8.4 Nature Conservation

8.4.1 Introduction

This section includes summary information on the study methodology, applicable legislation, and the existing environmental values based on the literature review and field surveys. This section also provides an assessment of the potential environmental impacts of the project on nature conservation issues, including proposed mitigation measures. Detailed terrestrial flora and fauna studies carried out for the LNG facility are presented in Appendix N3 of this EIS. This section should be read in conjunction with Appendix R1, which provides more specific details on the results of a marine ecology field survey undertaken as part of EIS field studies.

In addition, the effect of the project's LNG Facility component, Marine Facilities component and Bridge, Road and Services Corridor component on matters of national environmental significance (MNES) have also been assessed. This has been undertaken in accordance with the requirements of the Environmental Protection Biodiversity Conservation (EPBC) Act 1999 and is reported separately in Appendix G (EPBC Act Report). Appendix G includes specific sections on the LNG Facility (Section 2: LNG facility – EPBC 2008/4057), Marine Facilities (Section 3: Marine facilities – EPBC 2008/4058) and Bridge, Road and Services Corridor (Section 5: Bridge Road and Services Corridor – EPBC 2008/4060) and includes a description of proposed actions, a description of environmental values (MNES) and potential impacts to MNES and mitigation measures.

8.4.2 Methodology

8.4.2.1 Terrestrial Ecology

Study Area

The LNG facility study area is situated in the south-west of Curtis Island, which lies approximately 5 km offshore from the city of Gladstone. Curtis Island itself is approximately 47 km long and 24 km wide. The location of the terrestrial ecology study area is shown in Figure 8.4.1.

The LNG facility study area is dominated by *Eucalyptus* and *Corymbia* woodlands on moderate to low slopes and alluvial plains. Mangrove and saltmarsh communities are present within intertidal areas. The study area displays impacts consistent with a long history of use that includes grazing, clearing, agriculture, and selected timber felling. Agricultural weeds and a history of fire have also impacted upon the ecological values of the site. Many of these impacts from land use practices are in contrast with natural values displayed within less impacted ecosystems on adjacent properties to the east and north of the site. Much of the woodland on the study site is regrowth, however some mature trees are scattered throughout. A number of ephemeral streams that only flow following sustained rain drain the study area.

The methodology for the study included detailed literature review of published and unpublished papers and reports, and interrogation of databases held by Government agencies followed by field studies.

Literature Review

Existing data sources and literature on the ecology of the LNG facility study area was compiled through investigation of key references including:

- Queensland Environmental Protection Agency (EPA) Herbarium flora database (HERBRECS);
- Queensland EPA Wildnet Database;
- Queensland EPA 1:100,000 Regional Ecosystems (RE) mapping;
- Queensland EPA Ecomap environmentally sensitive areas database;
- Queensland EPA Essential Habitat mapping;

- Commonwealth Department of Environment, Water, Heritage and Arts (DEHWA) 'Matters of National Environmental Significance' Environment Protection and Biodiversity Conservation (EPBC) database;
- Queensland Museum fauna records;
- Birds Australia records;
- Species distribution maps from current field guides; and
- Previous relevant studies undertaken in the area including: URS (2007), EPA (2003), EPA (2007a) and EPA (2008).

Field Surveys

Field surveys, using standard sampling methodologies, were conducted to determine the diversity of flora and fauna at the site and map the extent of vegetation communities. Significant species or ecosystems occurring or expected to occur on the site were identified. Details of the methods used are provided in Appendix N3.

The primary fauna survey was conducted over an eight-day period between 2 and 9 April 2008. The survey sampled all habitat types within the study area, based on knowledge of the site gained during the desktop assessment and through aerial photograph interpretation. In addition the following additional surveys were undertaken:

- Three separate migratory wader bird surveys were undertaken in April 2008 (URS), June 2008 (URS) and December 2008 (BAAM); and
- A targeted survey of identified potential habitat for the water mouse (*Xeromys myoides*) was undertaken in December 2008 along the intertidal zone at Laird Point south of Graham Creek.

Preliminary vegetation community definition was used to identify locations for representative field flora survey plots to ground truth communities and obtain floristic and structural data. Fieldwork for the flora survey was conducted over an eight day period between 2 and 9 April 2008.

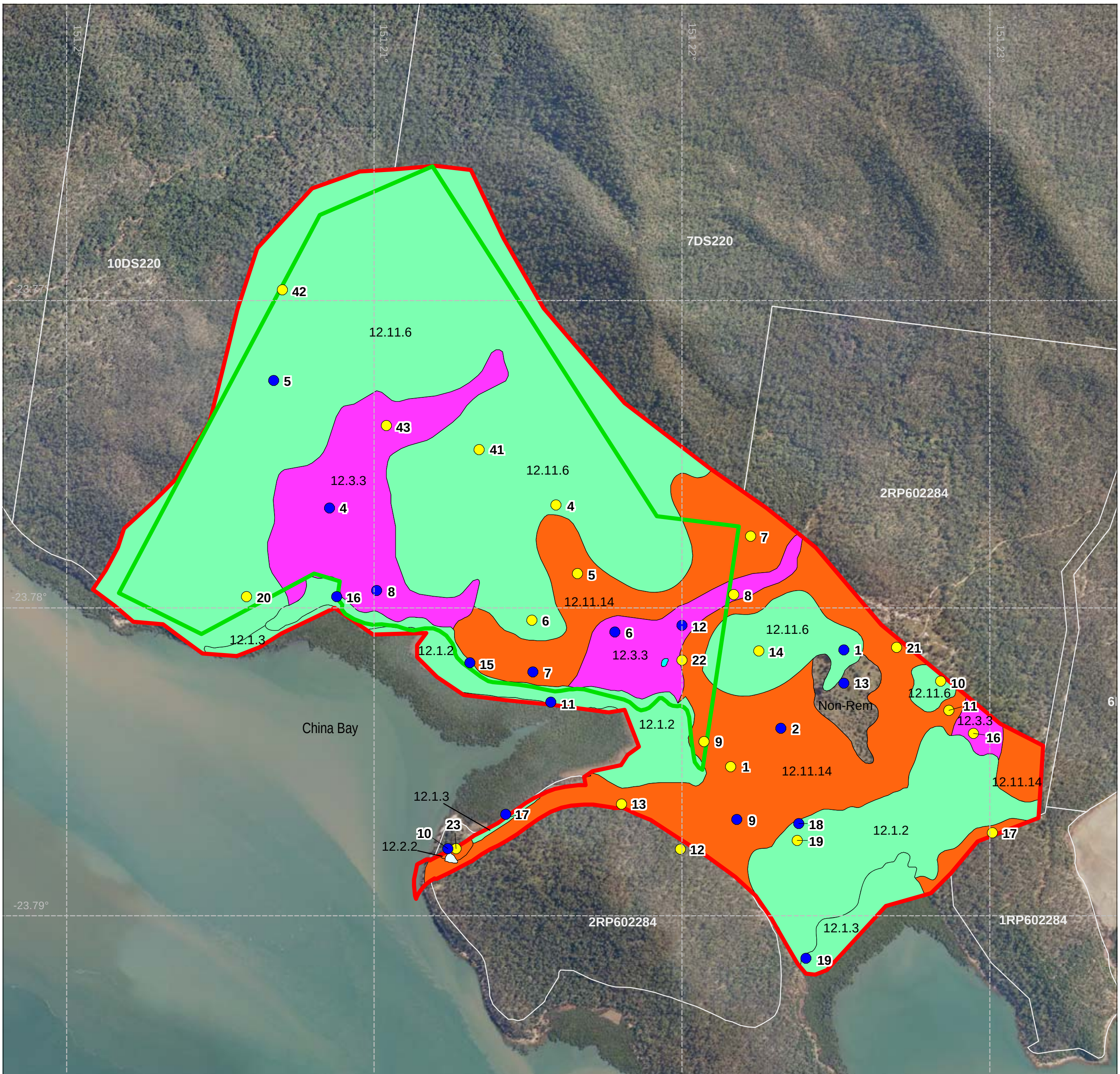
8.4.2.2 Marine Ecology

Study Area

Port Curtis falls within the Shoalwater Coast bioregion as defined in the Integrated Marine and Coastal Regionalisation for Australia (Commonwealth of Australia 2006). This bioregion includes the coastal and island waters from Mackay south to Baffle Creek. Port Curtis is a natural deepwater embayment that is protected from the open ocean by Curtis and Facing Islands. Coastal geomorphology in the main study area is characterised by a partially enclosed embayment and shallow estuaries, including small, continental rocky islands, intertidal flats and estuarine islands. Port Curtis estuary is a composite estuarine system that includes the Calliope and Boyne Rivers, The Narrows, Auckland Creek and several smaller creeks and inlets that merge with deeper waters to form a naturally deep harbour protected by southern Curtis Island and Facing Island. Elevated natural turbidity occurs within the shallow marine and estuarine waters with significant input of freshwater and alluvial sediments from the Boyne and Calliope Rivers.

The City of Gladstone has become one of the major industrial centres of Queensland due to its close proximity to the coal fields and deep water access port facilities (McKinnon et al. 1995). The area is heavily industrialised along the western shoreline and otherwise surrounded by large tracts of natural intertidal wetlands (Connolly et al. 2006).

The LNG facility marine ecology study area is shown in Figure 8.4.2 including the locations of the proposed project components (i.e. gas transmission pipeline, LNG facility, marine facilities and marine dredge material placement facility) which have the potential to impact upon the marine environment.



RE	Vegetation Management St	Area (ha)
Non Rem	Non Remnant	5.0
12.1.2	Not Of Concern	47.4
12.1.3	Not Of Concern	8.0
12.11.6	Not Of Concern	99.9
12.11.14	Of Concern	87.0
12.2.2	Of Concern	0.4
12.3.3	Endangered	45.6
Waterbody		0.1
Waterbody		0.0

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Scale 1:20 000 (A4)
Datum : GDA94

Quarternary Sites
Secondary Transects
LNG Facility
Terrestrial Ecology Study Area
Endangered dominant RE
Of concern dominant RE
Not of concern RE
Waterbody

Client: LNG
URS

Project: GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT

Title: **REGIONAL ECOSYSTEMS AND SURVEY LOCATIONS LNG FACILITY**

Drawn: CA	Approved: JB	Date: 18-05-2009	Figure: **8.4.1**	Rev:B
Job No: **4262 6220**	File No: 42626220-g-999b.wor			A4

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Scale 1:60 000 (A4)
Datum GDA94

Dredge Material Placement Facility
LNG Facility Site Boundary
Gas Transmission Pipeline

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

Client	Project	Title
LNG / URS	GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT	**MARINE STUDY AREA**

Drawn: CA	Approved: JB	Date: 18-05-2009	Figure: **8.4.2**	Rev:B
Job No: **4262 6220**	File No: 42626220-g-888b.wor			**A4**

Literature Review

A detailed review of the existing information on the marine flora and fauna (including literature reviews, consultation and field surveys) of the local environment within a regional context was undertaken and targeted marine species, communities and habitats potentially affected by the GLNG Project. This included reviews of the EPBC Act database, the Queensland Environmental Protection Agency (EPA) Wildnet database of species listed under the *Nature Conservation Act 1992*, scientific literature, material held by the Gladstone Ports Corporation, published material from the Port Curtis Integrated Monitoring Program (PCIMP), and consultation with government agencies and individual researchers.

Field Surveys

As part of the GLNG Project a number of field surveys were conducted to assess the estuarine and marine environment within Port Curtis. These included:

- A seagrass meadow aerial survey (May 2008);
- A sub-tidal habitat survey (May 2008);
- An intertidal habitat survey (June 2008); and
- A benthic survey (Central Queensland University, July 2008).

Forty-five intertidal sites, six sub-tidal sites, and twenty-four macroinvertebrates and sediment sites were surveyed. The field survey locations are shown in Figure 8.4.3. The results from these surveys are detailed in Appendix R1.

8.4.3 Regulatory Framework

Key legislation and planning policies governing nature conservation for Curtis Island and Port of Curtis includes:

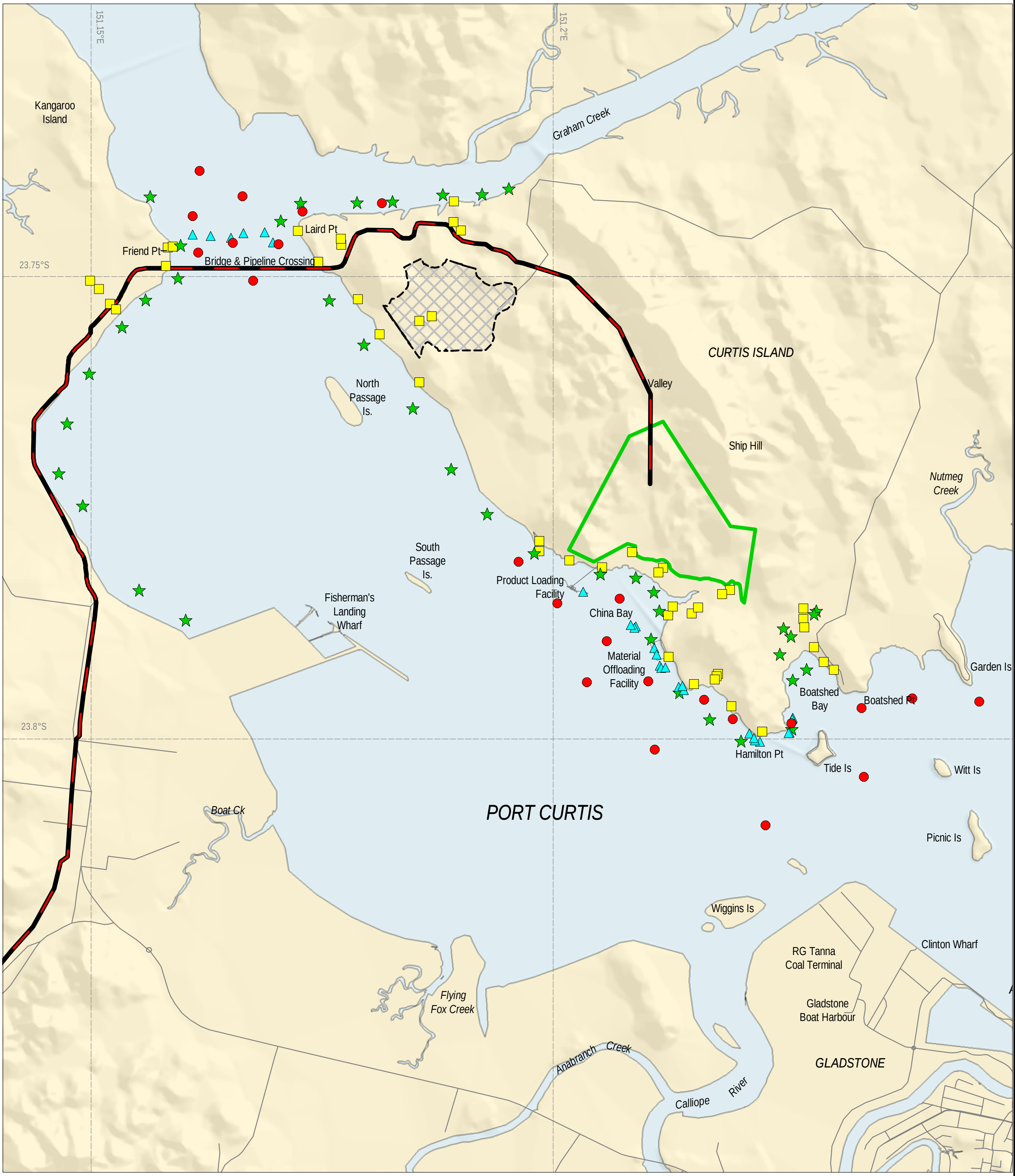
- Environment Protection and Biodiversity Conservation Act 1999 (Cth);
- Great Barrier Reef Marine Park Act 1975 (Cth);
- Environment Protection Act 1994 (Qld);
- Marine Parks Act 2004 (Qld);
- Nature Conservation Act 1992 (Qld);
- Fisheries Act 1994 (Qld);
- Vegetation Management Act 1999 (Qld);
- Coastal Protection and Management Act 1995 (Qld); and
- SPP2/02 Planning and Managing Development Involving Acid Sulfate Soils.

