	Eleotrididae	*Mogurnda adspersa*	southern purplespotted gudgeon				2
animals	bony fish	Hemiramphidae	*Arrhamphus sclerolepis*	snubnose garfish				2
animals	bony fish	Kuhliidae	*Kuhlia rupestris*	jungle perch				3
animals	bony fish	Melanotaeniidae	*Melanotaenia splendida splendida*	eastern rainbowfish				14
animals	bony fish	Monodactylidae	*Monodactylus argenteus*	diamondfish				1
animals	bony fish	Mugilidae	*Mugil cephalus*	sea mullet				4
animals	bony fish	Poeciliidae	*Gambusia holbrooki*	mosquitofish	Y			7
animals	bony fish	Poeciliidae	*Poecilia reticulata*	guppy	Y			1
animals	bony fish	Pseudomugilidae	*Pseudomugil signifer*	Pacific blue eye				2
animals	bony fish	Scatophagidae	*Selenotoca multifasciata*	striped scat				2
animals	bony fish	Terapontidae	*Terapon jarbua*	crescent grunter				1
animals	bony fish	Terapontidae	*Leiopotherapon unicolor*	spangled perch				2
animals	cartilaginous fishes	Dasyatidae	*Dasyatis fluviorum*	estuary stingray				1
animals	mammals	Bovidae	*Bos taurus*	European cattle	Y			1
animals	mammals	Canidae	*Vulpes vulpes*	red fox	Y			3
animals	mammals	Canidae	*Canis lupus dingo*	dingo				2
animals	mammals	Dasyuridae	*Planigale maculata*	common planigale		C		9
animals	mammals	Dasyuridae	*Sminthopsis murina*	common dunnart		C		2
animals	mammals	Delphinidae	*Tursiops truncatus*	bottlenose dolphin		C		1
animals	mammals	Dugongidae	*Dugong dugon*	dugong		V		1
animals	mammals	Emballonuridae	*Taphozous sp.*					3
animals	mammals	Emballonuridae	*Taphozous australis*	coastal sheathtail bat		V		4
animals	mammals	Emballonuridae	*Taphozous georgianus*	common sheathtail bat		C		4
animals	mammals	Emballonuridae	*Saccolaimus flaviventris*	yellow-bellied sheathtail bat		C		7
animals	mammals	Felidae	*Felis catus*	cat	Y			1

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	mammals	Leporidae	*Lepus capensis*	brown hare	Y			7
animals	mammals	Leporidae	*Oryctolagus cuniculus*	rabbit	Y			1
animals	mammals	Macropodidae	*Macropus parryi*	whiptail wallaby		C		11
animals	mammals	Macropodidae	*Macropus dorsalis*	black-striped wallaby		C		2
animals	mammals	Macropodidae	*Macropus robustus*	common wallaroo		C		1
animals	mammals	Macropodidae	*Macropus giganteus*	eastern grey kangaroo		C		21
animals	mammals	Macropodidae	*Wallabia bicolor*	swamp wallaby		C		9
animals	mammals	Molossidae	*Mormopterus sp.*					3
animals	mammals	Molossidae	*Mormopterus norfolkensis*	east coast freetail bat		C		1
animals	mammals	Molossidae	*Tadarida australis*	white-striped freetail bat		C		4
animals	mammals	Molossidae	*Mormopterus beccarii*	Beccari's freetail bat		C		2
animals	mammals	Muridae	*Mus musculus*	house mouse	Y			9
animals	mammals	Muridae	*Melomys cervinipes*	fawn-footed melomys		C		3
animals	mammals	Muridae	*Rattus rattus*	black rat	Y			1
animals	mammals	Peramelidae	*Isoodon macrourus*	northern brown bandicoot		C		10
animals	mammals	Petauridae	*Petaurus breviceps*	sugar glider		C		4
animals	mammals	Petauridae	*Petaurus norfolcensis*	squirrel glider		C		1
animals	mammals	Petauridae	*Petaurus australis australis*	yellow-bellied glider (southern subspecies)		C		4
animals	mammals	Phalangeridae	*Trichosurus vulpecula*	common brushtail possum		C		19
animals	mammals	Potoroidae	*Aepyprymnus rufescens*	rufous bettong		C		3
animals	mammals	Pseudocheiridae	*Petauroides volans*	greater glider		C		15
animals	mammals	Pteropodidae	*Pteropus alecto*	black flying-fox		C		1
animals	mammals	Suidae	*Sus scrofa*	pig	Y			1
animals	mammals	Tachyglossidae	*Tachyglossus aculeatus*	short-beaked echidna		C		3
animals	mammals	Vespertilionidae	*Nyctophilus sp.*					4
animals	mammals	Vespertilionidae	*Miniopterus schreibersii oceanensis*	eastern bent-wing bat		C		8
animals	mammals	Vespertilionidae	*Chalinolobus nigrogriseus*	hoary wattled bat		C		3
animals	mammals	Vespertilionidae	*Miniopterus australis*	little bent-wing bat		C		8
animals	mammals	Vespertilionidae	*Vespadelus vulturnus*	little forest bat		C		1
animals	mammals	Vespertilionidae	*Scotorepens greyii*	little broad-nosed bat		C		10
animals	mammals	Vespertilionidae	*Vespadelus pumilus*	eastern forest bat		C		1
animals	mammals	Vespertilionidae	*Chalinolobus gouldii*	Gould's wattled bat		C		7
animals	mammals	Vespertilionidae	*Scoteanax rueppellii*	greater broad-nosed bat		C		4
animals	mammals	Vespertilionidae	*Chalinolobus picatus*	little pied bat		R		2
animals	mammals	Vespertilionidae	*Chalinolobus morio*	chocolate wattled bat		C		1
animals	mammals	Vespertilionidae	*Scotorepens orion*	south-eastern broad-nosed bat		C		6
animals	reptiles	Agamidae	*Pogona barbata*	bearded dragon		C		2
animals	reptiles	Agamidae	*Diporiphora australis*			C		3
animals	reptiles	Agamidae	*Amphibolurus nobbi nobbi*	nobbi		C		1
animals	reptiles	Agamidae	*Chlamydosaurus kingii*	frilled lizard		C		5
animals	reptiles	Agamidae	*Amphibolurus nobbi*			C		4
animals	reptiles	Boidae	*Morelia spilota*	carpet python		C		2
animals	reptiles	Boidae	*Aspidites melanocephalus*	black-headed python		C		2
animals	reptiles	Chelidae	*Emydura sp.*					1
animals	reptiles	Colubridae	*Boiga irregularis*	brown tree snake		C		1

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	reptiles	Colubridae	*Tropidonophis mairii*	freshwater snake		C		2
animals	reptiles	Colubridae	*Dendrelaphis punctulata*	common tree snake		C		2
animals	reptiles	Elapidae	*Demansia vestigiata*	black whip snake		C		2
animals	reptiles	Elapidae	*Vermicella annulata*	bandy-bandy		C		6
animals	reptiles	Elapidae	*Hemiaspis signata*	black-bellied swamp snake		C		1
animals	reptiles	Elapidae	*Demansia psammophis*	yellow-faced whip snake		C		5
animals	reptiles	Elapidae	*Cacophis harriettae*	white-crowned snake		C		1
animals	reptiles	Elapidae	*Furina diadema*	red-naped snake		C		4
animals	reptiles	Elapidae	*Oxyuranus scutellatus*	coastal taipan		C		1
animals	reptiles	Elapidae	*Rhinoplocephalus nigrescens*	eastern small-eyed snake		C		2
animals	reptiles	Elapidae	*Rhinoplocephalus nigrostriatus*	black-striped snake		C		1
animals	reptiles	Gekkonidae	*Gehyra dubia*			C		11
animals	reptiles	Gekkonidae	*Oedura rhombifer*	zig-zag gecko		C		13
animals	reptiles	Gekkonidae	*Heteronotia binoei*	Bynoe's gecko		C		22
animals	reptiles	Gekkonidae	*Gehyra catenata*			C		1
animals	reptiles	Gekkonidae	*Diplodactylus vittatus*	wood gecko		C		7
animals	reptiles	Pygopodidae	*Lialis burtonis*	Burton's legless lizard		C		3
animals	reptiles	Scincidae	*Carlia munda*			C		12
animals	reptiles	Scincidae	*Carlia vivax*			C		39
animals	reptiles	Scincidae	*Menetia greyii*			C		3
animals	reptiles	Scincidae	*Carlia foliorum*			C		37
animals	reptiles	Scincidae	*Eulamprus tenuis*			C		3
animals	reptiles	Scincidae	*Lerista fragilis*			C		5
animals	reptiles	Scincidae	*Carlia pectoralis*			C		11
animals	reptiles	Scincidae	*Carlia schmeltzii*			C		19
animals	reptiles	Scincidae	*Ctenotus taeniolatus*	copper-tailed skink		C		8
animals	reptiles	Scincidae	*Eulamprus brachysoma*			C		4
animals	reptiles	Scincidae	*Anomalopus verreauxii*			C		3
animals	reptiles	Scincidae	*Lampropholis delicata*			C		5
animals	reptiles	Scincidae	*Morethia taeniopleura*	fire-tailed skink		C		2
animals	reptiles	Scincidae	*Calyptotis lepidorostrum*			C		2
animals	reptiles	Scincidae	*Glaphyromorphus punctulatus*			C		4
animals	reptiles	Scincidae	*Cryptoblepharus virgatus sensu lato*			C		34
animals	reptiles	Typhlopidae	*Ramphotyphlops wiedii*			C		6
animals	reptiles	Typhlopidae	*Ramphotyphlops unguirostris*			C		1
animals	reptiles	Varanidae	*Varanus varius*	lace monitor		C		1
animals	reptiles	Varanidae	*Varanus gouldii*	sand monitor		C		1
animals	reptiles	Varanidae	*Varanus tristis*	black-tailed monitor		C		5
animals	reptiles	Varanidae	*Varanus semiremex*	rusty monitor		R		1
plants	cycads	Zamiaceae	*Macrozamia miquelii*			C		2/1
plants	ferns	Adiantaceae	*Pellaea nana*			C		1/1
plants	ferns	Adiantaceae	*Cheilanthes sieberi*			C		3
plants	ferns	Adiantaceae	*Cheilanthes nudiuscula*			C		2
plants	ferns	Adiantaceae	*Adiantum hispidulum var. hispidulum*			C		2/2
plants	ferns	Adiantaceae	*Adiantum aethiopicum*			C		1
plants	ferns	Adiantaceae	*Adiantum hispidulum*			C		5