8.4.3.1 Environment Protection and Biodiversity Conservation Act 1999

Refer to Section 6.4.3.1 for details.

8.4.3.2 Great Barrier Reef Marine Park Act 1975

The *Great Barrier Reef Marine Park Act 1975* aims to provide for the long term protection and conservation of the environment, biodiversity and heritage values of the Great Barrier Reef Region, including the ecologically sustainable use of the Great Barrier Reef for recreational, economic and cultural activities. The Act provides for zoning plans and plans of management. The Act also establishes the Great Barrier Reef Marine Park Zoning Plan 2003 which provides for the establishment, control, care and development of the Great Barrier Reef Marine Park and is the primary planning instrument for the conservation and management of the Marine Park.



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- Subtidal Survey Sites
- Marine Survey Helicopter GPS Points
- Marine Intertidal Survey Sites
- Macrobenthic Fauna Field Survey Sites
- Dredge Material Placement Facility
- LNG Facility Site Boundary
- Gas Transmission Pipeline

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

Client	Project	Title
LNG / URS	GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT	MARINE SURVEY LOCATIONS

Drawn: CA	Approved: JB	Date: 18-05-2009	Figure: 8.4.3	Rev:B
Job No: **4262 6220**	File No: 42626220-g-890b.wor			A4

8.4.3.3 Environment Protection Act 1994

The *Environmental Protection Act 1994* (EP Act) aims to protect Queensland's 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 (being ecologically sustainable development).

8.4.3.4 Marine Parks Act 2004

The *Marine Parks Act 2004* provides for the conservation of the marine environment through establishing an integrated strategy of management including (amongst other things) the establishment of marine park zones (such as the Marine Parks (Great Barrier Reef Coast) Zoning Plan 2004 (MPGBRC Zoning Plan)), designated areas and highly protected areas within marine parks. The Marine Parks Act 2004 also sets out various permitting and licensing requirements to carryout activities within a declared marine park zone. The MPGBRC Zoning Plan regulates the area from the low water mark of the Great Barrier Reef Marine Park to either the high water mark or the seaward edge of significant mangrove forests.

8.4.3.5 Nature Conservation Act 1992

The Queensland *Nature Conservation Act 1992* (NC Act) is administered by the Environmental Protection Agency (EPA) and is the principal legislation for the conservation and management of the State's native flora and fauna. The primary objective of the NC Act is the conservation of nature which includes the preservation of protected areas, protected plants and protected wildlife as listed under relevant regulations and plans, including the Nature Conservation (Wildlife) Regulation 2006 and the Nature Conservation (Dugong) Conservation Plan 1999.

8.4.3.6 Fisheries Act 1994

The *Fisheries Act 1994* (Fisheries Act) ensures that Queensland fisheries resources are managed and utilised in an ecologically sustainable way, as well as providing for management of fish habitats and ensuring that there is equity in access to the resources by commercial, recreational and Indigenous fishers.

All waters of the state are protected against degradation by direct or indirect impact under Section 125 of the Fisheries Act. If litter, soil, a noxious substance, refuse or other polluting matter is on land (including the foreshore and non-tidal land), in waters, or in a fish habitat, and it appears to the Chief Executive that the polluting matter is likely to adversely affect fisheries resources or a fish habitat, the Chief Executive of the Department of Primary Industries & Fisheries (DPI&F) may issue a notice requiring the person suspected of causing the pollution to take action to redress the situation.

Under Division 8 of the Fisheries Act, a waterway barrier works approval is needed to build any structure across a freshwater waterway. The purpose of this part of the Act is to provide a balance between the need to construct dams and weirs and the need to maintain fish movement. Such structures include culverts and road crossings, which may need to be constructed to develop access roads in the CSG fields. If approval is given, the Chief Executive, DPI&F may direct the building of a specified fishway for the barrier if required.

8.4.3.7 Vegetation Management Act 1999

Refer to Section 6.4.3.4 for details.

8.4.3.8 Coastal Protection and Management Act 1995

The *Coastal Protection Management Act 1995* provides for the protection, conservation, rehabilitation and management of coastal areas. The Act has regard to the goal, core objectives and guiding principles of the National Strategy for Ecologically Sustainable Development and aims to a achieve, in conjunction with other legislation, a coordinated and integrated management and administrative framework for the ecologically sustainable development of the coastal zone.

The *Coastal Protection Management Act 1995* also establishes the *State Coastal Management Plan 2002* which includes policies relating to coastal use and development, physical coastal processes, water quality, Indigenous traditional owner cultural resources and nature conservation.

8.4.3.9 SPP2/02 Planning and Managing Development Involving Acid Sulfate Soils

The purpose of SPP2/02 is to ensure that development in low-lying coastal areas is planned and managed to avoid the generation of acid sulfate soils. The policy applies to land below 5 m AHD where the natural ground level is less than 20 m AHD and development on that land involves the following:

- Filling of land involving more than 500 m3 or more of material; or
- Excavation of more than 100 m3 or more of soil and sediment.

8.4.4 Existing Environmental Values

8.4.4.1 Regional Context

Bioregion

The LNG facility is situated within the Southeast Queensland bioregion, close to the boundary with the Brigalow Belt bioregion (Sattler and Williams, 1999). The bioregions of Queensland are based on landscape patterns that reflect changes in geology and climate, as well as major changes in floral and faunal assemblages at a broad scale and are used as the fundamental framework for the planning and conservation of biodiversity.

The South-east Queensland bioregion is one of the most species rich and diverse parts of Australia for flora and fauna (Young and Dillewaard, 1999). The bioregion is approximately 6,600,000 ha in size and contains localised areas of endemism and a wide range of habitat types. The area is also the most intensely populated part of Queensland and continues to experience high levels of growth (Young and Dillewaard, 1999).

Subregion

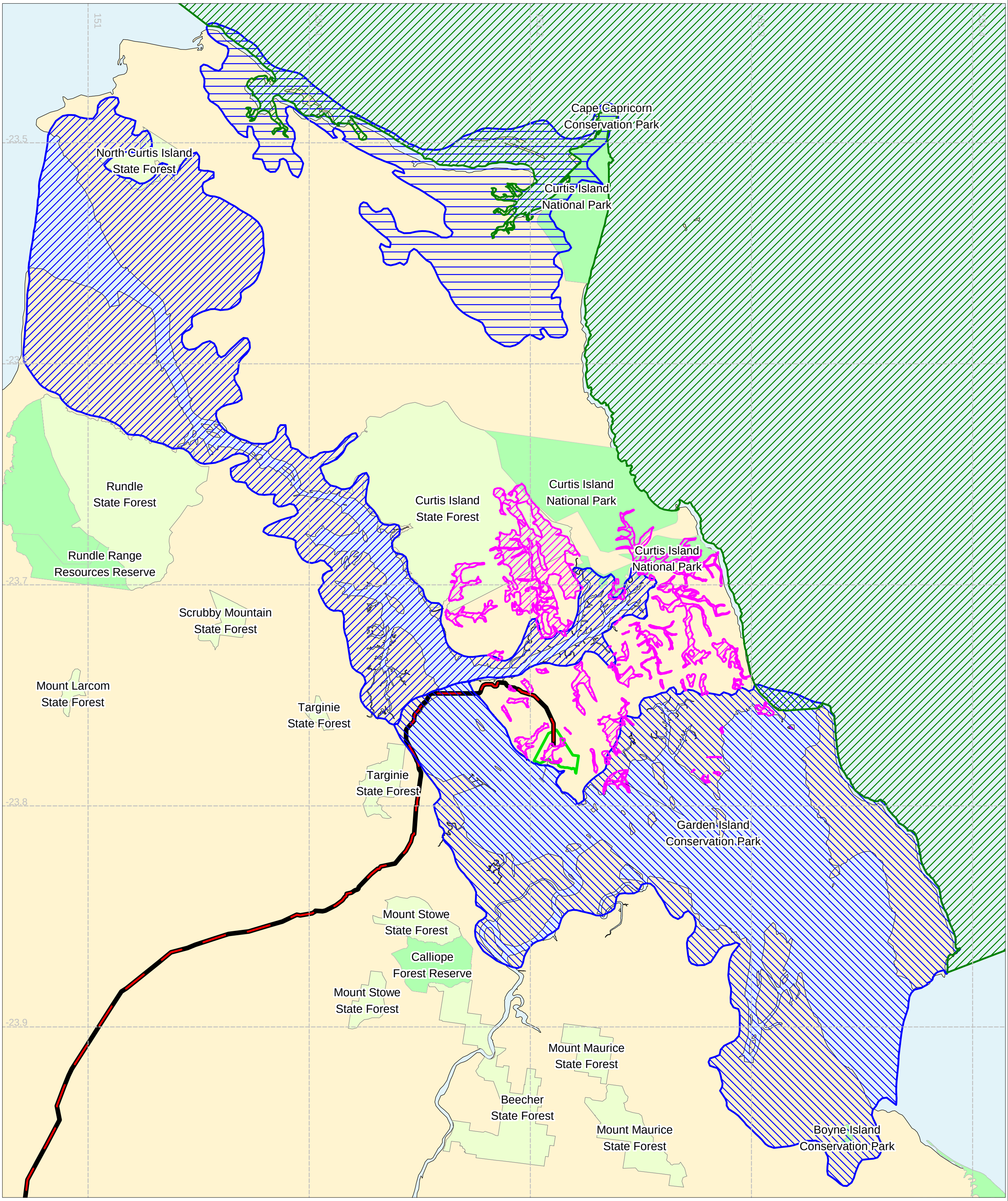
The South-east Queensland bioregion contains ten sub-regions or provinces that delineate significant differences in geology and geomorphology (Young and Dillewaard, 1999). The proposed LNG facility site is located within the Burnett-Curtis Hills and Ranges sub-region. It should be noted that the site is situated near the northern-most boundary of the Burnett-Curtis Hills and Ranges sub-region, bordering on the Marlborough Plains sub-region of the adjacent Brigalow Belt bioregion.

The Burnett-Curtis Hills and Ranges sub-region is geologically diverse and includes low rolling hills on old sedimentary rocks in the west and granite hills and ranges in the east. Major vegetation types of the province include *Eucalyptus crebra* and *Corymbia citriodora* woodlands, eucalypt mixed open forests and araucarian microphyll rainforests (Young and Dillewaard, 1999).

8.4.4.2 Environmentally Sensitive Areas

The LNG facility site is proposed to be located at Hamilton Point West in the south-west of Curtis Island. Santos intends to locate the haul road and material offloading facility off the Hamilton Point site (adjacent to Hamilton Point West). Figure 8.4.4 shows that there are a number of sensitive areas located on or around Curtis Island.

While there are no major environmentally sensitive areas (ESAs) within or immediately adjacent to the LNG facility site there is an Essential Habitat locate on part of the site. The Regional Ecosystem (RE) 12.3.3 (*Eucalyptus tereticornis* woodland to open forest on alluvial plains) within the study area has been mapped by the EPA as Essential Habitat for the koala (*Phascolarctos cinereus*) (EPA 2008b). RE 12.3.3 is also mapped as koala habitat to the immediate north of the study area.



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Scale: 1:250,000 (A4)
Datum: GDA94

- Gas Transmission Pipeline
- LNG Facility
- National Park
- State Forest
- Directory of Important Wetlands - The Narrows
- Directory of Important Wetlands - Port Curtis
- Directory of Important Wetlands - Northeast Curtis Island
- Commonwealth Great Barrier Reef Marine Park
- Essential Habitat

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

Client	Project	Title
LNG / URS	GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT	**ENVIRONMENTALLY SENSITIVE AREAS LNG FACILITY**

Drawn: RG	Approved: JB	Date: 18-05-2009	Figure: **8.4.4**	Rev:B
Job No: **4262 6220**	File No: 42626220-g-1000b.wor			**A4**

State Parks, Reserves, Forests and Refuges

The following conservation estates are present on Curtis Island. All are located north of Graham Creek, except for Garden Island Conservation Park which is located approximately 4 km to the east of the study site (EPA, 2007) and the Great Barrier Reef Coast Marine Park. The marine coastal park includes all tidal waters and tidal land between the tip of Cape York to Baffle Creek (north of Bundaberg) and extends approximately three nautical miles seaward from Highest Astronomical Tide (HAT).

- Great Barrier Reef Coast Marine Park;
- Cape Capricorn Conservation Park;
- Curtis Island Conservation Park;
- Curtis Island National Park;
- Curtis Island State Forest;
- North Curtis Island State Forest;
- Curtis Island Nature Refuge; and
- Garden Island Conservation Park.

Further details on the marine parks and associated legislation can be found in Section 8.4.4.5.

8.4.4.3 Terrestrial Flora

The key findings of the nature conservation (flora) field assessment for the LNG Facility are described in this section, with full details provided in the technical report, Appendix N3.

Species Diversity

The survey identified the presence of 191 taxa representing 60 families and 150 genera of plants. This result represents a moderate floral diversity typical of the ecosystems found within the region. Families represented by three or more genera included Asteraceae (10 genera), Chenopodiaceae (3), Convolvulaceae (3), Euphorbiaceae (4), Fabaceae (13), Malvaceae (3), Myrtaceae (4), Poaceae (26), Rhizophoraceae (3), and Verbenaceae (5).

Genera represented by three or more species included *Acacia* (6 species), *Chloris* (3), *Corymbia* (5), *Cyperus* (4), *Eucalyptus* (3), *Fimbristylis* (4) and *Sida* (3).

A full flora species list and a list of exotic species are provided in Appendix N3.

Vegetation Communities

Six Regional Ecosystems were described and mapped for the LNG facility site, based upon the field survey results and interpretation of aerial photo stereo images.

Figure 8.4.1 and Table 8.4.1 provide details of each community found on the LNG facility site. Full community descriptions including floristics, structure, location, ecological integrity and disturbance notes are given in Appendix N3.

The majority of the vegetation surveyed have been disturbed or modified to some degree by grazing, thinning, clearing for agriculture or weed invasion. Regeneration has occurred across most of the study area and now support open forest or woodland. A cleared area remains surrounding abandoned buildings in the east of the study area. This area supports a mixture of native grasses and herbs including *Bothriochloa decipiens* (pitted bluegrass), *Heteropogon contortus* (black speargrass) and *Cyperus gracilis* (graceful sedge) and exotic grass species including *Pennisetum ciliare** (buffel grass) and *Melinis repens** (red natal grass).

Table 8.4.1 Regional Ecosystems recorded at the LNG facility site

Regional Ecosystem (RE)	Vegetation Community Description	Area on LNG facility study area (ha)	Area within subregion (ha) [1]	% of subregional extent represented within study area
12.1.2	Saltpan vegetation comprising *Sporobolus virginicus* grassland and samphire herbland on Quaternary estuarine deposits.	47.4	15,242	0.31
12.1.3	Mangrove shrubland to low closed forest on Quaternary estuarine deposits.	8	16,580	0.05
12.2.2	Microphyll/notophyll vine forest on beach ridges.	0.4	1,562	0.03
12.3.3	*Eucalyptus tereticornis* open forest to woodland on Cainozoic alluvial plains.	45.6	28,525	0.16
12.11.6	*Corymbia citriodora* and *Eucalyptus crebra* open forest to woodland on Mesozoic to Proterozoic moderately to strongly deformed and metamorphosed sediments and interbedded volcanic.	99.9	178,480	0.06
12.11.14	*Eucalyptus crebra, E. tereticornis* grassy woodland on Mesozoic to Proterozoic moderately to strongly deformed and metamorphosed sediments.	87	4,171	2.09
n/a	Non-remnant areas.	5	n/a	n/a

[1] Derived from RE data for the Burnett-Curtis Hills and Ranges sub-region as per Accad et al. (2006)

The geology of the study area is predominantly metamorphic substrates which form low rising hills and support two distinct vegetation communities. The hill top and mid-slope areas support open forest dominated by *Corymbia citriodora* subsp. *citriodora* (lemon-scented gum) (RE 12.11.6); whereas the lower slopes and more flat, coastal areas support grassy woodlands dominated by *Eucalyptus tereticornis* (forest red gum) and *Eucalyptus crebra* (narrow-leaved ironbark) (RE 12.11.14). The ground layer of RE 12.11.6 was found to be relatively sparse due to the rocky substrate and shallow soils exhibited on the slopes and hilly areas on the site. Weed invasion also appeared to be more prevalent in this community.

Three alluvial plains associated with main drainage lines occur within the study area. These plains support *Eucalyptus tereticornis* (forest red gum) open woodlands (RE 12.3.3) with a mid-storey of *Lophostemon suaveolens* (swamp box) and a grassy understorey. The ground layer was generally the most disturbed by grazing adjacent to ephemeral streams; nonetheless, the ground layer was generally in good condition and supported a diversity of native grass species including *Themeda triandra* (kangaroo grass), *Cymbopogon refractus* (barbwire grass) and *Heteropogon contortus* (spear grass).

A single semi-evergreen vine thicket (RE 12.2.2) was identified within the study area on the proposed MOF haul road site on Hamilton Point. Although this community was only small in size, it was also relatively diverse and included dry rainforest shrub/tree species such as *Alectryon diversifolius* (scrub boonaree), *Cupaniopsis anacardioides* (tuckeroo), *Mallotus phillippensis* (kamala) and *Alchornea ilicifolia* (native holly). The ground cover was relatively dense and dominated by a number of invasive species including *Sida rhombifolia* (common flannel weed) and *Megathyrsus maximus* var. *maximus* (guinea grass), as well as numerous native rainforest creepers and herbs such as *Eustrephus latifolius* (wombat berry), *Indigofera hirsuta* (hairy indigo), and *Cyperus gracilis* (slender sedge).

Saltpan and mangrove communities were present along the sheltered intertidal zones at the south and west of the site. Saltpan species included *Enchylaena tomentosa* (ruby saltbush) and *Sarcocornia quinqueflora* (beadweed). Mangrove species included *Avicennia marina* (grey mangrove), *Rhizophora stylosa* (spotted mangrove), *Excoecaria agallocha* (milky mangrove) and *Lumnitzera racemosa* (black mangrove).

Ecological Integrity of Communities

Vegetation of the proposed LNG facility has a long history of disturbance including grazing, thinning and exotic weed invasion. The site supports remnant vegetation, modified woodlands and non-remnant shrubby regrowth. The majority of vegetation at the proposed LNG site is currently grazed and exhibits some degradation of ground-cover and mid-strata. Virtually all areas of remnant vegetation have undergone some past thinning or clearing, with the exception of the semi-evergreen vine-thicket found on Hamilton Point. Despite the relatively high degree of past disturbance, the ecological integrity of remnant communities within the proposed LNG facility was found to be moderate, with integral ecological processes intact.

Weeds

There was a moderate diversity of weed species within the site with 30 species found. Families with the most exotic weed taxa were Asclepediaceae (3), Asteraceae (5), Poaceae (5) and Verbenaceae (4). Four weed species were identified as being of management concern. These species are listed as pest species under the Queensland *Land Protection (Pest and Stock Route Management) Act, 2002.* Two of these species, rubber vine and lantana, are also listed as Weeds of National Significance (WONS). Developed by ANZECC, WONS are exotic weed species identified as causing significant environmental damage on a national scale (Thorp and Lynch, 2000).

Rubber Vine

Cryptostegia grandiflora (rubber vine) was found in several isolated locations across the study area, predominantly within or close to riparian vegetation. Rubber vine is a Weed of National Significance and is regarded as one of the worst weeds in Australia because of its invasiveness, potential for spread, and economic and environmental impacts. Rubber vine is a native of south-west Madagascar, although the exact date of its introduction into Australia is not known (DNRME, 2004).

Lantana

Lantana camara (lantana) was widespread over the LNG facility study area in the drier vegetation communities, with its abundance generally low. Lantana is a Weed of National Significance and is regarded as one of the worst weeds in Australia. Lantana forms dense, impenetrable thickets that take over native bushland and pastures throughout the east coast of Australia. It competes for resources with, and reduces the productivity of, pastures and forestry plantations. It adds fuel to fires and is toxic to stock (Weed Management CRC, 2003).

Creeping Lantana

Lantana montevidensis (creeping lantana) was uncommon over the LNG facility study area but was identified in the drier vegetation communities in the more modified environments. The species is a popular ornamental plant but is considered a weed when in natural ecosystems. Creeping lantana occurs in coastal and sub-coastal Queensland and as far south as Sydney. It is similar to lantana but does not have thorns, has mainly pink or purple flowers and trails along the ground and only growing to a height of 0.5 m. It is known to be toxic to sheep and cattle if ingested (Parsons and Cuthbertson, 2001) and readily displaces native vegetation (Anderson, 1993).

Prickly pear

Opuntia stricta var. *stricta* (prickly pear) was found in a number of vegetation communities across the study area, although densities were consistently low. Prickly pears were introduced into pastoral districts in the 1840's and by 1925 had invaded over 24 million hectares. The introduction of the moth, *Cactoblastis cactorum*, in the 1920's controlled the pest, and by the mid-1930's, prickly pear was no longer a major problem (DNRW, 2007).

Vegetation of Significance

Conservation Significant Species

The desktop literature review identified eight flora species of conservation significance as potentially present in the study area. Despite extensive targeted surveys, no significant flora species were identified from the surveys as being present within the LNG facility study area. None of the plants recorded in the field surveys (Appendix N3) are listed as threatened species under the Queensland *Nature Conservation Act, 1992* or the Commonwealth *Environment Protection and Biodiversity Conservation* (EPBC) *Act, 1999*.

Culturally Significant Species

Within the proposed LNG facility site many flora species of cultural significance were identified including species traditionally utilised for food or medicinal purposes, painting or decoration. Common bush tucker foods identified include *Avicennia marina* (grey mangrove), *Carissa ovata* (currant bush), *Dianella* species, *Eustrephus latifolius* (wombat berry), *Ficus* species, *Livistonia decipiens* (cabbage palm), *Lomandra multiflora* (many-flowered mat rush), *Marsilea hirsuta* (short-fruit nardoo), *Melaleuca* species, *Myoporum acuminatum* (coastal boobialla), *Planchonia careya* (cocky apple), *Portulaca oleracea* (pigweed) and *Sarcocornia quinqueflora* (bead weed).

Commercially Significant Species

Many of the woodland species identified on the LNG facility study area are considered a potential commercial resource as suitable timber for flooring, telephone poles and other wood products. Commercial timber sources found within the LNG facility study area include: *Corymbia citriodora* subsp. *citriodora* (lemon-scented gum), used for saw logs, fencing material, firewood, turnery, power poles and house poles; *Eucalyptus crebra* (narrow-leaved ironbark), used for power poles, house poles, fencing, and firewood; and *Eucalyptus tereticornis* (forest red gum), used for saw logs, power poles, posts, fencing material and firewood (Taylor & Williamson, 2000).

Significant Vegetation Communities

Three vegetation communities are identified as having either 'Of Concern' or 'Endangered' conservation status (as listed under the *Vegetation Management Act, 1999*) and 'Of Concern' or 'Endangered' biodiversity status (as per the EPA Biodiversity Status listing). Details are provided in Table 8.4.2.

Table 8.4.2 Regional Ecosystems of Conservation Significance

Regional Ecosystem (RE)	Vegetation Community Description	Vegetation Management Act Status	Biodiversity Status	EPBC Act Status
12.3.3	*Eucalyptus tereticornis* open forest to woodland on Cainozoic alluvial plains.	Endangered	Endangered	Not Listed
12.2.2	Microphyll/notophyll vine forest on beach ridges.	Of Concern	Endangered	Critically Endangered
12.11.14	*Eucalyptus crebra, E. tereticornis* grassy woodland on Mesozoic to Proterozoic moderately to strongly deformed and metamorphosed sediments and interbedded volcanic.	Of Concern	Of Concern	Not Listed

Regional Connectivity

At a local scale, the LNG facility study area is located within a broad contiguous tract of vegetation that covers Curtis Island south of Graham Creek. On a broader scale, the majority of the island is densely vegetated, largely due to 8,500 hectares being national park (EPA, 2008c). Curtis Island State Forest and Curtis Island Conservation Park also play a significant role representing large areas of core habitat in proximity to the LNG facility site. The LNG facility site provides a habitat link from the west shore of China Bay with the contiguous woodland covering the majority of the island, and in particular, the core protected native vegetation within the national park to the north east.

In the overall sub-region, industrial development and tree clearing within the Gladstone region has greatly reduced the presence of integral continuous stands of vegetation. Significant gaps exist between dense stands of vegetation surrounding Gladstone, where remnant vegetation appears to be restricted to the Rundle Ranges and Mount Larcom Range in the north, and the Mount Stowe State Forest and Calliope Forest Reserve to the immediate south-west. The remnant vegetation of Curtis Island thus represents a significant area of integral habitat at a regional scale, although habitat connectivity to the mainland is significantly disrupted by The Narrows, a naturally occurring estuarine passage.

There are four nationally important wetlands associated with Curtis Island: Northeast Curtis Island; Port Curtis; The Narrows; and the Great Barrier Reef Marine Park (EPA, 2007b). The intertidal areas surrounding the proposed LNG facility therefore play an important role as a significant local ecosystem, providing habitat continuity between each wetland. The islands surrounding Curtis Island also act as vegetative corridors for local and migratory birdlife.

8.4.4.4 Terrestrial Fauna

The key findings of the terrestrial fauna assessment for the LNG facility are described within this section, with full details provided in Appendix N3. The locations of fauna surveys sites are shown in Figure 8.4.5.

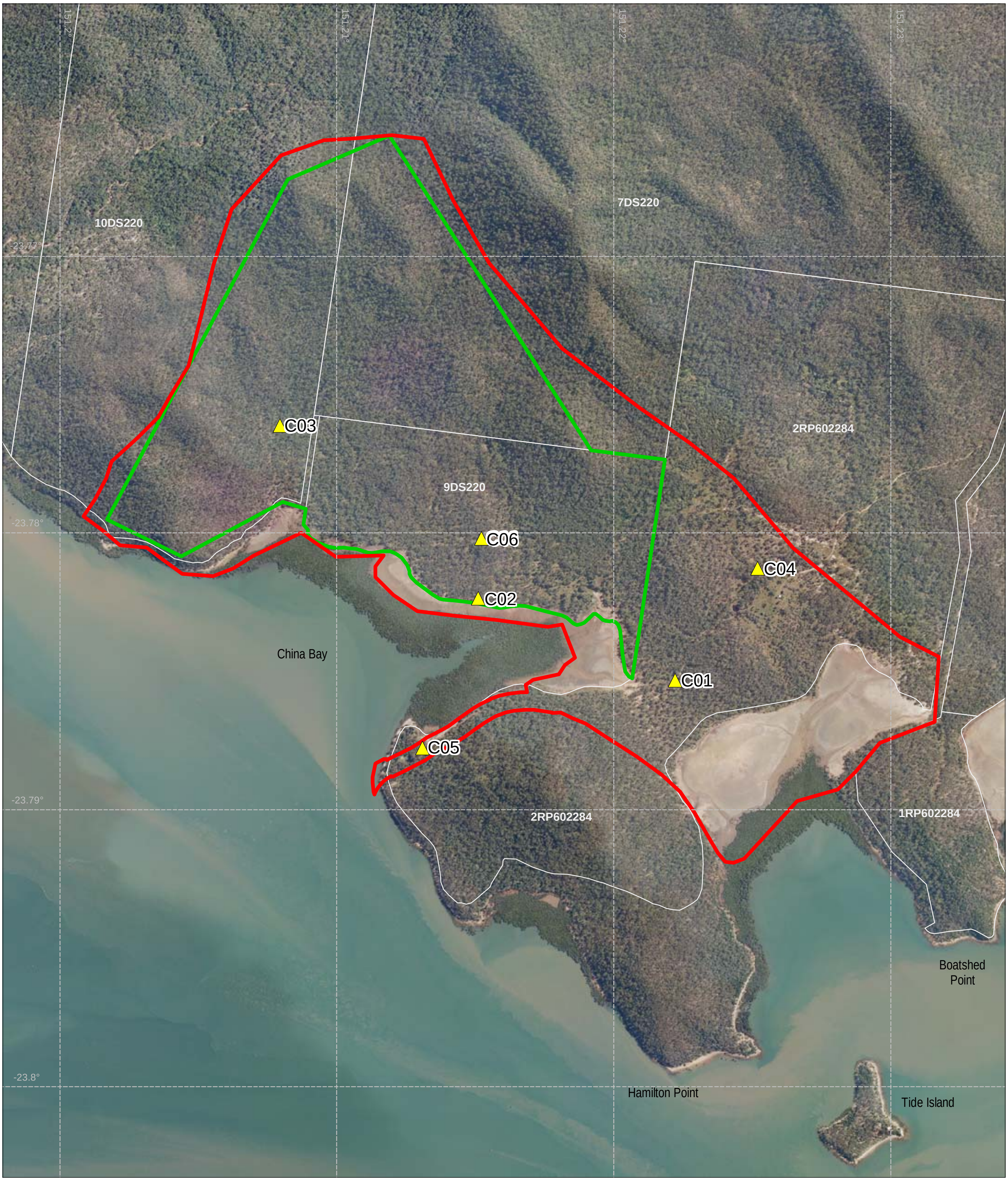
Fauna Habitats

The low-lying alluvial areas along watercourses support forest red gum (*Eucalyptus tereticornis*) woodland. Extremely dense *Acacia* and *Eucalyptus* regrowth was noted in places acting as functional habitat for small forest birds. Occasional habitat hollows were noted in the more mature trees lining the ephemeral creek lines. Dense growth of groundcover including native grasses and forbs such as spiked sida (*Sida hackettiana*) offer abundant habitat opportunities for reptiles and ground mammals.