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
plants	ferns	Adiantaceae	*Pellaea paradoxa*	heart fern		C		1
plants	ferns	Adiantaceae	*Pellaea falcata*			C		2
plants	ferns	Aspleniaceae	*Asplenium nidus*			C		1
plants	ferns	Aspleniaceae	*Asplenium australasicum*			C		3/1
plants	ferns	Davalliaceae	*Davallia pyxidata*			C		1
plants	ferns	Dennstaedtiaceae	*Pteridium esculentum*	common bracken		C		1
plants	ferns	Marsileaceae	*Marsilea mutica*	shiny nardoo		C		1
plants	ferns	Nephrolepidaceae	*Arthropteris tenella*	climbing fern		C		2/2
plants	ferns	Nephrolepidaceae	*Nephrolepis cordifolia*	fishbone fern		C		1
plants	ferns	Polypodiaceae	*Drynaria rigidula*			C		1
plants	ferns	Polypodiaceae	*Pyrrosia rupestris*	rock felt fern		C		1
plants	ferns	Polypodiaceae	*Microsorum punctatum*			C		2/1
plants	ferns	Polypodiaceae	*Platycerium bifurcatum*			C		1
plants	ferns	Polypodiaceae	*Pyrrosia confluens var. confluens*			C		2/2
plants	ferns	Polypodiaceae	*Drynaria sparsisora*			C		2/2
plants	ferns	Polypodiaceae	*Pyrrosia confluens*			C		1
plants	higher dicots	Acanthaceae	*Brunoniella*			C		1
plants	higher dicots	Acanthaceae	*Pseuderanthemum variabile*	pastel flower		C		4
plants	higher dicots	Acanthaceae	*Rostellularia adscendens*			C		2
plants	higher dicots	Acanthaceae	*Harnieria hygrophiloides*	white karambal		C		1
plants	higher dicots	Acanthaceae	*Brunoniella australis*	blue trumpet		C		2
plants	higher dicots	Aizoaceae	*Sesuvium portulacastrum*	sea purslane		C		1
plants	higher dicots	Amaranthaceae	*Achyranthes aspera*			C		1
plants	higher dicots	Amaranthaceae	*Alternanthera nana*	hairy joyweed		C		1
plants	higher dicots	Anacardiaceae	*Euroschinus falcatus*			C		5
plants	higher dicots	Anacardiaceae	*Pleiogynium timorense*	Burdekin plum		C		8
plants	higher dicots	Apocynaceae	*Carissa ovata*	currantbush		C		4
plants	higher dicots	Apocynaceae	*Hoya australis*			C		7
plants	higher dicots	Apocynaceae	*Alyxia magnifolia*			R		2
plants	higher dicots	Apocynaceae	*Marsdenia microlepis*			C		1
plants	higher dicots	Apocynaceae	*Parsonsia straminea*	monkey rope		C		2
plants	higher dicots	Apocynaceae	*Alstonia constricta*	bitterbark		C		4/1
plants	higher dicots	Apocynaceae	*Secamone elliptica*			C		4
plants	higher dicots	Apocynaceae	*Parsonsia velutina*	hairy silkpod		C		4
plants	higher dicots	Apocynaceae	*Marsdenia rostrata*			C		1/1
plants	higher dicots	Apocynaceae	*Cynanchum bowmanii*	bowman's milkvine		C		3
plants	higher dicots	Apocynaceae	*Marsdenia lloydii*			C		2/1
plants	higher dicots	Apocynaceae	*Alyxia ruscifolia*			C		5/1
plants	higher dicots	Apocynaceae	*Sarcostemma viminale subsp. brunonianum*			C		1
plants	higher dicots	Apocynaceae	*Sarcostemma viminale subsp. australe*			C		1
plants	higher dicots	Apocynaceae	*Parsonsia longipetiolata*			C		1
plants	higher dicots	Apocynaceae	*Gomphocarpus physocarpus*	balloon cottonbush	Y			3
plants	higher dicots	Apocynaceae	*Parsonsia paulforsteri*			C		1/1
plants	higher dicots	Apocynaceae	*Parsonsia leichhardtii*	black silkpod		C		1
plants	higher dicots	Apocynaceae	*Tylophora grandiflora*			C		1
plants	higher dicots	Apocynaceae	*Marsdenia viridiflora*			C		1

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
plants	higher dicots	Apocynaceae	*Parsonsia rotata*	veinless silkpod		C		2
plants	higher dicots	Araliaceae	*Polyscias elegans*	celery wood		C		5
plants	higher dicots	Araliaceae	*Schefflera actinophylla*	umbrella tree		C		1
plants	higher dicots	Asclepiadaceae	*Sarcostemma viminale*			C		1
plants	higher dicots	Asteraceae	*Bidens pilosa*		Y			1
plants	higher dicots	Asteraceae	*Olearia canescens*			C		1
plants	higher dicots	Asteraceae	*Emilia sonchifolia*		Y			4
plants	higher dicots	Asteraceae	*Peripleura hispidula*			C		2
plants	higher dicots	Asteraceae	*Acmella grandiflora var. brachyglossa*			C		2/1
plants	higher dicots	Asteraceae	*Centratherum australianum*			C		1/1
plants	higher dicots	Asteraceae	*Pterocaulon sphacelatum*	applebush		C		4
plants	higher dicots	Asteraceae	*Ozothamnus cassinioides*			C		1/1
plants	higher dicots	Asteraceae	*Sigesbeckia orientalis*	Indian weed		C		1
plants	higher dicots	Asteraceae	*Wedelia spilanthoides*			C		1
plants	higher dicots	Asteraceae	*Cyanthillium cinereum*			C		2
plants	higher dicots	Asteraceae	*Glossocardia bidens*	native cobbler's pegs		C		2
plants	higher dicots	Asteraceae	*Conyza sumatrensis*	tall fleabane	Y			2
plants	higher dicots	Bignoniaceae	*Pandorea pandorana*	wonga vine		C		4/1
plants	higher dicots	Cactaceae	*Opuntia*			C		2
plants	higher dicots	Caesalpiniaceae	*Caesalpinia*			C		1
plants	higher dicots	Caesalpiniaceae	*Barklya syringifolia*	golden shower tree		C		6/1
plants	higher dicots	Caesalpiniaceae	*Chamaecrista absus var. absus*			C		4/1
plants	higher dicots	Caesalpiniaceae	*Chamaecrista nomame var. nomame*			C		2
plants	higher dicots	Caesalpiniaceae	*Caesalpinia scortechinii*	large prickle vine		C		1
plants	higher dicots	Capparaceae	*Capparis arborea*	brush caper berry		C		3
plants	higher dicots	Capparaceae	*Capparis sarmentosa*	scrambling caper		C		1
plants	higher dicots	Capparaceae	*Capparis loranthifolia*			C		2
plants	higher dicots	Capparaceae	*Capparis canescens*			C		6
plants	higher dicots	Casuarinaceae	*Allocasuarina torulosa*			C		3
plants	higher dicots	Celastraceae	*Denhamia pittosporoides*			C		2
plants	higher dicots	Celastraceae	*Elaeodendron melanocarpum*			C		2
plants	higher dicots	Chenopodiaceae	*Suaeda australis*			C		1
plants	higher dicots	Chenopodiaceae	*Halosarcia indica*			C		1
plants	higher dicots	Chenopodiaceae	*Halosarcia halocnemoides*			C		1
plants	higher dicots	Chenopodiaceae	*Sarcocornia quinqueflora*			C		1
plants	higher dicots	Combretaceae	*Lumnitzera racemosa*			C		1
plants	higher dicots	Combretaceae	*Terminalia porphyrocarpa*			C		8/2
plants	higher dicots	Convolvulaceae	*Evolvulus alsinoides*			C		2
plants	higher dicots	Convolvulaceae	*Jacquemontia paniculata*			C		2/1
plants	higher dicots	Cornaceae	*Alangium villosum subsp. tomentosum*			C		1
plants	higher dicots	Cucurbitaceae	*Diplocyclos palmatus*			C		1/1
plants	higher dicots	Cucurbitaceae	*Diplocyclos palmatus subsp. palmatus*			C		1/1
plants	higher dicots	Ebenaceae	*Diospyros geminata*	scaly ebony		C		8/2
plants	higher dicots	Ebenaceae	*Diospyros australis*	black plum		C		2
plants	higher dicots	Ebenaceae	*Diospyros fasciculosa*	grey ebony		C		1
plants	higher dicots	Elaeocarpaceae	*Elaeocarpus obovatus*	blueberry ash		C		1/1

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
plants	higher dicots	Erythroxylaceae	*Erythroxylum australe*	cocaine tree		C		2
plants	higher dicots	Euphorbiaceae	*Ricinocarpos ledifolius*	scrub wedding bush		C		1
plants	higher dicots	Euphorbiaceae	*Excoecaria dallachyana*	scrub poison tree		C		1
plants	higher dicots	Euphorbiaceae	*Claoxylon tenerifolium*	Queensland brittlewood		C		1
plants	higher dicots	Euphorbiaceae	*Mallotus philippensis*	red kamala		C		6/1
plants	higher dicots	Euphorbiaceae	*Mallotus claoxyloides*	green kamala		C		4
plants	higher dicots	Euphorbiaceae	*Croton acronychioides*	thick-leaved croton		C		5/1
plants	higher dicots	Euphorbiaceae	*Alchornea ilicifolia*	native holly		C		5
plants	higher dicots	Euphorbiaceae	*Croton phebalioides*	narrow-leaved croton		C		3
plants	higher dicots	Euphorbiaceae	*Homalanthus nutans*			C		1/1
plants	higher dicots	Euphorbiaceae	*Croton stigmatosus*	white croton		C		1
plants	higher dicots	Euphorbiaceae	*Baloghia inophylla*	scrub bloodwood		C		3/1
plants	higher dicots	Euphorbiaceae	*Acalypha eremorum*	soft acalypha		C		5
plants	higher dicots	Euphorbiaceae	*Croton insularis*	Queensland cascarilla		C		2
plants	higher dicots	Euphorbiaceae	*Chamaesyce hirta*	asthma plant	Y			3
plants	higher dicots	Euphorbiaceae	*Tragia novae-hollandiae*	stinging-vine		C		2
plants	higher dicots	Fabaceae	*Glycine*			C		2
plants	higher dicots	Fabaceae	*Stylosanthes*			C		2
plants	higher dicots	Fabaceae	*Swainsona*			C		2
plants	higher dicots	Fabaceae	*Desmodium*			C		2
plants	higher dicots	Fabaceae	*Derris involuta*	native derris		C		1
plants	higher dicots	Fabaceae	*Zornia muriculata*			C		1
plants	higher dicots	Fabaceae	*Glycine tomentella*	woolly glycine		C		3
plants	higher dicots	Fabaceae	*Desmodium heterocarpon var. strigosum*			C		2/1
plants	higher dicots	Fabaceae	*Glycine clandestina var. clandestina*			C		2
plants	higher dicots	Fabaceae	*Austrosteenisia blackii var. blackii*			C		1/1
plants	higher dicots	Fabaceae	*Zornia muriculata subsp. muriculata*			C		2/1
plants	higher dicots	Fabaceae	*Tephrosia filipes subsp. filipes*			C		2
plants	higher dicots	Fabaceae	*Desmodium rhytidophyllum*			C		2
plants	higher dicots	Fabaceae	*Austrosteenisia blackii*	bloodvine		C		5
plants	higher dicots	Fabaceae	*Aeschynomene micranthos*			C		2/2
plants	higher dicots	Fabaceae	*Crotalaria medicaginea*	trefoil rattlepod		C		1
plants	higher dicots	Fabaceae	*Hardenbergia violacea*			C		1/1
plants	higher dicots	Fabaceae	*Erythrina vespertilio*			C		2
plants	higher dicots	Fabaceae	*Desmodium brachypodum*	large ticktrefoil		C		3
plants	higher dicots	Fabaceae	*Alysicarpus vaginalis*		Y			1
plants	higher dicots	Fabaceae	*Pycnospora lutescens*	pycnospora		C		2
plants	higher dicots	Fabaceae	*Indigofera linifolia*			C		1
plants	higher dicots	Fabaceae	*Galactia tenuiflora*			C		4
plants	higher dicots	Fabaceae	*Desmodium triflorum*		Y			1
plants	higher dicots	Fabaceae	*Zornia dyctiocarpa*			C		3
plants	higher dicots	Fabaceae	*Jacksonia scoparia*			C		1
plants	higher dicots	Fabaceae	*Indigofera linnaei*	Birdsville indigo		C		4/1
plants	higher dicots	Fabaceae	*Crotalaria montana*			C		4
plants	higher dicots	Fabaceae	*Rhynchosia minima*			C		1
plants	higher dicots	Flacourtiaceae	*Homalium alnifolium*	homalium		C		1