Corymbia citriodora subsp. *citriodora* (lemon-scented gum) and *Eucalyptus crebra* (narrow-leaved ironbark) woodland is generally found on the slopes and crests of the low hills present at the site and is adjoining the alluvial woodlands on low-lying ground. The typical tree size (generally <300 mm dbh) indicates that the majority of this woodland type is regrowth and has previously been felled in the past for timber or to improve grazing opportunities. Despite this, occasional habitat hollows and stag trees offer nesting resources for squirrel gliders (*Petaurus norfolcensis*) and other arboreal fauna. The skeletal soils on the hillslopes and ridges generally support lower densities of groundcover. An abundance of fallen timber is an outcome of reduced fire frequency on this portion of Curtis Island. The fallen timber tends to offset low densities of grasses and forbs as ground habitat.

Intertidal and terrestrial habitats converge at the high tide level at China Bay and Hamilton Point. Saltpan and mangrove communities, whilst significantly different to terrestrial communities, offer extended habitat for avian fauna and migratory wader birds in particular.

All waterways within the LNG facility study area are ephemeral, and as such are dry for the majority of the year. All flows stem from heavy and sustained rain in the catchment with flows generally ceasing quickly. Isolated pools within the waterways dry up soon after. One constructed farm dam is present in the study area and a natural waterhole is present on the northern side of Hamilton Point. They offer limited habitat for waterbirds due to their size and lack of suitable shoreline habitat.



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Terrestrial Fauna Study Area
LNG Facility
Survey Site

Client	Project	Title
LNG / URS	GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT	**FAUNA SURVEY LOCATIONS LNG FACILITY SITE**
	Drawn: CA; Approved: JB; Date: 18-05-2009	Figure: **8.4.5**
	Job No: **4262 6220**; File No: 42626220-g-1001b.wor	Rev:B; **A4**

Habitat Connectivity

The well-vegetated nature of the LNG facility site and broader study area currently allows for unrestricted movement for fauna in all directions. The LNG facility study area is enclosed on three sides by continuous native woodland. The western boundary features the littoral zone including saltpan, saltmarsh and mangrove communities. Whilst the marine communities are avoided by the majority of terrestrial fauna, some rodents, marsupials and birds will utilise these areas. There is no barrier to movement in this direction apart from habitat preferences amongst the various fauna groups present.

Species Diversity

A total of 81 native and 5 introduced terrestrial vertebrate species were recorded during the field survey at the project site. Native species included 4 amphibian, 13 reptile, 67 bird and 12 mammal species. A complete fauna species list for all taxa identified is provided in Appendix N3. This list also includes species observed outside the LNG facility study area site boundary which are likely to occur at the proposed site of the LNG facility and elsewhere on the island.

Overall, the fauna diversity recorded on the site was very low and some species expected to be present were not detected. These include native and exotic rats and mice and small ground dasyurids such as dunnarts (*Sminthopsis* spp.) and *Antechinus* spp.

Amphibians

Five amphibians were recorded during the surveys at the LNG facility study area, including one exotic species; the cane toad (*Bufo marinus*). Cane toad activity was high throughout the site at night, especially on tracks or around standing water. Despite this, native frogs were also commonly observed or heard. Overall, amphibian activity on the site was considered to be low due to the cooler night temperatures and a greater diversity would expect to be recorded during the warmer months. Common frogs expected to be present in addition to those observed include eastern sedge frog (*Litoria fallax*), emerald spotted treefrog (*Litoria peronii*) and great brown broodfrog (*Pseudophryne major*).

Reptiles

Twelve species of reptile were recorded during the LNG facility survey including one monitor (Varanidae), one blind snake (Typhlopidae), one python (Boidae), two geckos (Gekkonidae), seven skink (Scincidae) and one colubrid (Colubridae) snake species.

Skinks were found in areas of built up leaf litter and grass cover on the LNG facility. Geckoes such as tree dtella (*Gehyra dubia*) and Bynoe's Gecko (*Heteronotia binoei*) were observed sheltering under logs and bark. An additional two snakes were observed beyond the survey area; one elapid (Elapidae) and one colubrid (Colubridae) species. These could also be expected to occur on the study area.

Birds

Sixty-seven birds were recorded from within the LNG facility study area. Three additional species were recorded from the nearby pipeline alignment. Given the mobility of most species of bird, it is likely that all 70 species recorded during the surveys will utilise both the pipeline and LNG facility areas. Additional species were recorded from more remote sections of Curtis Island. Birds were recorded from all feeding groups, especially insectivores, nectarivores, marine raptors and shore/ wading birds.

A subsequent study in December 2008 (within the migration period) by BAAM revealed a total of 22 wader and shorebird species identified within or near the study area. Eleven of these species are considered as migratory species under the EPBC Act. BAAM noted that "Wader/shorebird species were observed in relatively low numbers within the study area. Habitat values appeared to be low for many species due to low foraging potential. There is abundant existing habitat elsewhere on Curtis Island and surrounds. Most of the observed wader species were recorded foraging on more suitable habitat (sand/mudflats) at South End in greater numbers than that seen within the study area" (BAAM 2008). All waderbirds recorded during studies on Curtis Island are shown in Appendix N2.

Mammals

Twelve species of native mammals were recorded during the survey, indicating that the diversity of this group was extremely low. No mammals were captured in Elliott or pitfall traps. Two species of arboreal mammals; the common brushtail possum (*Trichosurus Vulpecula*) and squirrel glider (*Petaurus norfolcensis*) were recorded within woodland communities at low densities. The eastern grey kangaroo (*Macropus giganteus*) was the commonest large native mammal observed. Nine species of microbat were positively identified with another three tentatively identified (from call recordings) from the LNG facility study area.

Rodents and dasyurids were not detected during the survey. These groups are especially vulnerable to feral predators and habitat disturbance and also naturally experience population irruptions and crashes. Their absence may primarily be attributed to the historical disturbance and presence of feral cats and wild dogs at the LNG facility study area.

Water Mouse

No distinctive signs of current water mouse activity were observed during the December 2008 survey. However, given the brief nature of the survey and the large size of the study area, the results are not considered conclusive. Portions of the marine habitats of the study area hold relatively large tracts of potential habitat and would provide suitable foraging resources.

Significant Fauna Species

Twenty significant fauna species were identified as potentially present as an outcome of the desktop database searches. Of these, two species; the beach stone curlew (*Esacus neglectus*) and sooty oystercatcher (*Haematopus fuliginosus*) were recorded at or near the LNG facility study area. The water mouse (*Xeromys myoides*) may be present although dedicated searches did not locate the mouse or signs of its presence. It is considered that the remaining 16 species, consisting of birds, reptiles and mammals, are unlikely to be present. Notes on all significant species and the likelihood of their presence within the study area are included as Appendix N3.

The fauna survey within the LNG facility study area noted the presence of the beach stone curlew (*Esacus neglectus*) at the terrestrial/saltmarsh interface. The beach stone curlew is listed as Vulnerable under the NC Act. The fauna survey for the adjacent pipeline alignment recorded the presence of the powerful owl (*Ninox strenua*) and glossy black cockatoo (*Calyptorhynchus lathami*), both listed as Vulnerable under the NC Act. While neither was recorded in the LNG facility study area, it is expected that both will utilise habitat and food resources within this area.

Essential Habitat Mapping (EPA 2008b) shows habitat mapped for the koala (*Phascolarctos cinereus*) (southern Queensland bioregion) within Regional Ecosystem 12.3.3, identified within and around the LNG facility site. The koala is listed as Vulnerable under the NC Act. No evidence of koalas was observed during the field survey. Anecdotal information from local informants on Curtis Island indicated that koalas had not been seen for many years in the vicinity of the proposed LNG facility site.

Migratory Bird Species

The EPBC Act Protected Matters Report (DEWHA, 2008) sourced for the study site notes 19 terrestrial, wetland and marine migratory birds that may occur within the area. The list includes eight terrestrial migratory species. The LNG facility study area does not act as core habitat for any of these species as similar vegetation communities and topography is found elsewhere in the region. Similarly, those wetland migratory species that favour freshwater wetland habitats are unlikely to be reliant on the two small water bodies present in the study area. The three listed migratory marine species reliant on marine wetlands are Latham's snipe (*Gallinago hardwickii*), little curlew (*Numenius minutus*) and little tern (*Sterna albifrons*).

Introduced Species

Domesticated cattle and horses are present throughout the LNG facility study area and surrounds. Impacts from grazing include erosion and weed infestations typical of pasture situations. One feral cat (*Felis catus*) was observed on the site, as were numerous signs and sightings of pigs, (*Sus scrofa*) and tracks from wild dogs or dingos (C*anis familiaris*). Cane toads were abundant throughout the study area. The presence of feral fauna may have impacted upon native ground dwelling fauna as indicated by the low trapping results seen from the fauna survey.

8.4.4.5 Marine Ecology

Regional Context

World Heritage Area and Marine Parks

The Great Barrier Reef World Heritage Area (GBRWHA) covers approximately 348,000 km^2, extending from the low water mark of the mainland and stretching for over 2,000 km along the north-eastern coast of Australia. The GBR WHA includes all islands and internal Queensland waters apart from *Sea and Submerged Lands Act 1973* exclusions. The Great Barrier Reef Marine Park Authority (GBRMPA) acts as a lead agency for the Commonwealth in matters relating to the GBRWHA. Port Curtis and parts of the Port of Gladstone are defined as internal Queensland waters and therefore controlled by the Queensland Government.

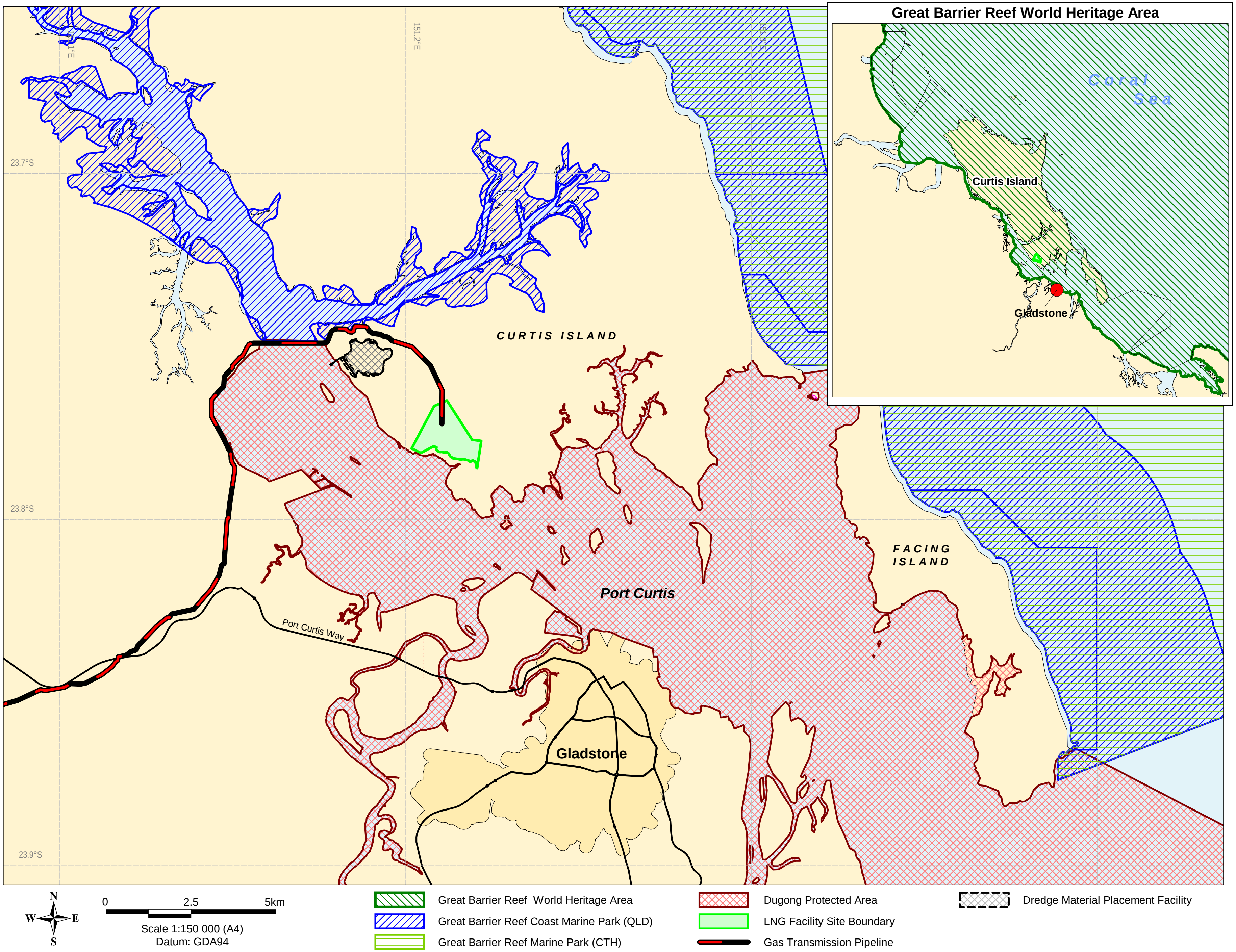
The Commonwealth *Great Barrier Reef Marine Park Act 1975* (GBRMP Act) established the Great Barrier Reef Region (GBR Region) extending approximately 346,000 km^2 (GBRMPA Website, 2009) within which sections of the Great Barrier Reef Marine Park (extending 344,400 km^2) were established and are controlled and developed. The boundary of the GBR Marine Park is nearly identical to that of the GBRWHA with the exclusion of Queensland owned islands and internal waters of Queensland and exclusions under the *Sea and Submerged Lands Act 1973*. This area extends from mean low water mark to 200 nautical mile Economic Exclusion Zone. Eight zones regulating access and use of the GBR Marine Park were established under the *Great Barrier Reef Marine Park Zoning Plan 2003.*

The Great Barrier Reef Coast Marine Park is regulated by the Queensland Government under the Queensland Marine Parks Act 2004, Marine Parks (Declaration) Regulation 2006, Marine Parks Regulation 2006 and the Marine Parks (Great Barrier Reef Coast) Zoning Plan 2004 and includes all tidal waters and tidal land between the tip of Cape York to Baffle Creek (north of Bundaberg), extending approximately three nautical miles seaward from Highest Astronomical Tide (HAT). This legislation is generally complimentary to the GBRMP Act with the exception of some Queensland-specific legislative requirements.