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
plants	higher dicots	Goodeniaceae	*Brunonia australis*	blue pincushion		C		3
plants	higher dicots	Lamiaceae	*Callicarpa pedunculata*	velvet leaf		C		1/1
plants	higher dicots	Lamiaceae	*Clerodendrum floribundum*			C		2
plants	higher dicots	Lamiaceae	*Glossocarya hemiderma*			C		6
plants	higher dicots	Lamiaceae	*Anisomeles malabarica*			C		1
plants	higher dicots	Lamiaceae	*Plectranthus parviflorus*			C		2/1
plants	higher dicots	Lecythidaceae	*Planchonia careya*	cockatoo apple		C		10
plants	higher dicots	Loganiaceae	*Strychnos psilosperma*	strychnine tree		C		7/1
plants	higher dicots	Malvaceae	*Sida*			C		2/2
plants	higher dicots	Malvaceae	*Sida rohlenae*			C		2
plants	higher dicots	Malvaceae	*Sida subspicata*	spiked sida		C		6/1
plants	higher dicots	Malvaceae	*Abutilon auritum*	Chinese lantern		C		1
plants	higher dicots	Malvaceae	*Sida rhombifolia*		Y			1
plants	higher dicots	Malvaceae	*Abutilon oxycarpum*			C		1
plants	higher dicots	Malvaceae	*Hibiscus divaricatus*			C		1/1
plants	higher dicots	Malvaceae	*Hibiscus heterophyllus*			C		2/1
plants	higher dicots	Malvaceae	*Malvastrum americanum var. americanum*		Y			1
plants	higher dicots	Meliaceae	*Melia azedarach*	white cedar		C		1
plants	higher dicots	Meliaceae	*Turraea pubescens*	native honeysuckle		C		6/1
plants	higher dicots	Mimosaceae	*Acacia maidenii*	Maiden's wattle		C		5
plants	higher dicots	Mimosaceae	*Acacia leiocalyx*			C		7
plants	higher dicots	Mimosaceae	*Acacia fasciculifera*	scaly bark		C		1
plants	higher dicots	Mimosaceae	*Acacia crassa subsp. longicoma*			C		9/3
plants	higher dicots	Mimosaceae	*Acacia excelsa subsp. excelsa*			C		1/1
plants	higher dicots	Mimosaceae	*Archidendropsis thozetiana*			C		5/1
plants	higher dicots	Mimosaceae	*Acacia aulacocarpa*			C		14
plants	higher dicots	Moraceae	*Ficus fraseri*	white sandpaper fig		C		1
plants	higher dicots	Moraceae	*Trophis scandens subsp. scandens*			C		1
plants	higher dicots	Moraceae	*Streblus brunonianus*	whalebone tree		C		4
plants	higher dicots	Moraceae	*Trophis scandens*			C		4
plants	higher dicots	Moraceae	*Ficus platypoda*			C		1
plants	higher dicots	Moraceae	*Ficus opposita*			C		5
plants	higher dicots	Myrsinaceae	*Myrsine variabilis*			C		2/1
plants	higher dicots	Myrsinaceae	*Embelia australiana*	embelia		C		1
plants	higher dicots	Myrsinaceae	*Aegiceras corniculatum*	river mangrove		C		1
plants	higher dicots	Myrtaceae	*Gossia bidwillii*			C		6/2
plants	higher dicots	Myrtaceae	*Eucalyptus crebra*	narrow-leaved red ironbark		C		14
plants	higher dicots	Myrtaceae	*Melaleuca nervosa*			C		4
plants	higher dicots	Myrtaceae	*Eucalyptus exserta*	Queensland peppermint		C		5
plants	higher dicots	Myrtaceae	*Osbornia octodonta*	myrtle mangrove		C		1
plants	higher dicots	Myrtaceae	*Corymbia citriodora*	spotted gum		C		9
plants	higher dicots	Myrtaceae	*Corymbia intermedia*	pink bloodwood		C		7
plants	higher dicots	Myrtaceae	*Corymbia tessellaris*	Moreton Bay ash		C		5
plants	higher dicots	Myrtaceae	*Corymbia clarksoniana*			C		7/1
plants	higher dicots	Myrtaceae	*Eucalyptus acmenoides*			C		1
plants	higher dicots	Myrtaceae	*Eucalyptus melliodora*	yellow box		C		1

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
plants	higher dicots	Myrtaceae	*Lophostemon confertus*	brush box		C		5/1
plants	higher dicots	Myrtaceae	*Corymbia erythrophloia*	variable-barked bloodwood		C		2/1
plants	higher dicots	Myrtaceae	*Lophostemon suaveolens*	swamp box		C		9
plants	higher dicots	Myrtaceae	*Eucalyptus tereticornis*			C		9
plants	higher dicots	Nyctaginaceae	*Boerhavia dominii*			C		1
plants	higher dicots	Oleaceae	*Olea paniculata*			C		1
plants	higher dicots	Oleaceae	*Notelaea microcarpa*			C		1
plants	higher dicots	Oleaceae	*Jasminum didymum subsp. racemosum*			C		4/1
plants	higher dicots	Oleaceae	*Jasminum didymum*			C		3
plants	higher dicots	Oleaceae	*Jasminum simplicifolium subsp. australiense*			C		1
plants	higher dicots	Oxalidaceae	*Oxalis corniculata*		Y			2
plants	higher dicots	Passifloraceae	*Passiflora aurantia*			C		2
plants	higher dicots	Passifloraceae	*Passiflora suberosa*	corky passion flower	Y			11
plants	higher dicots	Passifloraceae	*Passiflora subpeltata*	white passion flower	Y			3/2
plants	higher dicots	Pentapetaceae	*Melhania oblongifolia*			C		2
plants	higher dicots	Petiveriaceae	*Rivina humilis*		Y			2
plants	higher dicots	Phyllanthaceae	*Flueggea leucopyrus*			C		2
plants	higher dicots	Phyllanthaceae	*Breynia oblongifolia*			C		12
plants	higher dicots	Phyllanthaceae	*Phyllanthus virgatus*			C		6
plants	higher dicots	Phyllanthaceae	*Glochidion lobocarpum*			C		3
plants	higher dicots	Phyllanthaceae	*Phyllanthus microcladus*			C		2
plants	higher dicots	Phyllanthaceae	*Actephila sessilifolia*			R		1/1
plants	higher dicots	Phyllanthaceae	*Bridelia leichhardtii*			C		4
plants	higher dicots	Picrodendraceae	*Dissiliaria muelleri*	Mueller's redheart		C		8/4
plants	higher dicots	Picrodendraceae	*Petalostigma pubescens*	quinine tree		C		3
plants	higher dicots	Pittosporaceae	*Pittosporum revolutum*	yellow pittosporum		C		1
plants	higher dicots	Pittosporaceae	*Auranticarpa rhombifolia*			C		1
plants	higher dicots	Pittosporaceae	*Pittosporum spinescens*			C		5/2
plants	higher dicots	Plumbaginaceae	*Aegialitis annulata*	club mangrove		C		1
plants	higher dicots	Polygalaceae	*Polygala linariifolia*			C		1
plants	higher dicots	Putranjivaceae	*Drypetes deplanchei*	grey boxwood		C		8
plants	higher dicots	Rhamnaceae	*Pomaderris*			C		1/1
plants	higher dicots	Rhamnaceae	*Ventilago pubiflora*			C		1
plants	higher dicots	Rhamnaceae	*Alphitonia excelsa*	soap tree		C		13
plants	higher dicots	Rhizophoraceae	*Ceriops tagal*	yellow mangrove		C		1
plants	higher dicots	Rhizophoraceae	*Rhizophora stylosa*	spotted mangrove		C		1
plants	higher dicots	Rhizophoraceae	*Bruguiera gymnorhiza*	large-fruited orange mangrove		C		1
plants	higher dicots	Rubiaceae	*Psydrax*			C		1/1
plants	higher dicots	Rubiaceae	*Canthium*			C		2/1
plants	higher dicots	Rubiaceae	*Aidia racemosa*			C		7/5
plants	higher dicots	Rubiaceae	*Pomax umbellata*			C		1/1
plants	higher dicots	Rubiaceae	*Psydrax odorata*			C		7/2
plants	higher dicots	Rubiaceae	*Knoxia sumatrensis*			C		3/3
plants	higher dicots	Rubiaceae	*Morinda canthoides*			C		1
plants	higher dicots	Rubiaceae	*Pavetta australiensis*			C		2
plants	higher dicots	Rubiaceae	*Psychotria daphnoides*			C		4/1

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
plants	higher dicots	Rubiaceae	*Spermacoce brachystema*			C		3
plants	higher dicots	Rubiaceae	*Spermacoce multicaulis*			C		1/1
plants	higher dicots	Rubiaceae	*Triflorensia ixoroides*			C		3
plants	higher dicots	Rubiaceae	*Pogonolobus reticulatus*			C		16/1
plants	higher dicots	Rubiaceae	*Psychotria loniceroides*	hairy psychotria		C		2
plants	higher dicots	Rubiaceae	*Cyclophyllum coprosmoides*			C		3
plants	higher dicots	Rubiaceae	*Psydrax odorata forma buxifolia*			C		1
plants	higher dicots	Rubiaceae	*Pavetta australiensis var. australiensis*			C		2/2
plants	higher dicots	Rutaceae	*Acronychia laevis*	glossy acronychia		C		1
plants	higher dicots	Rutaceae	*Micromelum minutum*	clusterberry		C		2/2
plants	higher dicots	Rutaceae	*Bosistoa transversa*	three-leaved bosistoa		C	V	11/10
plants	higher dicots	Rutaceae	*Acronychia pauciflora*	soft acronychia		C		6/3
plants	higher dicots	Rutaceae	*Bosistoa medicinalis*			C		9/7
plants	higher dicots	Rutaceae	*Geijera salicifolia*	brush wilga		C		3/1
plants	higher dicots	Rutaceae	*Murraya paniculata*			C		2
plants	higher dicots	Rutaceae	*Medicosma cunninghamii*	pinkheart		C		1
plants	higher dicots	Rutaceae	*Zanthoxylum brachyacanthum*			C		1
plants	higher dicots	Rutaceae	*Dinosperma melanophloia*			C		7/4
plants	higher dicots	Rutaceae	*Bouchardatia neurococca*	union nut		C		3/1
plants	higher dicots	Rutaceae	*Murraya ovatifoliolata*			C		4/1
plants	higher dicots	Santalaceae	*Exocarpos latifolius*			C		1
plants	higher dicots	Sapindaceae	*Dodonaea*			C		1
plants	higher dicots	Sapindaceae	*Atalaya multiflora*	broad-leaved whitewood		C		1
plants	higher dicots	Sapindaceae	*Dodonaea lanceolata*			C		7
plants	higher dicots	Sapindaceae	*Rhysotoechia bifoliolata subsp. bifoliolata*			C		1
plants	higher dicots	Sapindaceae	*Cupaniopsis anacardioides*	tuckeroo		C		4
plants	higher dicots	Sapindaceae	*Rhysotoechia bifoliolata*			C		1
plants	higher dicots	Sapindaceae	*Elattostachys xylocarpa*	white tamarind		C		5/1
plants	higher dicots	Sapindaceae	*Cupaniopsis wadsworthii*			C		3
plants	higher dicots	Sapindaceae	*Alectryon diversifolius*	scrub boonaree		C		1
plants	higher dicots	Sapindaceae	*Mischocarpus anodontus*	veiny pearfruit		C		1
plants	higher dicots	Sapindaceae	*Cupaniopsis shirleyana*			V	V	5/5
plants	higher dicots	Sapindaceae	*Atalaya salicifolia*			C		1
plants	higher dicots	Sapindaceae	*Arytera divaricata*	coogera		C		1
plants	higher dicots	Sapindaceae	*Atalaya rigida*			R		8/6
plants	higher dicots	Sapindaceae	*Harpullia hillii*			C		1
plants	higher dicots	Sapindaceae	*Alectryon connatus*	grey birds-eye		C		5
plants	higher dicots	Sapindaceae	*Jagera pseudorhus*			C		2
plants	higher dicots	Sapotaceae	*Planchonella*			C		1
plants	higher dicots	Sapotaceae	*Pouteria pohlmaniana*			C		2
plants	higher dicots	Sapotaceae	*Pouteria queenslandica*			C		2/1
plants	higher dicots	Sapotaceae	*Pouteria cotinifolia var. pubescens*			C		4
plants	higher dicots	Sapotaceae	*Planchonella pohlmaniana*			C		1/1
plants	higher dicots	Sapotaceae	*Pouteria sericea*			C		1
plants	higher dicots	Scrophulariaceae	*Scoparia dulcis*	Scoparia	Y			1
plants	higher dicots	Scrophulariaceae	*Mecardonia procumbens*		Y			1/1

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
plants	higher dicots	Solanaceae	*Solanum nigrum*		Y			2
plants	higher dicots	Solanaceae	*Physalis peruviana*		Y			2/2
plants	higher dicots	Solanaceae	*Solanum stelligerum*	devil's needles		C		2/1
plants	higher dicots	Solanaceae	*Lycianthes shanesii*			C		2/2
plants	higher dicots	Sparrmanniaceae	*Corchorus*			C		3/3
plants	higher dicots	Sparrmanniaceae	*Corchorus trilocularis*			C		3/2
plants	higher dicots	Sparrmanniaceae	*Grewia latifolia*	dysentery plant		C		5
plants	higher dicots	Sterculiaceae	*Sterculia quadrifida*	peanut tree		C		6
plants	higher dicots	Sterculiaceae	*Brachychiton australis*	broad-leaved bottle tree		C		3
plants	higher dicots	Urticaceae	*Dendrocnide photinophylla*	shiny-leaved stinging tree		C		1
plants	higher dicots	Verbenaceae	*Lantana camara*		Y			7
plants	higher dicots	Verbenaceae	*Stachytarpheta jamaicensis*	Jamaica snakeweed	Y			1
plants	higher dicots	Violaceae	*Hybanthus stellarioides*			C		1
plants	higher dicots	Vitaceae	*Cissus opaca*			C		3
plants	higher dicots	Vitaceae	*Cissus oblonga*			C		7/2
plants	higher dicots	Vitaceae	*Cayratia acris*	hairy grape		C		4/1
plants	higher dicots	Vitaceae	*Cissus antarctica*			C		1
plants	higher dicots	Vitaceae	*Tetrastigma nitens*	shining grape		C		3/1
plants	lower dicots	Annonaceae	*Melodorum leichhardtii*			C		4
plants	lower dicots	Aristolochiaceae	*Aristolochia pubera*			C		2
plants	lower dicots	Avicenniaceae	*Avicennia marina subsp. australasica*			C		1
plants	lower dicots	Hernandiaceae	*Hernandia bivalvis*	cudgerie		R		5/3
plants	lower dicots	Hernandiaceae	*Gyrocarpus americanus*			C		2
plants	lower dicots	Lauraceae	*Litsea reticulata*			C		1
plants	lower dicots	Lauraceae	*Cryptocarya triplinervis var. pubens*			C		1/1
plants	lower dicots	Lauraceae	*Cryptocarya triplinervis*			C		3
plants	lower dicots	Lauraceae	*Cassytha pubescens*	downy devil's twine		C		2
plants	lower dicots	Menispermaceae	*Legnephora moorei*			C		1
plants	lower dicots	Menispermaceae	*Pleogyne australis*	wiry grape		C		4/1
plants	lower dicots	Menispermaceae	*Tinospora smilacina*	snakevine		C		2
plants	lower dicots	Menispermaceae	*Hypserpa decumbens*			C		1
plants	lower dicots	Monimiaceae	*Wilkiea macrophylla*	large-leaved wilkiea		C		1
plants	lower dicots	Nymphaeaceae	*Nymphaea caerulea*		Y			1
plants	lower dicots	Piperaceae	*Peperomia blanda var. floribunda*			C		1/1
plants	lower dicots	Ranunculaceae	*Clematis glycinoides*			C		1
plants	monocots	Agavaceae	*Furcraea foetida*		Y			1/1
plants	monocots	Amaryllidaceae	*Proiphys cunninghamii*	Moreton Bay lily		C		2/1
plants	monocots	Araceae	*Gymnostachys anceps*	settler's flax		C		2/1
plants	monocots	Arecaceae	*Livistona decora*			C		1
plants	monocots	Arecaceae	*Livistona australis*	cabbage tree palm		C		1
plants	monocots	Asparagaceae	*Asparagus africanus*		Y			1
plants	monocots	Commelinaceae	*Commelina diffusa*	wandering jew		C		3
plants	monocots	Commelinaceae	*Aneilema acuminatum*			C		3/2
plants	monocots	Cyperaceae	*Scleria*			C		2
plants	monocots	Cyperaceae	*Cyperus gracilis*			C		3
plants	monocots	Cyperaceae	*Fimbristylis dichotoma*	common fringe-rush		C		1

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
plants	monocots	Cyperaceae	*Abildgaardia ovata*			C		1
plants	monocots	Cyperaceae	*Cyperus difformis*	rice sedge		C		1
plants	monocots	Cyperaceae	*Scleria brownii*			C		3
plants	monocots	Cyperaceae	*Gahnia aspera*			C		2
plants	monocots	Cyperaceae	*Cyperus fulvus*			C		4
plants	monocots	Dioscoreaceae	*Dioscorea transversa*	native yam		C		6
plants	monocots	Hemerocallidaceae	*Dianella longifolia*			C		2
plants	monocots	Hemerocallidaceae	*Dianella caerulea*			C		5
plants	monocots	Hemerocallidaceae	*Geitonoplesium cymosum*	scrambling lily		C		3
plants	monocots	Hemerocallidaceae	*Dianella*			C		2
plants	monocots	Hemerocallidaceae	*Dianella brevipedunculata*			C		2/1
plants	monocots	Juncaginaceae	*Triglochin procerum*			C		1
plants	monocots	Laxmanniaceae	*Lomandra filiformis*			C		1
plants	monocots	Laxmanniaceae	*Lomandra multiflora subsp. multiflora*			C		2/1
plants	monocots	Laxmanniaceae	*Eustrephus latifolius*	wombat berry		C		10
plants	monocots	Laxmanniaceae	*Lomandra confertifolia*			C		2
plants	monocots	Laxmanniaceae	*Lomandra confertifolia subsp. pallida*			C		3
plants	monocots	Laxmanniaceae	*Lomandra longifolia*			C		5
plants	monocots	Poaceae	*Aristida*			C		6
plants	monocots	Poaceae	*Eragrostis leptostachya*			C		1
plants	monocots	Poaceae	*Ancistrachne uncinulata*	hooky grass		C		3
plants	monocots	Poaceae	*Urochloa subquadripara*		Y			1
plants	monocots	Poaceae	*Enneapogon lindleyanus*			C		2
plants	monocots	Poaceae	*Chrysopogon sylvaticus*			C		2
plants	monocots	Poaceae	*Bothriochloa decipiens*			C		3
plants	monocots	Poaceae	*Arundinella nepalensis*	reedgrass		C		5
plants	monocots	Poaceae	*Sporobolus virginicus*	sand couch		C		3
plants	monocots	Poaceae	*Eragrostis sororia*			C		1
plants	monocots	Poaceae	*Aristida queenslandica var. dissimilis*			C		2
plants	monocots	Poaceae	*Dichanthium sericeum subsp. sericeum*			C		1/1
plants	monocots	Poaceae	*Capillipedium spicigerum*	spicytop		C		1
plants	monocots	Poaceae	*Eragrostis spartinoides*			C		3
plants	monocots	Poaceae	*Chrysopogon fallax*			C		2
plants	monocots	Poaceae	*Aristida personata*			C		3
plants	monocots	Poaceae	*Digitaria diffusa*			C		2
plants	monocots	Poaceae	*Dichanthium tenue*	small bluegrass		C		1
plants	monocots	Poaceae	*Themeda triandra*	kangaroo grass		C		9
plants	monocots	Poaceae	*Sarga leiocladum*			C		1
plants	monocots	Poaceae	*Ottochloa nodosa*			C		1
plants	monocots	Poaceae	*Digitaria minima*			C		1
plants	monocots	Poaceae	*Heteropogon contortus*	black speargrass		C		11
plants	monocots	Poaceae	*Leptochloa decipiens*			C		1
plants	monocots	Poaceae	*Digitaria parviflora*			C		4
plants	monocots	Poaceae	*Cymbopogon refractus*	barbed-wire grass		C		6
plants	monocots	Poaceae	*Paspalidium gracile*	slender panic		C		3
plants	monocots	Poaceae	*Paspalidium distans*	shotgrass		C		2