Port Curtis and Curtis Island (above the mean low water mark) are within the WHA (Figure 8.4.6) and outside of the Commonwealth Great Barrier Reef Marine Park. The Narrows (north of Friend and Laird Points) and the marine areas within approximately three nautical miles of the seaward side of Curtis and Facing Islands lie within the Mackay/Capricorn Management Area of the Queensland Great Barrier Reef Coast Marine Park, including waters around Curtis Island, as listed under Schedule 2 of the *Marine Parks (Declaration) Regulation 2006*. The Narrows is zoned a habitat protection zone under the Queensland *Marine Parks (Great Barrier Reef Coast) Zoning Plan 2004*, as are two areas on the seaward sides of Curtis and Facing Islands (Figure 8.4.6).

Curtis Coast Coastal Management District

The Curtis Coast Regional Coastal Management Plan (Curtis Coastal Plan), developed under the Queensland *Coastal Protection and Management Act 1995* (Coastal Act), provides regional direction for the implementation of the *State Coastal Management Plan – Queensland's Coastal Policy* (State Coastal Plan) in the Curtis Coast region and describes how the coastal zone of the Curtis Coast region is to be managed. This includes the LNG facility site.



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Client: URS; LNG

Project: GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Drawn: CA | Approved: JB | Date: 18-05-2009

Job No: 4262 6220 | File No: 42626220-g-859b.wor

Title: MARINE PROTECTED AREAS

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As a statutory instrument under the Coastal Act, the Curtis Coastal Plan has the force of law to guide relevant decisions by State and local governments and the Planning and Environment Court. State Government is required to consider the Curtis Coastal Plan when making relevant decisions about coastal management in the Curtis Coast region. The Coastal Act also binds the Commonwealth as far as the legislative power of Parliament permits. The Curtis Coastal Plan and the State Coastal Plan, also have the effect of State planning policies under the *Integrated Planning Act 1997*.

Under this plan the Curtis Coast is managed in an ecologically sustainable manner that allows for:

- The region's continued industrial and port development using best practice;
- The protection and maintenance of natural ecosystems while allowing for responsible hunting, fishing and harvesting of resources;
- Recognising and protecting the region's diverse and cultural resources and values;
- Recognising the importance of tourism and recreational facilities to accommodate the increasing population and visitors;
- Maintaining and enhancing lifestyle, liveability and public access to the coast; and
- Strong local Indigenous Traditional Owner community involvement in management and development.

The key challenge for coastal management within the Curtis Coast region is the long term management of further development related to the Port of Gladstone and associated industrial development, and the management of significant impacts on coastal resources. Key initiatives in the Curtis Coast Plan include the recognition of the Gladstone State Development Area as an area of state and national significance that has been established by Government for large-scale industry development.

Significant Wetlands

The nearest Ramsar wetlands are the Shoalwater and Corio Bay areas, located approximately 150 km to the north. It is not expected that Santos' proposal will have any impacts on this Ramsar site.

The Directory of Important Wetlands (DEW 2005) lists The Narrows, Port Curtis and Colosseum Inlet/Rodds Bay as important wetlands. Figure 8.4.6 shows the location of these areas.

Other Protected Areas

The Rodds Bay Dugong Protection Area (DPA) was designated in 2002 and encompasses the majority of the Gladstone port limit area. DPAs are prescribed under the Queensland *Fisheries Regulation 2008* and restrict the use of fishing nets in those areas. DPAs are also prescribed under the *Nature Conservation Act 1992* through the *Nature Conservation (Dugong) Conservation Plan 1999,* and more recently through the implementation of Species Conservation (Dugong Protection) Special Management Areas declared under the *Great Barrier Reef Marine Park Zoning Plan 2003.*

The Rodds Harbour Fish Habitat Area (FHA) and the Colosseum Inlet FHA are approximately 20 km south of Gladstone. FHAs are declared under the Queensland *Fisheries Act 1994* for the conservation, protection and management of essential fish habitat. Both FHAs are designated management levels A and B, and are regulated to restrict coastal development while recognising the significance of the marine habitats and the contribution they make supporting fisheries resources for the recreational and commercial fishing. Considering the 20 km distance from the proposed LNG facility and associated infrastructure, it is unlikely that potential negative impacts will occur to the FHAs as a result of the construction and/or operational phases of the project.

Marine Habitats of Port Curtis

The Port Curtis area includes over 1,000 km^2 of coastal hinterland, wetlands and estuarine waters with marine and coastal zone wetlands covering an area over 300 km^2 (McKinnon et al. 1995). Mangrove, seagrass, salt marsh, rocky and sandy shoreline, open water and subtidal benthic habitats support varied biological communities within Port Curtis and adjacent marine areas. Much of the estuarine near-shore is lined by dense stands of mangrove, mainly *Avicennia marina* and *Rhizophora stylosa*, while bare soft sediments cover most of the remaining bedforms (Currie & Small 2005).

Intertidal and subtidal marine areas provide a variety of habitats for many species during different stages of their life cycle. The importance of marine habitats such as seagrass, mangroves, rocky outcrops and sand bars contributing to maintaining marine communities has been well documented. Mangroves, saltmarsh and seagrass communities are known for their contribution to fisheries productivity particularly as nursery areas for juvenile fish species (Danaher et al. 2005). Studies conducted by DPI&F indicate that mangroves and seagrass are critical to more than 75% of commercial and recreational species during some stage of their life cycle, including mud and blue swimmer crabs, prawns, barramundi, whiting, flathead, bream and mullet (Danaher et al. 2005).

Intertidal Habitats

The results from the field surveys generally agree with the Queensland DPI&F research that used Landsat imagery, aerial photography and ground truthing combined with a baseline of seagrass in 2002 (Rasheed et al. 2003). During DPI research, a total of 30 intertidal habitats within The Narrows and Port Curtis were mapped including seagrass, mudflats, saltmarsh, mangroves and rocky shores (Danaher et al. 2005). Exposed mud banks and sandbanks dominated the intertidal marine habitat within Port Curtis with a total cover of 24% or 5,143 ha. Closed *Rhizophora* mangrove forest (20%) and saltpans (18%) were also dominant intertidal habitat types within Port Curtis (Danaher et al. 2005). The intertidal substrates in the vicinity of the LNG facility site are shown on Figure 8.4.7.

Low Tidal Mudflats

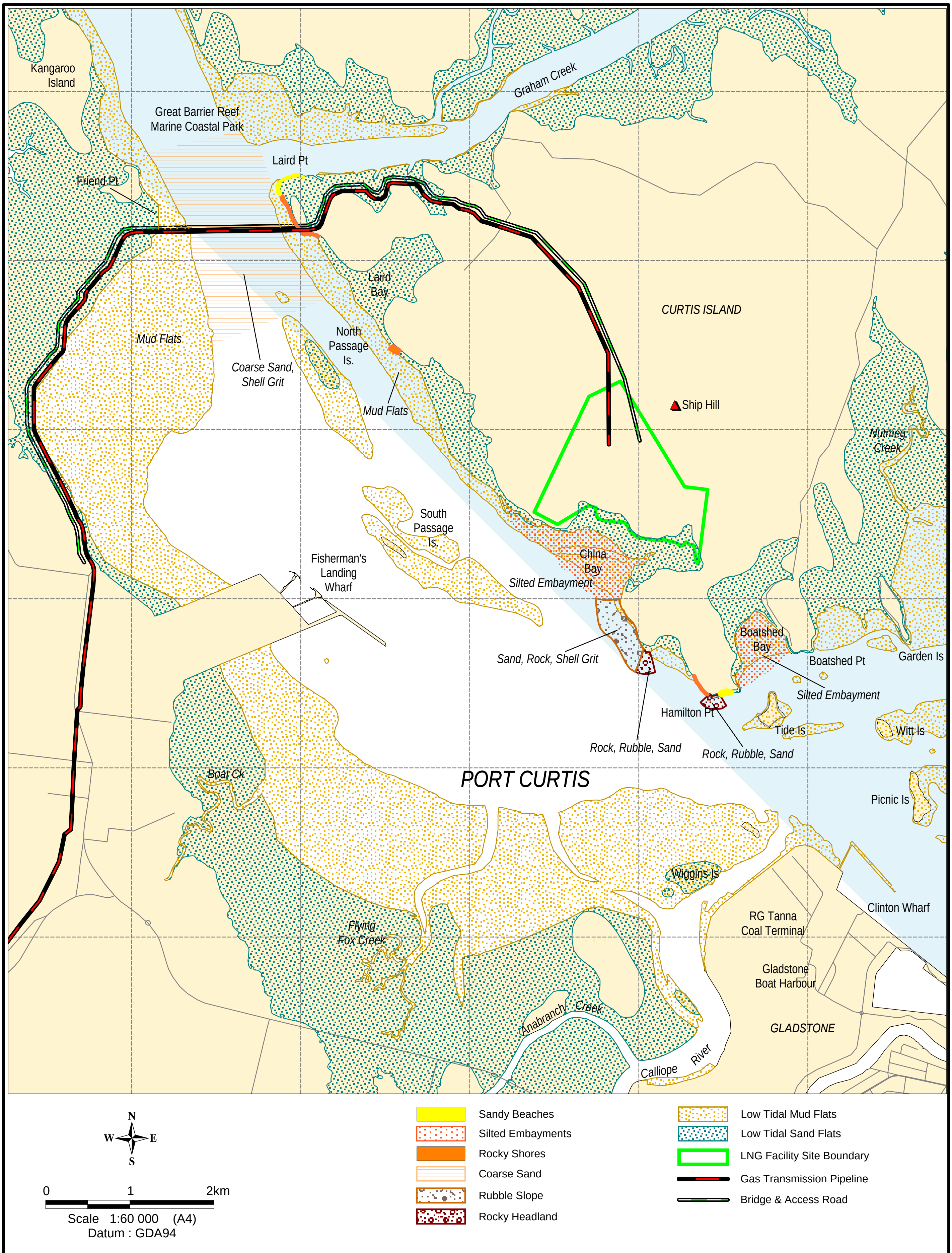
The low tidal mudflats are defined as the zone that is exposed at low tide and submerged at high tide and may be non-vegetated or colonised by seagrass or algal beds. Extensive areas of mudflats with very fine mud dominated the lower intertidal habitats of almost all sites during the June 2008 survey. Soft mudflats up to 300 m wide were exposed at low tide in areas seaward of the mangrove shoreline at locations such as China Bay and the Kangaroo Island/Friend Point area.

Previous studies in Port Curtis have illustrated strong links between macrobenthos and environmental and sediment characteristics (Currie & Small 2005). Mudflats lacking conspicuous vegetation may play an important trophic role yet to be fully acknowledged (Connolly & Guest 2004). Intertidal mudflats constitute an important habitat that support a high biodiversity and biomass of benthic invertebrates, sustain productive fisheries and provide important feeding grounds for migratory shorebirds (Erfemeijer and Lewis,1999; Connolly & Guest, 2004). The contribution of adjacent seagrass meadows to available organic matter for fish species was considered significant in a study assessing autotrophic contribution of mudflats and adjacent seagrass meadows (Connolly & Guest 2004).

Saltflats

Saltflats are dominated by salt tolerant herbs and low shrubs in the intertidal zone, generally landward of the mangrove zone where tidal inundation occurs during the spring tide cycle only. Saltpans also occur in this zone and are generally devoid of vegetation. In contrast to mangrove communities in Queensland, saltmarsh species diversity and community complexity increases with increasing latitude (Danaher et al. 2005). Saenger (1996) recorded 40 saltflat species for the Curtis Coast Region including shrubs, herbs and algae.

High evaporation rates and extreme soil salinities largely preclude macrobiota from living in this habitat, except in some shallow drainage lines. While saltflats are largely devoid of vegetation, there were sparse areas of halophytic shrubs and grasses (e.g. *Sporobolus virginicus* or salt couch) growing amongst the salt flats. In some areas the saltflat surface was covered with algal mats (cyanobacterial mats) that were in various degrees of desiccation, dependent on their location and extent of tidal wetting received.



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Project: GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT

Title: **INTERTIDAL AND SUBTIDAL SUBSTRATE TYPE**

Drawn: LL	Approved: JB	Date: 18-05-2009
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Although saltflats are only inundated at spring high tides, they are considered important in terms of fisheries productivity. Previous studies indicate that shallow tidal pools within saltmarshes provide transitory feeding habitat for larval and juvenile fishes and a variety of invertebrate species. The distribution of fish found on saltflats has been linked to the proximity to intertidal, mangrove lined feeder creeks (Danaher et al. 2005).

Saltflats landward of the mangroves are generally almost devoid of invertebrates (Wells 1983; 1984); a feature that was present at the Port Curtis sites. During this study, many of the open saltflats had no molluscs or crab holes. Other areas, particularly those closest to mangroves or along small tidal channels had some crab holes and isolated individuals of the mud whelk, *Telescopium telescopium*.

Extensive excavations by feral pigs were noted in several areas along the saltflat/landward mangrove margin.

Sandy Substrates

The shifting sands make upper intertidal sand beaches a difficult environment for invertebrate fauna, and the upper intertidal biota is restricted to a few species of crustaceans and molluscs. Extensive wave action that moves the sand about rapidly means that organisms living on, or in, the beach sand can be alternately exposed or submerged in the sand during storms, by currents, and wave action during tides. They must be able to burrow back into the sand if they are exposed, or emerge if they are covered up. The lack of ability to move eliminates plants from upper intertidal sand beaches. As on rocky shores, the fauna is zoned, but zonation patterns are subtle as the species are buried into the sand on upper shores.

Sandy beaches were limited to small areas at Hamilton Point and Laird Point, though the habitat at Hamilton Point had a mixture of sandy beach, rocky shore and some mangroves. Invertebrates on the sandy beach were generally impoverished. The upper intertidal areas of sandy beaches in northern Australia are typically characterised by ghost crabs (*Ocypode*) and burrowing donacid bivalves that can be locally abundant, but neither group was found at Hamilton Point during the June 2008 survey. Although usually abundant, only a small colony of soldier crabs (*Mictyrs*) in the mid-tide region was found, and a single individual each of the sand bubbler crab *Scopimera inflata* and the fiddler crab *Uca polita*. Several individuals of the mud snail *Nassarius dorsatus* were observed lower in the intertidal zone.

Low tidal sandflats are uncommon in Port Curtis, with only one site investigated during the survey at Laird Point. The sand was relatively coarse, indicating considerable sorting by currents. Few living species were found, but the presence of several species of dead shells suggests other species may occur in the deeper waters offshore. Colonies of soldier crabs were active during low tide on the sandflat surface at Laird Point.

Rocky Shores

Rocky foreshores provide a hard substrate for the attachment of algal flora as well as sedentary invertebrates such as oysters and tube worms (Danaher et al. 2005). A wide variety of biota occurs on rocky shores. Most are derived from marine groups, species of which are adapted to live in intertidal regions. The zonation of intertidal fauna generally relates to proximity to the high water mark where the upper areas are exposed to the air, and thus desiccation, for the longest periods and have a restricted number of species. The biota of the upper intertidal zone is often characterized by limpets, littorinid snails and *Leptograpsus* crabs (Wells 1984). However, during the study in June 2008, these groups were largely absent at the sites examined in Port Curtis, possibly due to extensive siltation of the rocky foreshores at these locations.

In between the mangrove embayments, rocky foreshores with a high silt content occurred at the mid to upper intertidal zone at Hamilton Point and immediately south of Laird Point. The shores were mostly composed of small oyster encrusted boulders and rubble at mid tide levels. A low mangrove shrubland community dominated by *Aegiceras corniculatum* with *Avicennia marina* and *Aegialitis annulata* also occurred at mid to high tide levels at many rocky shore areas.

An oyster fringe was present at mean sea level on most of the rocky shore areas inspected along the coastline of Port Curtis. As there is less exposure to the air, invertebrate diversity is greater in mid-tidal areas. The mid-tidal accumulations of oysters increase habitat diversity, which in turn further increases the number of other invertebrate species present. Thaid snails (predominantly *Morula marginalba*) were common in this area, and feed on the oysters and other species. Several species of nerites were common, mostly those associated with muddy shorelines. Large chitons (*Acanthopleura*) characteristic of tropical Australian rocky shores were absent. Pulmonate slugs (*Onchidium* sp.) can be abundant shortly after the tide goes out, but soon migrate into crevices where they are protected from desiccation. However, *Onchidium* were uncommon in Port Curtis, even just after the rocks were exposed by a falling tide.

Diversity is generally greatest on the lower portions of rocky shores, but in Port Curtis the habitat at lower levels (~MLWN to MLWS) consists of soft mudflats comprising a different suite of intertidal species than that usually found on lower rocky shores.

Sub-Tidal Habitats

The limited literature available on the subtidal habitats within the Port Curtis region generally agrees with the results from this study. The areas surveyed included coarse sand channels between Friend and Laird Point, silted embayments at China Bay and the unnamed bay between Hamilton Point and Boatshed Point, rubble slopes south of China Bay, and rocky reef communities at Hamilton Point and the rock walls adjacent to deeper channels around Hamilton Point to the southern side of the island. Friend Point and Laird Point were found to have a silt/mud substrate with some rubble, whereas the main channel consisted of a coarse sand substrate with some shell grit. Marine species found in this location included macroalgae, hydroids, gorgonians and zoanthids.

Coral reefs have been reported between Facing and Curtis Islands and south-west of Facing Island (QDEH/GPA 1994). Subtidal rocky slopes and outcrop areas are restricted to small headlands, drop-offs and rocky outcrops off Curtis Island and Facing Island and some small islands south of Curtis Island – principally Tide and Picnic Islands (LDM 1998). According to QDEH/GPA (1994) and LDM (1998) brown algae are the predominant macroalgae on these substrates with hard coral assemblages restricted to relatively clear, open coastal water sites located between Facing Island and Curtis Island.

The Narrows

Targinie Creek, located behind Kangaroo Island on the western side of The Narrows is distinguished by frequently clear waters that flow across exposed rock, rubble and coarse sandy substrates in several sections of its middle and lower reaches (LDM 1998). Marine surveys conducted by LDM (1998) determined that parts of these substrates are colonised by macroalgae, seagrasses, hydroids, grey sponges, tube worms and tunicates. Several small isolated hard corals (possibly *Goniastrea*) were recorded in 1995 and 1997 during the same study. No hard corals were observed during the recent survey. LDM (1998) reported that other creeks in the area (Boat Creek, Flying Fox Creek and Nutmeg Creek) do not contain any significant areas of corals.

The benthic habitat at 5 m depth near Friend Point is primarily silt with numerous small and large burrows. Strong currents occur around Friend Point creating a scouring effect on the benthic substrate. Gorgonians (sea fans) and Pennatulacids (sea pens) were observed at this site. Both are commonly found within the region.

The benthic substrate in the centre of the channel is coarse sand with a high proportion of shell grit, which may be attributed to a combination of the strong currents between The Narrows and Port Curtis and/or discards of scallop shell from the commercial fishery.

The proportion of silt increases towards Laird Point with lesser amounts of sand and shell grit. Topographic relief across the channel was flat with some small and large burrows present in the softer sediment. Ripples of mud were observed in the substrate at Laird Point, along with numerous small and large burrows.

China Bay to Hamilton Point

The silted embayments were largely devoid of marine species and contained numerous small to large burrows in the soft mud. In the subtidal zone of the silted embayments, gorgonians and sea pens were sparsely distributed in the soft mud substrate in China Bay. The unnamed bay between Hamilton Point and Boatshed Point on the southern side of Curtis Island is also a relatively shallow embayment consisting of silt with some rubble in the subtidal zone and dominated by macroalgae interspersed with a sparse cover of sponges and hydroids. Other subtidal marine species sighted at this location include a feather star (Crinoid), tube anemone and sea pen. These silted embayments within Port Curtis consist of mud flats lined with mangrove communities and extensive saltflats on the landward edge of the mangroves. These shallow silted embayments on the leeward side of Curtis Island offer protected areas for mangrove seed to colonise.

The slope between China Bay and Hamilton Point consists of silt with some rubble at depths greater than 6 m and some rock at the small headland south of the rubble slope. Although marine species were sparse at this site, several tube anemones, sponges, soft corals, tube worms and bivalves were present. Percentage cover was higher at the southern end of the slope where the substrate becomes rockier. This area was dominated by hydroids, zoanthids and algae with numerous gorgonians, sponges and soft corals.

Hamilton Point is a rocky headland that continues down to a rocky wall adjacent to a relatively deep channel. The substrate is sandy with rubble, rock and some shell grit. The higher flow velocity of the channel provides periodic strong currents suitable for a more complex benthic community consisting of filter feeding organisms. This area had the highest percentage of live cover (up to 35%) and marine species community complexity found within the subtidal sites surveyed within Port Curtis. The subtidal areas of Hamilton Point are dominated by hydroids, ascidians and zoanthids, with gorgonians, soft corals, macroalgae and large areas of sponge gardens. Encrusting and boulder sponges up to 70 cm in diameter were recorded. Several colonies of the non-scleractinian coral, *Tubastrea coccinea*, were sighted at this location.

Few motile species were observed during the subtidal surveys, due to the very poor visibility (generally less than 1 m). A Nurse shark was sighted resting in a cave and several butterfly and damsel fish were observed. Several nudibranchs (Phylum Mollusca) were also sighted at this location.

Sediments

Sediment types within Port Curtis have been described by Currie and Small (2005) as:

- Silts and muds largely restricted to protected intertidal flats in the inner harbour;
- Fine sands in shallow banks between Curtis and Facing Islands and more extensively through much of the outer harbour north of Hummock Island;
- Medium sands on the edge of channels through much of the inner harbour; and
- Coarse sands and gravels found in the scour holes of arterial channels and entrances, and around fringing reefs on the eastern side of Facing Island.

In later studies, Currie and Small (2006) found that bottom sediments in the Port Curtis estuary were variable over small distances (<1.5 km) with median size classes ranging from silt and mud to sand, coarse-sand and gravel. Their results indicate that:

- Median grain size increased significantly with depth; and
- The spatial patterns in the sediments broadly reflected bathymetry patterns within Port Curtis.

Areas of lower flow water velocity have higher deposition rates of carbon content and finer sediment, with high cohesive properties including silts and clays. During the Central Queensland University study conducted in July 2008, sites that had significant carbon content in the sediment also expressed the highest silt mud fraction. Conversely, systems with high flow rates generally have sediments composed of sand and gravels and therefore low cohesive properties. Changes in water depths and currents within

Port Curtis may explain why some sites had significantly elevated carbon content and finer particle sizes, whereas sites with higher water velocities had lower carbon contents and increased particle sizes (Alquezer 2008).

Seagrass Meadows

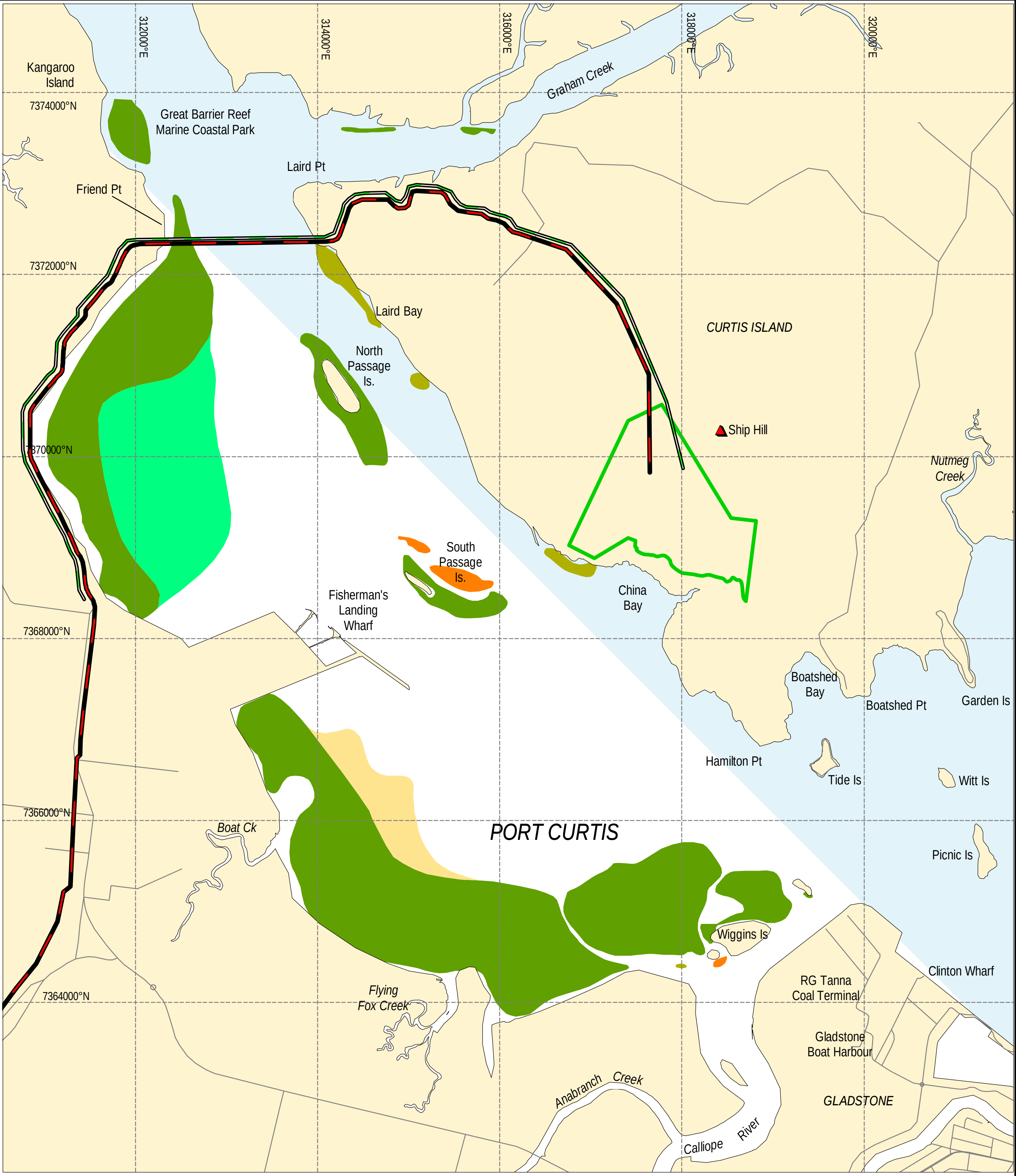
In Australia, seagrass meadows grow in temperate and tropical waters with the highest number of species found near the tip of Cape York. Seagrasses are productive flowering plants capable of completing their life cycle completely submerged by marine waters (Danaher et al. 2005). Seagrasses are well recognised as important nursery habitat for juvenile prawns and commercial fish species (Rasheed et al*.* 1996; Watson et al. 1993). Seagrasses in Queensland are also an important food resource for dugong and sea turtles, with both these species observed within Port Curtis during the 2002 baseline seagrass survey (Rasheed et al*.* 2003).

Seagrass meadow area and biomass vary seasonally and between years with peaks in late spring/summer and troughs in winter (McKenzie 1994; McKenzie et al*.* 1998; Rasheed 1999). Despite seagrass meadows being less conspicuous in Port Curtis than in other large estuarine embayments along the Australian east coast, they are considered to contribute significantly to the food webs that sustain fisheries species living over mudflats. Much of the existing seagrass meadows are adjacent to port infrastructure or dredged channels within Port Curtis and although the seagrass is considered healthy, it is vulnerable to the impacts of industrialisation. The seagrass meadows of Port Curtis are considered of regional significance as they are the only significant meadows found within 170 km north and south of the area (Connolly et al*.* 2006).

A 2002 baseline study by the Queensland DPI&F, conducted between October and December, during peak seagrass meadow biomass, found extensive areas of seagrass in the Port Curtis region, mainly on shallow coastal mud and sand banks (Figure 8.4.8). A total of six species of seagrass were found in the region and in the peak period of cover the seagrass meadows were estimated to cover 20% of the Port Curtis and Rodds Bay area (7,246 ha on intertidal banks and 6,332 ha subtidal). The intertidal seagrass communities on muddy sediments were dominated by *Zostera capricorni* (the most widely distributed community type within Port Curtis) and *Halodule uninervis* on sandy sediments. *Halophila* dominated communities were located adjacent to Fisherman's Landing, and *Halophila decipiens* and *H. spinulosa* dominated deeper areas (more than 5 m below mean sea level) (Rasheed et al*.* 2003).

Following the 2002 survey, the DPI&F selected several of the more important seagrass meadows for ongoing monitoring, including the meadows to the north and south of Fisherman's Landing. Significant declines in both biomass and area were recorded in these meadows up until the 2005 survey, but had recovered substantially by the November 2006 survey (Taylor et al. 2007). The ephemeral seagrass meadows found around Fisherman's Landing took longer to recover than other seagrass meadows in the region. This could be because the highly patchy meadows with low overall biomass may have lower resilience and no substantial seed bank to support rapid regeneration of seagrass species (Rasheed et al*.* 2006). Results from the 2006 DPI&F survey (Figure 8.4.9) indicate that seagrasses in Port Curtis were healthy, and changes to seagrass meadows and biomass were likely related to climatic and environmental factors, rather than port related activities (Taylor et al. 2007).