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
plants	monocots	Poaceae	*Imperata cylindrica*	blady grass		C		1
plants	monocots	Poaceae	*Aristida gracilipes*			C		2
plants	monocots	Poaceae	*Oplismenus aemulus*	creeping shade grass		C		3
plants	monocots	Poaceae	*Eragrostis*			C		2
plants	monocots	Poaceae	*Melinis repens*	red natal grass	Y			3
plants	monocots	Poaceae	*Panicum simile*			C		2
plants	monocots	Poaceae	*Panicum effusum*			C		7
plants	monocots	Poaceae	*Aristida spuria*			C		1
plants	monocots	Ripogonaceae	*Ripogonum album*	white supplejack		C		1
plants	monocots	Smilacaceae	*Smilax australis*	barbed-wire vine		C		6
plants	monocots	Typhaceae	*Typha orientalis*	broad-leaved cumbungi		C		1
plants	monocots	Xanthorrhoeaceae	*Xanthorrhoea*			C		3
plants	monocots	Xanthorrhoeaceae	*Xanthorrhoea latifolia subsp. latifolia*			C		2
plants	monocots	Zingiberaceae	*Alpinia caerulea*	wild ginger		C		2
plants	monocots	Zosteraceae	*Zostera muelleri subsp. capricorni*			C		1

CODES

I - Y indicates that the taxon is introduced to Queensland and has naturalised.

Q - Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992.* The codes are Presumed Extinct (PE), Endangered (E), Vulnerable (V), Rare (R), Common (C) or Not Protected ( ).

A - Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999.* The values of EPBC are Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Extinct in the Wild (XW) and Vulnerable (V).

Records – The first number indicates the total number of records of the taxon for the record option selected (i.e. All, Confirmed or Specimens).
This number is output as 99999 if it equals or exceeds this value. The second number located after the / indicates the number of specimen records for the taxon.
This number is output as 999 if it equals or exceeds this value.

Appendix E

Queensland Museum database search results

Qld Museum Database Search Results for Marine Reptiles and Mammals

Family	Species	Common Name	Locality	Latitude Longitude	Collection Date
Cheloniidae	Chelonia mydas	Green Turtle	Burnett River crossing, 8 km W Gayndah	25.12 151.53	4-Feb-95
Cheloniidae	Natator depressus	Flatback Turtle	Curtis Is, Sth Beach"	23.63 151.17	
Cheloniidae	Natator depressus	Flatback Turtle	Curtis Is, Sth Beach"	23.75 151.28	2-Jan-70
Cheloniidae	Natator depressus	Flatback Turtle	Gladstone, Curtis Is, S Ocean Beach	23.63 151.17	2-Jan-70
Cheloniidae	Natator depressus	Flatback Turtle	Gladstone, Curtis Is, S Ocean Beach	23.63 151.17	3-Jan-70
Hydrophiidae	Aipysurus eydouxii	Eydoux's Sea Snake	Rockhampton, Fitzroy R	23.5 150.83	
Hydrophiidae	Aipysurus eydouxii	Eydoux's Sea Snake	Rodds Bay, via Calliope	24 151.48	7-May-71
Hydrophiidae	Aipysurus laevis	Olive Sea Snake	Boyne Island, off Gladstone	23.93 151.35	
Hydrophiidae	Hydrophis sp	Sea Snake	Gladstone, Auckland Ck, Gladstone Power Stn	23.83 151.25	
Hydrophiidae	Hydrophis sp	Sea Snake	Targinie, via Gladstone	23.77 151.13	1-Jan-98
Hydrophiidae	Hydrophis elegans	Sea Snake	Boyne Island, off Gladstone	23.93 151.35	
Hydrophiidae	Hydrophis elegans	Sea Snake	Gladstone, Auckland Ck, Gladstone Power Stn	23.83 151.25	
Hydrophiidae	Hydrophis kingii	Spectacled Sea Snake	Curtis Is, S end, off Gladstone	23.75 151.3	2-Aug-70
Hydrophiidae	Hydrophis macdowelli		Gladstone, beach	23.85 151.28	
Hydrophiidae	Hydrophis major	Olive-headed Sea Snake	Boyne Island, off Gladstone	23.93 151.35	
Hydrophiidae	Hydrophis major	Olive-headed Sea Snake	Curtis Is, lighthouse	23.63 151.17	

Family	Species	Common Name	Locality	Latitude Longitude	Collection Date
Hydrophiidae	Hydrophis major	Olive-headed Sea Snake	Tannum Sands, E"	23.95 151.37	8-May-71
Hydrophiidae	Lapemis curtus	Spine-bellied Sea Snake	Off Tannum Sands	23.93 151.55	8-May-71
Cetacea			Curtis Is	23.63 151.17	
Balaenopteridae	Megaptera novaeangliae	Humpback whale	Gladstone	23.85 151.27	Aug-99
Dugongidae	Dugong cf dugong	Dugong	Gladstone Harbour, in cave	-23.85 151.27	

Qld Museum Database Search Results for Fish

Family	Species	Location	Lat/Long	Collection Date
Carcharhinidae	Rhizoprionodon taylori	Parsons Point, near Gladstone"|	23.52|151.18	06/11/1924
Rhinobatidae	Rhinobatos typus	Boyne Island, south of Gladstone	23.5623.52|151.18|151.21	12/04/1982/ 07/06/1982
Elopidae	Elops hawaiensis	Gladstone	23.51|151.17	20/10/1936
Megalopidae	Megalops cyprinoides	Gladstone	23.51|151.17	30/10/1936
Anguillidae	Anguilla reinhardtii	Baffle Ck, Colosseum, NC Line	24.21|151.37	30/09/1932
Anguillidae	Anguilla reinhardtii	Briffney Ck, Gladstone	23.53|151.14	08/12/1977|03/01/1978
Anguillidae	Anguilla reinhardtii	Clyde Ck, 15 km SW of Gladstone	23.56|151.13	09/12/1977|03/01/1978
Anguillidae	Anguilla reinhardtii	Gladstone, Ck at QAL access Rd	23.5|151.15	07/12/1977|10/01/1978
Anguillidae	Anguilla reinhardtii	Gladstone, Ck at Ufer Motors	23.5|151.15	08/12/1977|10/01/1978
Anguillidae	Anguilla reinhardtii	Miriamvale	24.2|151.34	24/08/1953
Anguillidae	Anguilla reinhardtii	Sunvalley, Gladstone, at Ck	23.52|151.16	08/12/1977|04/01/1978
Muraenidae	Gymnothorax favagineus	Off Gladstone	23.51|151.17	07/05/1937
Clupeidae	Herklotsichthys castelnaui	Boyne River estuary	23.58|151.2	18/02/1999|27/10/1999
Clupeidae	Nematalosa erebi	Auckland Ck, Gladstone	23.51|151.14	02/09/1978|11/06/1979
Clupeidae	Nematalosa erebi	Boyne River, above Awoonga Dam	24.06|151.17	11/10/1976
Clupeidae	Nematalosa erebi	Calliope River, downstream of Calliope	23.58|151.09	03/09/1978|11/06/1979
Clupeidae	Nematalosa erebi	Calliope River, downstream of	23.58|151.09	19/11/1985|28/02/1986

Family	Species	Location	Lat/Long	Collection Date
		Calliope		
Clupeidae	Nematalosa erebi	Calliope River, downstream of Calliope	23.58|151.09	19/11/1985|03/03/1986
Clupeidae	Nematalosa erebi	Calliope River, downstream of Calliope	23.58|151.09	
Clupeidae	Nematalosa erebi	Calliope River, downstream of Calliope	23.58|151.09	
Clupeidae	Sardinella gibbosa	Port Curtis, near Facing Island	23.55|151.23	05/02/1968
Synodontidae	Synodus sp	Off Gladstone	23.51|151.17	30/09/1936
Synodontidae	Trachinocephalus myops		23.34.5'S 151.20.1'E"|23.34|151.2	20/09/2004|23/05/2005
Harpodontidae	Harpadon translucens	Gladstone Harbour	23.51|151.17	23/04/1947
Ariidae	Arius graeffei	Boyne River below Awoonga Dam	24.04|151.19	18/10/1979
Ariidae	Arius graeffei	Calliope River, downstream of Calliope	23.58|151.09	19/11/1985|28/02/1986
Ariidae	Arius graeffei	Gladstone	23.51|151.17	30/09/1936
Plotosidae	Neosilurus hyrtlii	Awoonga Dam, Boyne River	24.05|151.18	02/07/1986
Plotosidae	Neosilurus hyrtlii	Boyne River below Awoonga Dam	24.04|151.19	
Batrachoididae	Batrachomoeus dubius	Rundle Island, east of	23.33|151.29	01/10/2000|14/07/2003
Antennariidae	Tathicarpus butleri	Auckland Ck, Gladstone	23.51|151.14	29/07/1981|10/09/1981
Antennariidae	Tathicarpus butleri	Boyne Island, south of Gladstone	23.56|151.21	16/03/1959
Antennariidae	Tathicarpus butleri	Gladstone	23.51|151.17	18/05/1935
Antennariidae	Tathicarpus butleri	Port Curtis	23.55|151.23	29/10/1912
Antennariidae	Tathicarpus butleri	Port Curtis	23.55|151.23	02/02/1968
Hemiramphidae	Arrhamphus sclerolepis	Awoonga Dam, Boyne River	24.05|151.18	02/07/1986
Hemiramphidae	Arrhamphus sclerolepis	Awoonga Dam, Boyne River	24.05|151.18	20/12/1978|18/06/1987
Hemiramphidae	Arrhamphus sclerolepis	Boyne River below Awoonga Dam	24.04|151.19	
Hemiramphidae	Arrhamphus sclerolepis	Boyne River, above Awoonga Dam	24.06|151.17	18/06/1987