Additional surveys were undertaken for this EIS, to compliment the existing baseline survey data. Minimal seagrass was observed at the subtidal sites and highly patchy seagrass was only observed north of Fisherman's Landing in the intertidal zone, however the surveys were undertaken during late Autumn (May 2008) when seagrass biomass and area would be expected to be much reduced.



N
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0 1 2km

Scale 1:60 000 (A4)
Datum : GDA94

SEAGRASS LEGEND

- Zostera capricorni with Halophila ovalis
- Zostera capricorni
- Halophila decipiens
- Halophila ovalis with Zostera Capricorni
- Halophila decipiens with Halophila ovalis

- LNG Facility Site Boundary
- Gas Transmission Pipeline
- Proposed Access Road

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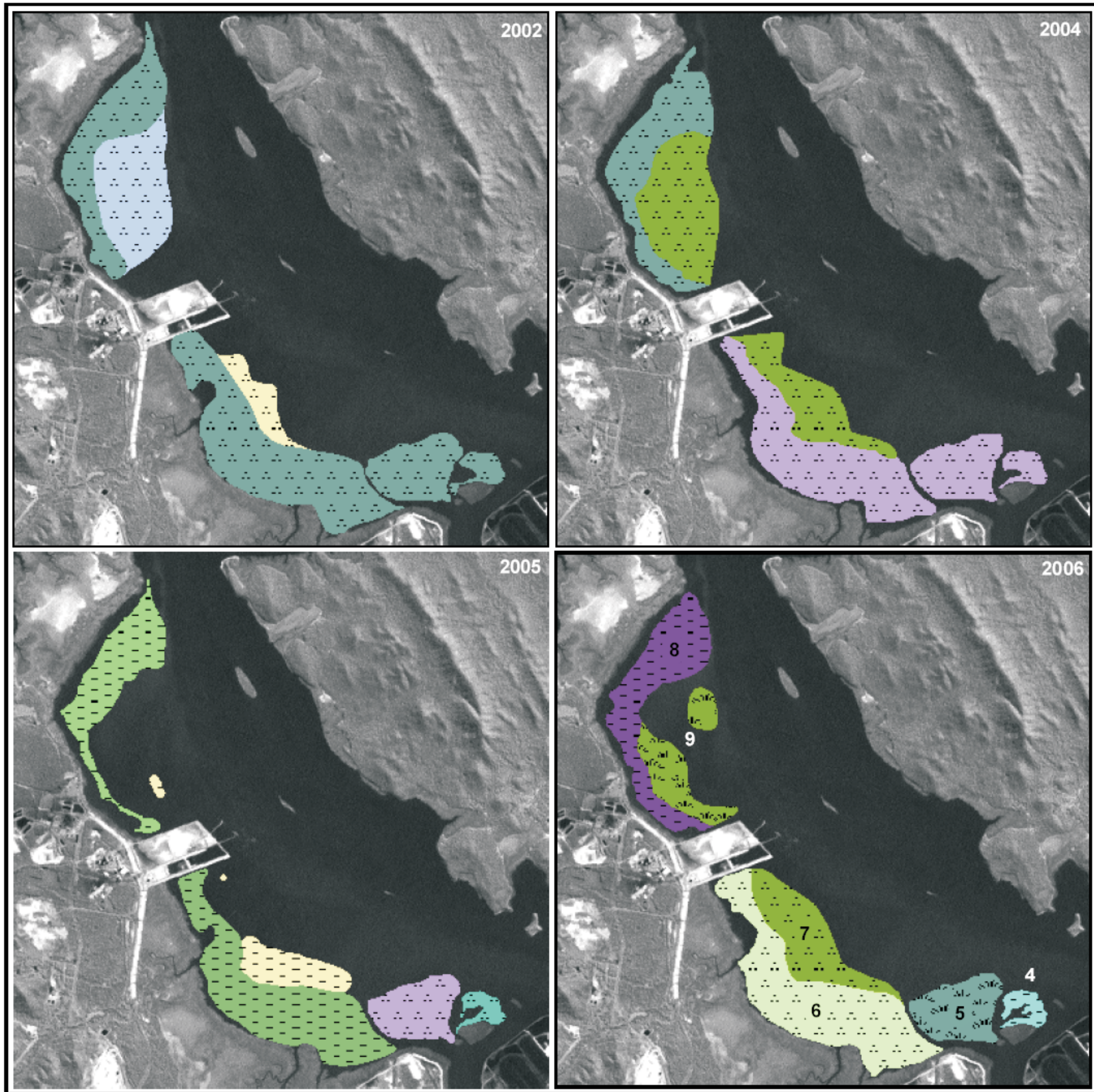
Client	Project	Title
LNG	GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT	COASTAL SEAGRASS 2002
URS	Drawn: CA · Approved: JB · Date: 18-05-2009	Figure: **8.4.8**
	Job No: **4262 6220** · File No: 42626220-g-1036.wor	Rev:A · **A4**



Legend

Community type

- Light *Halophila ovalis*
- Light *Halophila ovalis* with *Zostera capricorni*
- Light *Halophila ovalis / Zostera capricorni*
- Moderate *Halophila ovalis* with *Zosterna capricorni*
- Light *Halophila decipiens*
- Light *Halophila decipiens* with *Halophila ovalis*
- Moderate *Halophila decipiens*
- Light *Zostera capricorni*
- Light *Zosterna capricorni* with *Halophila ovalis*
- Light *Zostera capricorni / Halophila ovalis*
- Light *Zostera capricorni* / mixed *Halophila* species

Meadow Cover

- Continuous cover
- Aggregated patches
- Isolated patches

N

0 2.5 5

Kilometres

Source: 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).

Funded by Central Queensland Ports Authority, the Australian Government's Marine and Tropical Sciences Research Facility represented in North Queensland by the Reef and Rainforest Reasearch Centre, and the Queensland Department of Primary Industries and Fisheries.

Produced by the Marine Ecology Group, Queensland Department of Primary Industries and Fisheries, Northern Fisheries Centre, Cairns, 2007.

* This is not a complete seagrass distribution, only selected seagrass monitoring meadows displayed

Background: Landsat ETM + Panchromatic 24 July 1994

Client

Project

GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Title

MONITORING MEADOWS
2002, 2004
2005 AND 2006

Drawn: CA | Approved: JB | Date: 18-05-2009

Job No.: 4262 6220 | File No. 42626220-g-1037.cdr

Figure: 8.4.9

Rev. A

A4

Mangroves

Of the 14 mangrove species previously recorded from the Port Curtis area, 11 were recorded during the June 2008 intertidal survey (see Table 8.4.3). The mangrove species recorded from the survey were consistent with those species noted from other intertidal surveys in the Gladstone area and no new species for the Port Curtis area were found in the June 2008 survey. Species such as *Acanthus ilicifolius* (Spiny Holly Mangrove) and *Acrostichum speciosum* (Mangrove Fern) have previously been recorded from the Gladstone area but were not encountered during the June 2008 survey as suitable habitat for these species (i.e. upper reaches of large creek or river systems) do not occur in the immediate study area. While not considered to be a mangrove, the mistletoe *(Amyema* sp.) was also noted in mangrove canopies at a few sites.

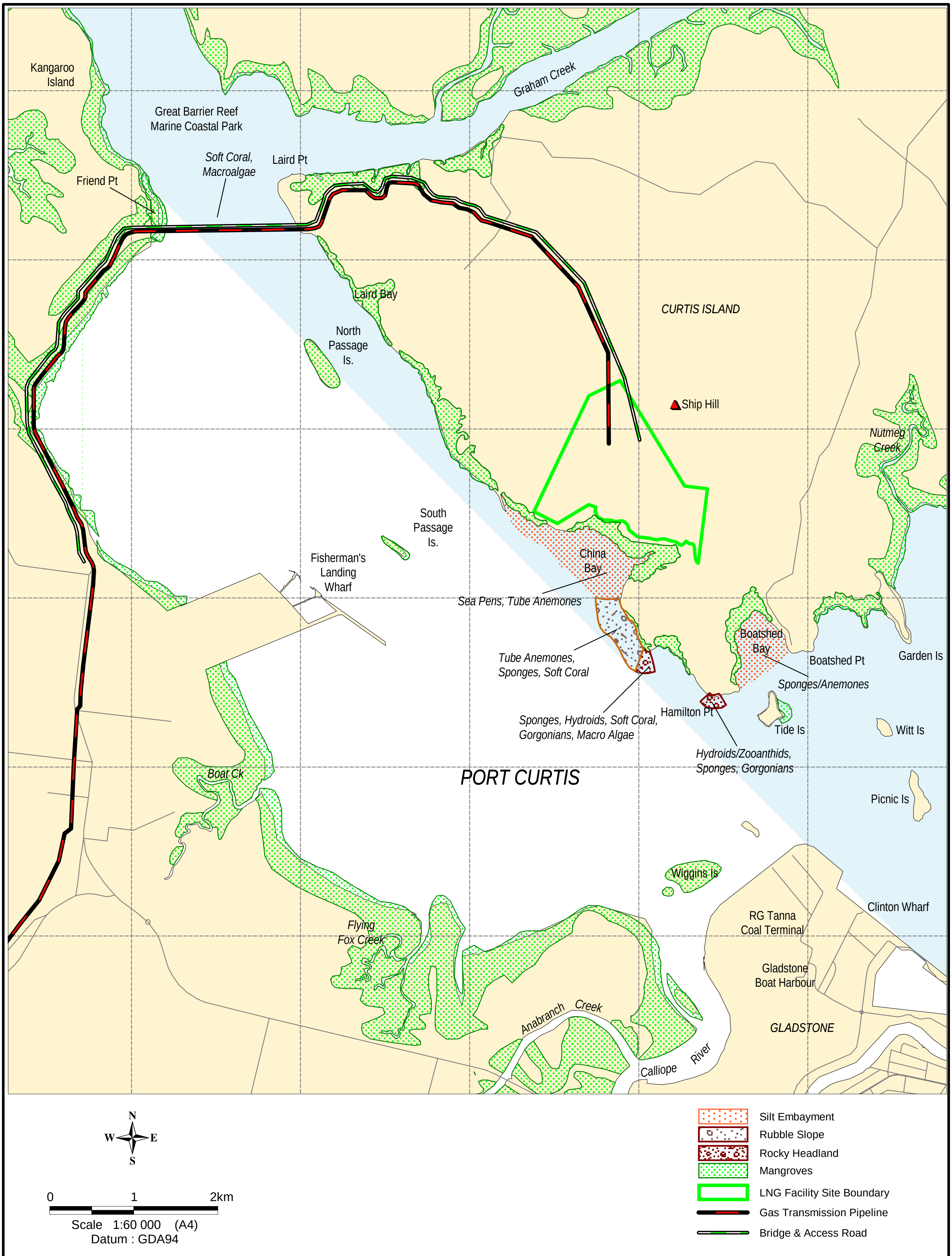
The distribution of mangroves in the vicinity of the LNG facility site is shown on Figure 8.4.10. Further details are provided in Table 8.4.3.

Table 8.4.3 Mangrove Species recorded from 2008 intertidal habitat survey

Mangrove Species	Common Name	Boatshed Point to China Bay	China Bay to Laird Point	Laird Point and Graham Creek	Friend Point and Kangaroo Island
Aegialitis annulata	*Club Mangrove*	✓	✓	✓	✓
Aegiceras corniculatum	*River Mangrove*	✓	✓	✓	✓
Avicennia marina	*Grey Mangrove*	✓	✓	✓	✓
Bruguiera gymnorhiza	*Large-leaved orange Mangrove*	✓	✓	✓	✓
Ceriops australis	*Smooth-fruited Yellow Mangrove*	✓	✓	✓	✓
Excoecaria agallocha	*Milky Mangrove*	✓	✓	✓	✓
Lumnitzera racemosa	*White-flowered Black Mangrove*	✓	✓	✓	
Osbornia octodonta	*Mrytle Mangrove*	✓	✓	✓	✓
Rhizophora stylosa	*Long-style Stilt Mangrove*	✓	✓	✓	✓
Xylocarpus granatum	*Cannonball Mangrove*		✓		
Xylocarpus moluccensis	*Cedar Mangrove*	✓	✓		✓

The June 2008 intertidal survey confirms the mapping provided in Danaher et al. (2005) showing *Rhizophora* forests dominating the mangrove embayments along the south-west coast of Curtis Island. There were some smaller/minor areas of other mangrove communities (i.e. non *Rhizophora* forests) that were recorded in the survey that were not shown in Danaher et al. (2005). These were typically narrow bands (~10 – 30 m wide) of mixed species shrublands or low forests at the landward edge of the mangrove zone, or along the margin of cheniers (or beachridges). While mangroves mostly occurred within small embayments and tidal flat settings, they also occurred intermittently on rocky shores at mid to upper tidal levels.

In addition to the mangrove communities described above, the presence of cheniers or beachridges (shoe-string shaped sand/shell deposits formed during storm events) has resulted in the development of a species-rich and very localised habitat. The cheniers, which are supratidal in elevation, provide localised freshwater seepage at their margins with the surrounding mudflats and, together with a different substrate type (calcareous sands and shell gravel), these conditions have developed narrow mangrove habitats of either a mixed species woodland on the chenier crests (*Excoecaria agallocha, Lumnitzera racemosa*, *Bruguiera gymnorhiza, Xylocarpus moluccensis* and *Xylocarpus granatum*) or a mixed species



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Client	Project	Title
URS	GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT	**MANGROVES AND SUBTIDAL BIOTA**
	Drawn: LL/CA — Approved: JB — Date: 18-05-2009	Figure: **8.4.10** — Rev:A
	Job No: **4262 6220** — File No: 42626220-g-1051.wor	**A4**

shrubland on chenier slopes (*Avicennia marina*, *Rhizophora stylosa*, *Ceriops tagal*, *Aegialitis annulata*, *Aegiceras corniculatum, Lumnitzera racemosa* and *Osbornia octodonta*). Coastal dune species and halophytic grasses (*Sprobolus virginicus*) and shrubs (*Sueada* sp.) also occur on the cheniers together with some non-mangrove tree species. Chenier habitats were recorded amongst the seaward mangrove zone at Friend Point and at the small mangrove embayment approximately 1.5 km south of Laird Point (preferred dredge material disposal area).

Several areas of mangrove mortality recorded historically are most likely related to natural factors and the dynamic environment in which mangroves occur. These included areas of mostly dead *Ceriops* trees located along the margin between the landward mangrove edge and saltflats. Such mortality in these areas is possibly related to changes in tidal flat hydrology that results in progressive increases in soil/porewater salinities, resulting in mangrove dieback. In addition, on the extensive tidal flat areas south-west of Friend Point there are several isolated stands of dead and fallen mangroves, possibly resulting from storm events and/or shoreline erosion.