Family	Species	Location	Lat/Long	Collection Date
Hemiramphidae	Hyporhamphus quoyi	Boyne River estuary	23.58|151.2	18/02/1999|27/10/1999
Hemiramphidae	Zenarchopterus buffonis	Calliope River, Gladstone	23.5|151.13	13/12/1993|28/09/1993
Hemiramphidae	Zenarchopterus buffonis	Flying Fox Creek, 2.5km N of Calliope River mouth	23.49|151.12	05/12/1989
Belonidae	Strongylura strongylura	Gladstone	23.51|151.17	03/03/1983|17/09/1984
Poeciliidae	Poecilia reticulata	Auckland Ck, Gladstone	23.51|151.14	02/09/1978|11/06/1979
Poeciliidae	Poecilia reticulata	Boyne Island, spillway channel	23.55|151.2	15/08/2004|01/02/2005
Poeciliidae	Poecilia reticulata	Briffney Ck, Gladstone	23.53|151.14	08/12/1977|03/01/1978
Poeciliidae	Poecilia reticulata	Gladstone, Ck at QAL access Rd	23.5|151.15	07/12/1977|10/01/1978
Poeciliidae	Poecilia reticulata	Gladstone, Ck at Ufer Motors	23.5|151.15	08/12/1977|10/01/1978
Poeciliidae	Poecilia reticulata	Gladstone, drain near railway line	23.51|151.16	08/12/1977|03/01/1978
Poeciliidae	Poecilia reticulata	Sunvalley, Gladstone, at Ck	23.52|151.16	08/12/1977|04/01/1978
Poeciliidae	Xiphophorus helleri	Gladstone, Ck at Ufer Motors	23.5|151.15	08/12/1977|10/01/1978
Melanotaeniidae	Melanotaenia duboulayi	3 Moon Ck, Cania Dam, Burnett R system	24.31|151.01	05/11/1986|30/10/1987
Melanotaeniidae	Melanotaenia duboulayi	Monto, Burnett River system	24.52|151.08	27/06/1950
Melanotaeniidae	Melanotaenia duboulayi	Wuruma Dam, Nogo River, Burnett River system	25.1|150.59	28/03/1973|17/10/1978
Melanotaeniidae	Melanotaenia splendida	Calliope River, downstream of Calliope	23.58|151.09	03/09/1978|11/06/1979
Melanotaeniidae	Melanotaenia splendida	Farm Dam, east of Mt Larcom	23.46|151.08	01/08/1999|08/09/1999
Melanotaeniidae	Melanotaenia splendida	Auckland Ck, Gladstone	23.51|151.14	02/09/1978|11/06/1979
Melanotaeniidae	Melanotaenia splendida	Awoonga Dam, Boyne River	24.05|151.18	20/12/1978|01/02/1979
Melanotaeniidae	Melanotaenia splendida	Awoonga Dam, Boyne River	24.05|151.18	02/07/1986
Melanotaeniidae	Melanotaenia splendida	Boyne River, above Awoonga Dam	24.06|151.17	11/10/1976
Melanotaeniidae	Melanotaenia splendida	Boyne River, above Awoonga Dam	24.06|151.17	01/06/1976|30/07/1990
Melanotaeniidae	Melanotaenia splendida	Briffney Ck, Gladstone	23.53|151.14	08/12/1977|06/01/1978
Melanotaeniidae	Melanotaenia splendida	Clyde Ck, 15 km SW of Gladstone	23.56|151.13	09/12/1977|06/01/1978

Family	Species	Location	Lat/Long	Collection Date
Melanotaeniidae	Melanotaenia splendida	Sunvalley, Gladstone, at Ck	23.52|151.16	08/12/1977|06/01/1978
Melanotaeniidae	Melanotaenia splendida	Varris Ck, S of Mt Larcom	23.52|151	11/12/1977|06/01/1978
Melanotaeniidae	Pseudomugil signifer	Boyne River crossing, 4 ml SW of Bulburin	24.32|151.23	21/03/1975|24/05/1976
Melanotaeniidae	Pseudomugil signifer	Boyne River, above Awoonga Dam	24.06|151.17	
Melanotaeniidae	Pseudomugil signifer	Boyne River, Bulburin	24.31|151.29	08/12/1973|13/11/1985
Melanotaeniidae	Pseudomugil signifer	Calliope River, downstream of Calliope	23.58|151.09	03/09/1978|11/06/1979
Melanotaeniidae	Pseudomugil signifer	Calliope River, downstream of Calliope	23.58|151.09	19/11/1985|03/11/1986
Melanotaeniidae	Pseudomugil signifer	Clyde Ck, 15 km SW of Gladstone	23.56|151.13	09/12/1977|03/01/1978
Melanotaeniidae	Pseudomugil signifer	Futten Ck, Gladstone	23.51|151.16	02/08/1979|11/06/1979
Melanotaeniidae	Pseudomugil signifer	Three Mile Ck, trib Baffle Ck, S of Bororen	24.17|151.3	12/12/1977|10/01/1978
Atherinidae	Craterocephalus mugiloides	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|12/12/1985
Atherinidae	Craterocephalus stercusmuscarum	3 Moon Ck, Cania Dam, Burnett R system	24.31|151.01	05/11/1986|30/10/1987
Atherinidae	Craterocephalus stercusmuscarum	Auckland Ck, Gladstone	23.51|151.14	02/09/1978|11/06/1979
Atherinidae	Craterocephalus stercusmuscarum	Awoonga Dam, Boyne River	24.05|151.18	20/12/1978|01/02/1979
Atherinidae	Craterocephalus stercusmuscarum	Awoonga Dam, Boyne River	24.05|151.18	02/07/1986
Atherinidae	Craterocephalus stercusmuscarum	Boat Ck, east of Yarwun	23.49|151.09	01/08/1999|08/09/1999
Atherinidae	Craterocephalus stercusmuscarum	Boyne River crossing, 4 ml SW of Bulburin	24.32|151.23	27/03/1975|19/11/1975
Atherinidae	Craterocephalus	Boyne River, above Awoonga Dam	24.06|151.17	

Family	Species	Location	Lat/Long	Collection Date
	stercusmuscarum			
Atherinidae	Craterocephalus stercusmuscarum	Calliope River, downstream of Calliope"|	23.58|151.09	03/09/1978|11/06/1979
Atherinidae	Craterocephalus stercusmuscarum	Clyde Ck, 15 km SW of Gladstone	23.56|151.13	09/12/1977|03/01/1978
Atherinidae	Craterocephalus stercusmuscarum	Futten Ck, Gladstone	23.51|151.16	02/08/1979|11/06/1979
Atherinidae	Craterocephalus stercusmuscarum	Larcom Ck, SW of Aldoga	23.5|151.03	01/08/1999|08/09/1999
Atherinidae	Craterocephalus stercusmuscarum	Monto, Burnett River system	24.52|151.08	27/06/1950
Atherinidae	Craterocephalus stercusmuscarum	Three Moon Creek, Burnett R system Mulgildie	25.06|151.08	18/06/1974
Atherinidae	Craterocephalus stercusmuscarum	Varris Ck, S of Mt Larcom	23.52|151.|	11/12/1977|03/01/1978
Atherinidae	Craterocephalus stercusmuscarum	Wuruma Dam, Nogo River, Burnett River system	25.1|150.59	28/03/1973|04/07/1973
Syngnathidae	Filicampus tigris	Gladstone	23.51|151.17	26/04/1982|17/09/1984
Syngnathidae	Hippocampus hendriki		23.39.9'S 151.24.3'E"|23.4|151.24	20/05/2004|05/10/2004
Syngnathidae	Hippocampus multispinus		23.43.5'S 151.39.9'E"|23.43|151.4	20/09/2004|09/05/2005
Scorpaenidae	Centropogon marmoratus	Auckland Inlet, near Gladstone Power Stn	23.51|151.14	04/10/1978|23/02/1984
Scorpaenidae	Centropogon marmoratus	Gladstone	23.51|151.17	03/03/1982|17/09/1984
Scorpaenidae	Notesthes robusta	Boyne River, south of Gladstone	24.01|151.2	14/02/1921
Scorpaenidae	Paracentropogon vespa	Calliope River mouth, Gladstone	23.55|151.1	28/03/1995|09/05/1995
Scorpaenidae	Parascorpaena mossambica		23.43.5'S	20/09/2004|04/06/2005

Family	Species	Location	Lat/Long	Collection Date
			151.39.9'E"|23.43|151.4	
Scorpaenidae	Scorpaena n.sp.1		23.39.9'S 151.24.3'E"|23.4|151.24	20/05/2004|05/10/2004
Scorpaenidae	Scorpaena sp M		23.45.3'S 151.33.3'E"|23.45|151.33	14/11/2005|09/06/2006
Scorpaenidae	Scorpaena sp M		23.50.1'S 151.35.1'E"|23.5|151.35	14/11/2005|09/06/2006
Aploactidae	Aploactis aspera	Curtis Island, east of	23.35|151.35	13/04/2002|10/09/2002
Aploactidae	Bathyaploactis ornatissimus	Gladstone	23.51|151.17	03/03/1983|17/09/1984
Synanceiidae	Erosa erosa		23.45.3'S 151.33.3'E23.45|151.33	14/11/2005|09/06/2006
Synanceiidae	Inimicus caledonicus		23.38.1'S 151.27.9'E"|23.38|151.28	20/09/2004|04/06/2005
Synanceiidae	Inimicus caledonicus		23.45.3'S 151.33.3'E"|23.45|151.33	14/11/2005|09/06/2006
Synanceiidae	Synanceia horrida	Gladstone	23.51|151.17	08/06/1916
Synanceiidae	Synanceia horrida	Gladstone	23.51|151.17	17/11/1958
Platycephalidae	Ambiserrula jugosa		23.39.9'S 151.24.3'E"|23.4|151.24	20/05/2004|05/10/2004
Ambassidae	Ambassis agassizii	Auckland Ck, Gladstone	23.51|151.14	02/09/1978|11/06/1979
Ambassidae	Ambassis agassizii	Awoonga Dam, Boyne River	24.05|151.18	20/12/1978|01/02/1979
Ambassidae	Ambassis agassizii	Awoonga Dam, Boyne River	24.05|151.18	02/07/1986
Ambassidae	Ambassis agassizii	Boat Ck, east of Yarwun	23.49|151.09	01/08/1999|08/09/1999
		Boyne River, above Awoonga Dam	24.06|151.17	
Ambassidae	Ambassis agassizii	Calliope R drainage, in dam, W of Mt Sugarloaf	23.52|151.06	01/08/1999|08/09/1999
Ambassidae	Ambassis agassizii	Farm Dam, east of Mt Larcom	23.46|151.08	01/08/1999|08/09/1999
Ambassidae	Ambassis agassizii	Farm Dam, NNE of Mt Larcom	23.46|151.06	01/08/1999|08/09/1999

Family	Species	Location	Lat/Long	Collection Date
Ambassidae	Ambassis agassizii	Futten Ck, Gladstone	23.51|151.16	02/08/1979|11/06/1979
Ambassidae	Ambassis agassizii	Sunvalley, Gladstone, at Ck	23.52|151.16	08/12/1977|04/01/1978
Ambassidae	Ambassis agassizii	Varris Ck, S of Mt Larcom	23.52|151	11/12/1977|04/01/1978
Ambassidae	Ambassis marianus	Calliope River, downstream of Calliope	23.58|151.09	19/11/1985|03/11/1986
Serranidae	Anyperodon leucogrammicus	Off Gladstone	23.51|151.17	23/04/1938
Serranidae	Epinephelus coioides	Auckland Inlet, near Gladstone Power Stn	23.51|151.14	01/02/1978|23/02/1984
Serranidae	Epinephelus coioides	Calliope River mouth, Gladstone	23.55|151.1	07/05/1980|23/02/1984
Serranidae	Epinephelus coioides	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|12/12/1985
Serranidae	Epinephelus sp	Off Gladstone"|	23.51|151.17	28/12/1932
Serranidae	Triso dermopterus	Rundle Island, off	23.32|151.16	01/01/1994|14/06/1995
Serranidae	Triso dermopterus	Rundle Island, off	23.32|151.16	01/01/1994|13/09/1999
Plesiopidae	Fraudella carassiops		23.50.1'S 151.35.1'E"|23.5|151.35	14/11/2005|09/06/2006
Teraponidae	Amniataba percoides	Awoonga Dam, Boyne River	24.05|151.18	02/07/1986
Teraponidae	Amniataba percoides	Boyne River below Awoonga Dam	24.04|151.19	18/06/1987
Teraponidae	Amniataba percoides	Calliope River, downstream of Calliope	23.58|151.09	03/09/1978|11/06/1979
Teraponidae	Leiopotherapon unicolor	Clyde Ck, 15 km SW of Gladstone	23.56|151.13	09/12/1977|03/01/1978
Teraponidae	Leiopotherapon unicolor	Farm Dam, east of Mt Larcom	23.46|151.08	01/08/1999|08/09/1999
Teraponidae	Leiopotherapon unicolor	Nogong Creek, Rundle Range	23.4|151	26/03/1975
Teraponidae	Leiopotherapon unicolor	Wuruma Dam, Nogo River, Burnett River system	25.1|150.59	28/03/1973|04/07/1973
Teraponidae	Terapon puta	Gladstone	23.51|151.17	03/03/1983|17/09/1984
Priacanthidae	Priacanthus macracanthus	Off Gladstone	23.51|151.17	01/09/1924
Apogonidae	Apogon argyrogaster		23.39.9'S	20/05/2004|05/10/2004

Family	Species	Location	Lat/Long	Collection Date
			151.24.3'E"|23.4|151.24	
Apogonidae	Apogon argyrogaster	Curtis Island, east of	23.35|151.35	13/04/2002|10/09/2002
Apogonidae	Apogon argyrogaster	Gladstone, NE of	23.43|151.31	10/10/2000|27/07/2001
Apogonidae	Apogon limenus	Gladstone	23.51|151.17	02/02/1924
Apogonidae	Glossamia aprion	Awoonga Dam, Boyne River	24.05|151.18	20/12/1978|01/02/1978
Apogonidae	Glossamia aprion	Awoonga Dam, Boyne River	24.05|151.18	02/07/1986
Apogonidae	Glossamia aprion	Boat Ck, east of Yarwun	23.49|151.09	01/08/1999|08/09/1999
Apogonidae	Glossamia aprion	Boyne River crossing, 4 ml SW of Bulburin	24.32|151.23	21/03/1975|19/11/1975
Apogonidae	Glossamia aprion	Boyne River, above Awoonga Dam	24.06|151.17	11/10/1976
Apogonidae	Glossamia aprion	Calliope River, downstream of Calliope	23.58|151.09	03/09/1978|11/06/1979
Apogonidae	Glossamia aprion	Futten Ck, Gladstone	23.51|151.16	02/08/1978|11/06/1979
Apogonidae	Glossamia aprion	Three Mile Ck, trib Baffle Ck, S of Bororen	24.17|151.3	12/12/1977|10/01/1978
Apogonidae	Glossamia aprion	Varris Ck, S of Mt Larcom	23.52|151	11/12/1977|03/01/1978
Apogonidae	Gymnapogon sp	Rundle Island, east of	23.33|151.29	01/01/2002|25/07/2002
Sillaginidae	Sillago analis	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|12/12/1985
Sillaginidae	Sillago ciliata	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|12/12/1985
Carangidae	Carangoides fulvoguttatus	Off Gladstone	23.51|151.17	
Carangidae	Caranx ignobilis	Gladstone	23.51|151.17	23/10/1936
Carangidae	Caranx melampygus	Off Gladstone"|	23.51|151.17	04/04/1974
Carangidae	Caranx sexfasciatus	Gladstone	23.51|151.17	03/03/1983|17/09/1984
Carangidae	Gnathanodon speciosus	Off Gladstone	23.51|151.17	23/10/1936
Carangidae	Gnathanodon speciosus	Off Gladstone	23.51|151.17	27/02/1974
Carangidae	Scomberoides commersonianus	Gladstone	23.51|151.17	29/09/1936
Carangidae	Scomberoides lysan	Gladstone	23.51|151.17	08/11/1950|21/08/1974

Family	Species	Location	Lat/Long	Collection Date
Carangidae	Seriola lalandi	Off Gladstone	23.51|151.17	13/08/1936
Leiognathidae	Leiognathus equulus	Calliope River, downstream of Calliope	23.58|151.09	19/11/1985|03/11/1986
Lutjanidae	Lutjanus argentimaculatus	Rundles Beach, mouth of Fitzroy River	23.3|150.51	05/04/1972
Lutjanidae	Lutjanus gibbus	Off Gladstone	23.51|151.17	25/06/1974
Lutjanidae	Lutjanus russelli	Gladstone	23.51|151.17	24/07/1973
Nemipteridae	Scolopsis monogramma	Off Gladstone	23.51|151.17	12/04/1939
Gerridae	Gerres oyena	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|12/12/1985
Gerridae	Gerres subfasciatus	Boyne River estuary	23.58|151.2	18/02/1999|27/10/1999
Gerridae	Gerres subfasciatus	Gladstone"|	23.51|151.17	03/03/1983|17/09/1984
Gerridae	Gerres subfasciatus	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|28/09/1993
Haemulidae	Pomadasys kaakan	Gladstone	23.51|151.17	30/09/1936
Haemulidae	Pomadasys maculatus	Gladstone	23.51|151.17	03/03/1983|17/09/1984
Lethrinidae	Lethrinus genivittatus	Off Gladstone	23.51|151.17	30/09/1936
Lethrinidae	Lethrinus genivittatus	Off Gladstone	23.51|151.17	30/09/1936
Lethrinidae	Lethrinus aticaudis	Off Gladstone	23.51|151.17	05/04/1972
Pentapodidae	Pentapodus aradiseus	Rock Cod Shoal	23.41|151.38	10/09/1913
Sparidae	Acanthopagrus australis	Calliope River, downstream of Calliope	23.58|151.09	19/11/1985|03/11/1986
Sparidae	Acanthopagrus australis	Curtis Island, south end	23.46|151.16	19/11/2002|22/07/2004
Sparidae	Acanthopagrus australis	Nogong Creek, Rundle Range	23.4|151	26/03/1975|24/05/1976
Sparidae	Acanthopagrus berda	Curtis Island, south end	23.46|151.16	19/11/2002|22/07/2004
Sparidae	Acanthopagrus berda	Gladstone	23.51|151.17	03/03/1982|17/09/1984
Sciaenidae	Johnius australis	Gladstone	23.51|151.17	03/03/1983|17/09/1984
Sciaenidae	Johnius borneensis	Gladstone	23.51|151.17	06/07/1982|17/09/1984
Mullidae	Upeneus tragula	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|12/12/1985
Pempheridae	Leptobrama muelleri	Gladstone	23.51|151.17	09/10/1936
Pempheridae	Leptobrama muelleri	Gladstone	23.51|151.17	21/08/1974

Family	Species	Location	Lat/Long	Collection Date
Pempheridae	Parapriacanthus ransonneti	Polymaise Reef, south of	23.38|151.37	12/04/2002|11/07/2003
Kyphosidae	Kyphosus bigibbus	Off Gladstone	23.51|151.17	25/06/1974
Kyphosidae	Microcanthus strigatus	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|12/12/1985
Ephippidae	Drepane punctata	Gladstone	23.51|151.17	03/10/1936
Ephippidae	Drepane punctata	Gladstone	23.51|151.17	17/09/1984
Pomacanthidae	Pomacanthus semicirculatus	Off Gladstone	23.51|151.17	23/06/1974
Mugilidae	Liza subviridis	Gladstone	23.51|151.17	02/12/1980|17/09/1984
Mugilidae	Liza subviridis	Gladstone	23.51|151.17	03/03/1982|17/09/1984
Mugilidae	Liza subviridis	Gladstone	23.51|151.17	03/04/1983|17/09/1984
Mugilidae	Liza subviridis	Gladstone	23.51|151.17	26/10/1977|17/09/1984
Mugilidae	Liza subviridis	Gladstone	23.51|151.17	03/04/1983|17/09/1984
Mugilidae	Liza subviridis	Gladstone	23.51|151.17	06/07/1982|17/09/1984
Mugilidae	Liza subviridis	Gladstone, Ck at QAL access Rd	23.5|151.15	07/12/1977|10/01/1978
Mugilidae	Liza subviridis	Nogong Creek, Rundle Range	23.4|151	02/03/1975|24/05/1976
Mugilidae	Liza tade	Gladstone	23.51|151.17	04/09/1913
Mugilidae	Liza vaigiensis	Gladstone	23.51|151.17	04/09/1913
Mugilidae	Liza vaigiensis	Gladstone	23.51|151.17	09/02/1924
Mugilidae	Liza vaigiensis	Gladstone	23.51|151.17	10/12/1924
Mugilidae	Liza vaigiensis	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|12/12/1985
Mugilidae	Mugil cephalus	Boyne River below Awoonga Dam	24.04|151.19	
Mugilidae	Mugil cephalus	Calliope River, downstream of Calliope	23.58|151.09	03/09/1978|11/06/1979
Mugilidae	Mugil cephalus	Calliope River, downstream of Calliope	23.58|151.09	19/11/1985|28/02/1986
Mugilidae	Mugil cephalus	Gladstone	23.51|151.17	04/09/1913
Mugilidae	Paramugil georgii	Gladstone	23.51|151.17	03/03/1983|17/09/1984
Mugilidae	Paramugil georgii	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|12/12/1985
Mugilidae	Valamugil cunnesius	Gladstone	23.51|151.17	03/03/1983|03/09/1987

Family	Species	Location	Lat/Long	Collection Date
Sphyraenidae	Sphyraena jello	Gladstone	23.51|151.17	03/03/1983|17/09/1984
Sphyraenidae	Sphyraena obtusata	Auckland Ck, Gladstone	23.51|151.14	30/09/1936
Sphyraenidae	Sphyraena sp	Gladstone	23.51|151.17	15/01/1924
Polynemidae	Eleutheronema tetradactylum	Gladstone	23.51|151.17	20/10/1936
Polynemidae	Eleutheronema tetradactylum	Gladstone	23.51|151.17	03/03/1983|17/09/1984
Polynemidae	Polydactylus multiradiatus	Gladstone	23.51|151.17	03/03/1983|17/09/1984
Polynemidae	Polydactylus sp	Gladstone	23.51|151.17	20/10/1936
Labridae	Oxycheilinus bimaculatus	Masthead Island, west of	23.31|151.35	11/10/2002|11/07/2003
Labridae	Pteragogus flagellifer		23.45.3'S 151.33.3'E"|23.45|151.33	14/11/2005|09/06/2006
Scaridae	Scarus sp	Off Gladstone	23.51|151.17	04/08/1936
Opisthognathidae	Opistognathus eximius	Off Gladstone	23.51|151.17	18/06/1941
Blenniidae	Meiacanthus luteus		23.39.9'S 151.24.3'E"|23.4|151.24	20/05/2004|05/10/2004
Blenniidae	Omobranchus rotundiceps	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|12/12/1985
Blenniidae	Petroscirtes variabilis		23.36.3'S 151.35.1'E"|23.36|151.35|	20/09/2004|04/06/2005
Callionymidae	Orbonymus rameus	Cape Capricorn, 13 ml SE of	23.36|151.23	22/02/1924
Gobiidae	Bathygobius fuscus	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|12/12/1985
Gobiidae	Cabillus macrophthalmus		23.39.9'S 151.24.3'E"|23.4|151.24	20/05/2004|05/10/2004
Gobiidae	Favonigobius exquisitus	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|12/12/1985
Gobiidae	Lubricogobius ornatus		23.34.5'S 151.20.1'E"|23.34|151.2	20/09/2004|23/05/2005
Gobiidae	Mugilogobius stigmaticus	Gladstone Marina	23.51|151.15	04/02/2001|10/02/2003
Gobiidae	Pseudogobius sp	Boyne River, south of Gladstone	24.01|151.2	21/12/1992|02/08/1995
Eleotrididae	Hypseleotris compressus	Auckland Ck, Gladstone	23.51|151.14	02/09/1978|11/06/1979
Eleotrididae	Hypseleotris compressus	Boat Ck, east of Yarwun	23.49|151.09	01/08/1999|08/09/1999

Family	Species	Location	Lat/Long	Collection Date
Eleotrididae	Hypseleotris compressus	Briffney Ck, Gladstone	23.53|151.14	08/12/1977|03/01/1978
Eleotrididae	Hypseleotris compressus	Calliope River, downstream of Calliope	23.58|151.09	03/09/1978|11/06/1979
Eleotrididae	Hypseleotris compressus	Clyde Ck, 15 km SW of Gladstone	23.56|151.13	09/12/1977|03/01/1978
Eleotrididae	Hypseleotris compressus	Farm Dam, east of Mt Larcom	23.46|151.08	01/08/1999|08/09/1999
Eleotrididae	Hypseleotris compressus	Four Mile Ck, S of Miriamvale	24.36|151.35	12/12/1977|03/01/1978
Eleotrididae	Hypseleotris compressus	Futten Ck, Gladstone	23.51|151.16	02/08/1979|11/06/1979
Eleotrididae	Hypseleotris compressus	Gladstone, Ck at QAL access Rd	23.5|151.15	07/12/1977|10/01/1978
Eleotrididae	Hypseleotris compressus	Gladstone, Ck at Ufer Motors	23.5|151.15	08/12/1977|10/01/1978
Eleotrididae	Hypseleotris compressus	Larcom Ck, SW of Aldoga	23.5|151.03	01/08/1999|08/09/1999
Eleotrididae	Hypseleotris compressus	Skeleton Ck, N of Miriamvale	24.2|151.3	12/12/1977|03/01/1978
Eleotrididae	Hypseleotris compressus	Sunvalley, Gladstone, at Ck	23.52|151.16	08/12/1977|04/01/1978
Eleotrididae	Hypseleotris compressus	Three Mile Ck, trib Baffle Ck, S of Bororen	24.17|151.3	12/12/1977|10/01/1978
Eleotrididae	Hypseleotris compressus	Varris Ck, S of Mt Larcom	23.52|151	11/12/1977|03/01/1978
Eleotrididae	Hypseleotris galii	Three Mile Ck, trib Baffle Ck, S of Bororen	24.17|151.3	12/12/1977|10/01/1978
Eleotrididae	Hypseleotris klunzingeri	3 Moon Ck, Cania Dam, Burnett R system	24.31|151.01	05/11/1986|30/10/1987
Eleotrididae	Hypseleotris klunzingeri	Awoonga Dam, Boyne River	24.05|151.18	20/12/1978|01/02/1979
Eleotrididae	Hypseleotris klunzingeri	Burnett R system, below Cania Dam, N of Monto	24.41|150.58	21/10/1987|30/10/1987
Eleotrididae	Hypseleotris klunzingeri	Three Moon Creek, Burnett R system, Mulgildie	25.06|151.08	08/06/1974
Eleotrididae	Hypseleotris sp	Boyne River, above Awoonga Dam	24.06|151.17	
Eleotrididae	Hypseleotris sp	Burnett R system, below Cania Dam, N of Monto	24.41|150.58	21/10/1987|30/10/1987
Eleotrididae	Hypseleotris sp	Clyde Ck, 15 km SW of Gladstone	23.56|151.13	09/12/1977|04/01/1978

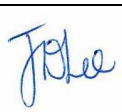
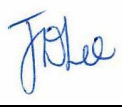
Family	Species	Location	Lat/Long	Collection Date
Eleotrididae	Hypseleotris sp	Farm Dam, SW of Scrubby Mountain	23.45|151.04	01/08/1999|08/09/1999
Eleotrididae	Hypseleotris sp	Larcom Ck, SW of Aldoga	23.5|151.03	01/08/1999|08/09/1999
Eleotrididae	Hypseleotris sp	Varris Ck, S of Mt Larcom	23.52|151	11/12/1977|03/01/1978
Eleotrididae	Mogurnda adspersa	Calliope River, downstream of Calliope	23.58|151.09	03/09/1978|11/06/1979
Eleotrididae	Mogurnda adspersa	Clyde Ck, 15 km SW of Gladstone	23.56|151.13	09/12/1977|03/01/1978
Eleotrididae	Mogurnda adspersa	Granite Creek, Bulburin National Park	24.31|151.29	18/03/1975
Eleotrididae	Mogurnda adspersa	Larcom Ck drainage, in dam, Calliope R system	23.47|151.04	01/08/1999|08/09/1999
Eleotrididae	Mogurnda adspersa	Monto, Burnett River system	24.52|151.08	
Eleotrididae	Ophiocara porocephala	Auckland Ck, Gladstone	23.51|151.14	01/10/1991|15/04/1996
Periophthalmidae	Periophthalmodon freycineti	Port Alma	23.35|150.52	22/10/1913
Periophthalmidae	Periophthalmus novaeguiniaensis	Gladstone	23.51|151.17	23/09/1912
Amblyopidae	Caragobius sp	Boyne River estuary	23.58|151.2	18/02/1999|27/10/1999
Amblyopidae	Caragobius sp	Calliope River, Gladstone	23.5|151.13	11/05/1976
Acanthuridae	Acanthurus fuliginosus	Off Gladstone	23.51|151.17	21/02/1974
Acanthuridae	Naso unicornis	Off Gladstone	23.51|151.17	09/10/1941
Scombridae	Thunnus albacares	Off Gladstone	23.51|151.17	02/05/0039
Scombridae	Thunnus albacares	Off Gladstone	23.51|151.17	20/08/1938
Scombridae	Thunnus tonggo	Off Gladstone	23.51|151.17	23/04/1938
Bothidae	Grammatobothus	Port Curtis, near Facing Island	23.55|151.23	01/02/1968
Bothidae	Pseudorhombus arsius	Port Curtis, near Facing Island	23.55|151.23	05/02/1968
Soleidae	Paradicula setifer	Boyne River	23.56|151.18	24/03/2003|10/08/2004
Soleidae	Paradicula setifer	Calliope River	23.51|151.11	20/07/2003|10/08/2004
Soleidae	Pardachirus rautheri	Boyne River	23.55|151.17	11/05/2003|12/08/2004
Soleidae	Pardachirus rautheri	Boyne River	23.55|151.17	4/02/2003|12/08/2004
Soleidae	Pardachirus rautheri	Boyne River	23.55|151.17	09/03/2003|12/08/2004

Family	Species	Location	Lat/Long	Collection Date
Soleidae	Pardachirus rautheri	Boyne River	23.55|151.17	11/02/2003|12/08/2004
Soleidae	Pardachirus rautheri	Boyne River	23.55|151.17	19/04/2003|12/08/2004
Soleidae	Pardachirus rautheri	Calliope River	23.51|151.11|	17/04/2003|12/08/2004
Soleidae	Pardachirus rautheri	Calliope River	23.51|151.11|	21/03/2003|12/08/2004
Soleidae	Pardachirus rautheri	Fitzroy River	23.3|150.51	10/05/2003|12/08/2004
Soleidae	Phyllichthys sclerolepis	Calliope River, Gladstone	23.5|151.13	13/12/1993|28/09/1993
Monacanthidae	Anacanthus barbatus	Boyne River mouth	23.56|151.21	15/05/1959
Monacanthidae	Cantherhines sp		23.36.3'S 151.35.1'E"|23.36|151.35	20/09/2004|04/06/2005
Monacanthidae	Pseudomonacanthus elongatus	Cape Capricorn, SE of	23.38|151.25	18/10/2002|10/07/2003
Tetraodontidae	Anchiosomus multistriatus	Cape Capricorn, SE of	23.35|151.27	14/04/2002|11/07/2003
Tetraodontidae	Arothron hispidus	Gladstone	23.51|151.17	03/02/1982|17/09/1984

GHD

201 Charlotte Street Brisbane QLD 4000
GPO Box 668 Brisbane QLD 4001
T: (07) 3316 3000 F: (07) 3316 3333 E: bnemail@ghd.com.au

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	K Neil A Boden	J Lee		J Lee		1/10/09
1	R Fryar	J Lee		J Lee		5/11/09