Invertebrate Marine Fauna

Intertidal iInvertebrates

A total of 76 species or groups of invertebrate fauna were recorded from intertidal habitats mostly from low tidal mudflats, mangroves and rocky shores (Appendix R1). Molluscs were the most diverse group taxonomically (55 species, including 30 species of gastropods, 24 bivalves and one chiton).. Other groups represented were crustaceans (18 species and groups), echinoderms (two species, each represented by a single individual) and one species of polychaete found at a single site. While there are undoubtedly additional species that were not recorded during the 2008 surveys, species diversity was generally low, possibly due to low habitat diversity. In particular, rocky shores had very high silt content with the lower intertidal entirely comprised of very silty mudflats with low biodiversity.

Sub-tidal Macroinvertebrates

Several trophic groups of benthic invertebrates, including deposit-feeders, filter-feeders, grazers and predators are represented within the sediment of Port Curtis. Central Queensland University (Alquezar 2008) was commissioned to investigate macrobenthic assemblages in the study area (Appendix R1). Species abundance, species richness, diversity and species evenness was investigated in subtidal benthos within the study site area. Data from previous studies were reviewed to determine changes in macroinvertebrate biodiversity among years within sites, where available.

A total of 656 organisms from 129 taxa were collected throughout the study. Polychaetes, molluscs and crustaceans accounted for more than 85% of individuals. While macroinvertebrate biodiversity differed significantly between sites and within sites, and also between years and within sites (where there was available data). From previous data sets, the highest biodiversity was recorded in 1995-96 and 2003. Macroinvertebrate community assemblages were also different among sites in 2008.

Results from the macroinvertebrate and sediment assessment within Port Curtis indicate that:

- Macroinvertebrate abundance, species richness, diversity and species evenness (biodiversity) was significantly different among sites in 2008;
- Macroinvertebrate community assemblages were significantly dissimilar among sites within Port Curtis in 2008;
- Macroinvertebrate biodiversity was significantly different between years, within sites, based on previous years data;
- Changes in biodiversity and assemblage composition among sites and years may be attributed to differences in water depth, sediment carbon content loads and sediment particle sizes; and

- Other biotic (ecological) and abiotic (anthropogenic disturbance, contamination, freshwater inputs etc) influences may also effect macroinvertebrate biodiversity and assemblage composition.

Within Port Curtis, a number of environmental variables such as salinity, sediment grain size and organic content may contribute to differences in macrobenthic biodiversity and assemblage composition. Results from this study indicate that sediment size, water depth and carbon content appear to be correlated with macrobenthic assemblages among sites; however other environmental factors that were not investigated in this study such as freshwater output and potential contamination can influence macrobenthic community assemblages.

Sub-Tidal Marine Communities

Sparsely distributed (less than 1% live cover) soft corals, zoanthids, sea pens, sponges and gorgonians were found across the channel in the potential bridge/pipeline area. Sea whips and sea fans were scattered throughout the seabed. Razor shells and other bivalves were present, along with clumps of macroalgae such as *Padina sp*. Some sponges were present, but not common, at this site. The zoanthids were approximately 30 cm in height, solitary and resembled flower soft corals. The highest cover of marine species at the potential bridge/pipeline crossing was at GPS015 and GPS018, possibly due to a greater current strength and food source for marine organisms.

Hamilton Point contained the highest percentage live cover of all sites surveyed (up to 35%). The marine communities found at this site were dominated by dense stands of stinging hydroids (suborder Thecata) and zoanthids, with soft corals, sponges, ascidians and algae. The steep slope and the strong currents through this area contribute to the higher diversity and abundance. The silted embayments of China Bay and the unnamed bay on the southern side of Curtis Island were largely devoid of marine species. Numerous small and large burrows were observed in the soft mud substrate. Percentage cover in the silted embayments was generally less than 1%.

The distribution of subtidal marine biota is given in Figure 8.4.10.

Fish and Fisheries

Species

Fish surveys conducted within Port Curtis and the Calliope River have recorded a total of 180 species of fish, including commercial and recreational species. A study on the Calliope River conducted by DPI&F in 1994 recorded a total of 99 fish species, 13 crustaceans and three species of molluscs. Although the majority of species were recorded within the tidal influence, 33 species were recorded from the freshwater reaches of the Calliope River (Connell Hatch 2006; McKinnon et al*.* 1995; Connelly et al*.* 2006).

Trawl surveys of 105 intertidal and shallow subtidal sites in Port Curtis conducted between November and December 2003 showed a high level of fish diversity with 88 fish species recorded. The fish assemblages recorded were dominated by two common inshore species; ponyfish (*Leiognathus equulas*) and herring (*Herklotsichthys castelnaui*) (Connolly et al. 2006).

The Wiggins Island EIS (Connell Hatch 2006) study of fish assemblages inhabiting the tidal creeks and the near shore environments of the project area identified a total of 27 fish species. Although the dominant species recorded were mullet and herring, a number of recreationally and commercially important fish species were also recorded including whiting, flathead, salmon, banana prawns and mud crab. Results from the Wiggins study are broadly comparable with those from Connolly et al*.* (2006) and McKinnon et al*.* (1995).

Under Queensland legislation, spawning closures for Barramundi are in force between midday 1 November to 1 February each year.

Recreational Fishing

Recreational fishing is popular and has a high participation rate within Port Curtis (Connolly et al*.* 2006) as evidenced by the long term establishment of a number of recreational fishing clubs, such as the

Yaralla Fishing Club (mainly fishing in offshore waters of the Capricorn Bunker Group) and the Wanderer's Fishing Club (operating mainly in inshore locations within Port Curtis). Whiting is the most common species of fish taken by recreational fishers in Queensland (Higgs 1998). Sand whiting (*Silago ciliata*) are most commonly found on sand bars or associated with seagrass meadows (Halliday & Robins 2005). A study conducted by Platten (2005) on the historical trends in recreational fishing catches in the Gladstone region indicate that recreational catch rates (median fish per person per trip) were generally lower in Port Curtis than at Cape Capricorn (ocean side of Curtis Island) and that recreational catch rates of whiting have shown a decline in both Port Curtis and Cape Capricorn over time. Between 1991 and 2001, this trend has been more obvious in Port Curtis compared to Cape Capricorn (Platten 2005).

Commercial Fishing

Commercial catch data available from the DPI&F is represented in 30 nautical mile grids and therefore includes offshore catch data as well as inshore catch information from within Port Curtis. Available commercial catch data includes Gladstone Port, Calliope River estuary, Boyne River estuary, inshore and offshore Curtis and Facing Island and The Narrows.

Commercial catch for the otter-trawl banana prawn fishery ranged from approximately 1,500 to 9,000 kg between 1989 and 1999. Otter trawling is prohibited north of Quoin Island (between Auckland Point to Tail Point) Results for barramundi indicate there is a large degree of interchange via The Narrows and that much of the barramundi landed in Gladstone could have been caught in the Fitzroy River or in The Narrows. Barramundi has been recorded as caught and landed in Gladstone since 1945 from the QFB data. Catches varied from 5,000 to 45,000 kg between 1945 and 1980 (Halliday & Robins 2005).

Reported catches of mud crab in the Port Curtis region have dramatically increased from 17 tonnes in 1960 to approximately 143 tonnes in 2002, possibly a result of increased fishing effort and more accurate reporting of catch data. This mud crab fishery is thought to be one of the largest in Queensland with about eight fishers operating in the harbour between the Narrows and Auckland Creek (pers comm. Steve Platt, QBFP Gladstone).

There is a small commercial net fishery with several fishers for bait fish (targeting mullet and garfish) and for shark, salmon, whiting and mullet, using ring, mesh and haul nets (pers comm. Steve Platt, QBFP Gladstone).

Conservation Significant Fish

Results from the EPBC Act Protected Matters search identified 37 species of sygnathids (seahorses and pipefishes) listed as likely to occur in the area. No sygnathids were sighted during the subtidal survey conducted in 2008 and as most species are coral reef associated they are unlikely to occur in Port Curtis.

The whale shark (*Rhincodon typus*) is also listed as potentially occurring within the area. The whale shark is listed as vulnerable and migratory under the EPBC Act. Sightings of whale sharks are rare on the east coast of Australia, and then generally only in more offshore areas. It is considered highly unlikely that whale sharks will occur in Port Curtis.

The grey nurse shark (*Carcharius taurius*) is listed as Endangered under the Queensland *Nature Conservation Act 1992* (NC Act). Grey nurse sharks are generally offshore species that inhabit rocky reefs in southern to central Queensland. It is considered unlikely that grey nurse sharks inhabit the estuarine waters of Port Curtis. The "nurse shark" sighted during the subtidal survey is a different species to the Grey Nurse Shark discussed here and not listed under the EPBC Act.

Marine Reptiles

Turtles

All six species of marine turtles in Australian waters are protected under the EPBC Act and the NC Act. Marine turtles are recognised internationally as species of conservation concern and are listed in the 2000 IUCN (World Conservation Union) Red List of Threatened Animals. All marine turtle species occurring in Australian waters are listed under the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES). In addition, all marine turtles occurring in the Indo-Pacific region are a priority for conservation under the *Convention on the Conservation of Migratory Species of Wild Animals* (CMS) also known as the Bonn Convention.

Details of the marine turtles recorded in the Port Curtis Area are given in Table 8.4.4.

Table 8.4.4 Marine Turtles in Port Curtis

Species	EPBC Act Status	NC Act Status	Bonn	CITES	Notes
Caretta caretta *Loggerhead Turtle*	Endangered	Endangered	Appendix I & II	Appendix I	Occasional breeding in area
Chelonia mydas *Green Turtle*	Vulnerable	Vulnerable	Appendix I & II	Appendix I	Occasional breeding in area
Dermochelys coriacea *Leatherback Turtle*	Vulnerable	Endangered	Appendix I & II	Appendix I	Species known to occur within area
Eretmochelys imbricate *Hawksbill Turtle*	Vulnerable	Vulnerable	Appendix I & II	Appendix I	Species known to occur within area
Lepidochelys olivacea *Olive Ridley*	Endangered	Endangered	Appendix I & II	Appendix I	Species or species habitat may occur within area
Natator depressus *Flatback Turtle*	Vulnerable	Vulnerable	Appendix I & II	Appendix I	Breeding known to occur within area

Convention for the Conservation of Migratory Species of Wild Animals (Bonn)
Convention for International Trade in Endangered Species (CITES)

The beaches on the ocean side of southern Curtis Island and Facing Island support an important, intermediate breeding population of Flatback turtles (Limpus 2007), with occasional nesting by green and loggerhead turtles (Limpus 1999). The flatback turtle population utilising these beaches for nesting has remained at approximately 50 females annually throughout the 35 years monitoring has been conducted (Limpus et al. 2006). Flatback turtle nesting commences in mid October, reaches a peak in late November – early December and ceases by about late January. Hatchlings emerge from nests between early December and late March, with a peak in February (Limpus 2007).

Predation by foxes, pigs, dogs and goannas have been reported as the most serious threat to flatback turtle nests on Curtis Island, as has the trampling of nests by cattle (Limpus & Gilmore 1999). Limpus (2007) estimates that 90-95% of turtle egg clutches were lost to feral dog predation between the late 1970s and 1988.

Several green turtles were seen by researchers during the field surveys and it has been reported that The Narrows and the Calliope River mouth are major foraging areas (Connell Hatch 2006). According to a study conducted by QDEH and GPA (1994), the loggerhead turtle (*Caretta caretta*) and flatback turtle (*Natator depressus*) utilise habitats in the outer harbour and occasionally move northward through Port Curtis into The Narrows. However there are no recognised nesting beaches inside Port Curtis, with the closest sites being used by flatback (and occasionally green) turtles at North Cliff Beach (Facing Island) and the main beach at South End (Curtis Island), where annual numbers have been estimated at 25-50 per beach (QDEH & GPA 1994). Figure 8.4.11 shows the locations where turtle nesting has been recorded.

0 5 10Km

Scale 1:250 000 (A4)
Datum : GDA94

- LNG Facility Site Boundary
- Gas Transmission Pipeline
- Green Turtle
- Flatback Turtle
- Recorded Turtle Nesting Beaches
- Major Shorebird Roost Sites
- Major Shorebirds Feeding Areas

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Client	Project	Title
LNG / URS	GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT	**TURTLES AND SHOREBIRDS**
	Drawn: CA · Approved: JB · Date: 18-05-2008	Figure: **8.4.11** · Rev:B
	Job No: **4262 6220** · File No: 42626220-g-887b.wor	A4

Sea Snakes

Sea snakes are listed under the EPBC Act as Other Matters Protected by the EPBC Act. Of 14 sea snakes species found in Queensland waters, 13 species of sea snakes were recorded as potentially occurring in the region of Port Curtis in the EPBC Act Protected Matters search. Most of these are unlikely to be found in near proximity to the project locations, as they have only previously been recorded from coral reef habitat. However, two sea snakes were observed during the subtidal surveys, possibly *Hydrophis elegans* or *H. mcdowell* as they are known to inhabit estuarine waters. Although very little information is available on the status and distribution of sea snake populations in Australian waters, the main threat to populations is capture and mortality from commercial trawling activities.

Sea-kraits (*Laticaudidae*) may inhabit waters within Port Curtis, as indicated by the EPBC Protected Matters Report. Sea-kraits are adapted to terrestrial and marine environments, laying eggs on land and foraging in the marine environment. None were recorded during the 2008 survey.

Crocodiles

The EPBC Act Protected Matters Search (refer Appendix G) lists saltwater crocodiles (*Crocodylus porosus*) or their habitat as likely to occur in the area. Saltwater Crocodiles are protected under the EPBC Act. Connell Hatch (2006) reported that saltwater crocodiles had been seen within the Calliope and Boyne Rivers prior to 2004; however no reports of sightings have been made since then. Saltwater crocodiles are also protected under the NC Act.

Marine Mammals

Dugongs

Australia has international, national and state obligations to conserve dugongs. The dugong (*Dugong dugon)* is listed as Vulnerable to Extinct at a global scale by the IUCN and is also listed on Appendix I of CITES and on Appendix II of the CMS or Bonn Convention. Australia is signatory to both the IUCN and the CMS Conventions. The GBR region supports globally significant populations of the dugong. Dugongs are the only marine mammal that are herbivorous and are the only surviving species in the Family Dugonidae (GBRMPA 2007). Dugongs have a high conservation value as well as cultural, social and spiritual significance for Indigenous Australians and are considered an indicator of ecosystem health for coastal marine habitats, particularly seagrass systems.

In Australia, dugongs are protected under the EPBC Act as both a listed migratory species and a listed marine species. The dugong is a protected species in the GBR region under the *Great Barrier Reef Marine Park Zoning Plan 2003* and the Queensland government lists the dugong as Vulnerable in Queensland waters under the *Nature Conservation Act 1992*. Dugongs are culturally significant to Indigenous communities within Australia and throughout their range.

The Rodds Bay Dugong Protection Area is declared under the Queensland *Fisheries Act 1994* and regulated under the *Fisheries Regulation* 2008, restricting the use of nets for commercial fishing purposes in the Port of Gladstone from The Narrows entrance to Rodds Peninsula (Figure 8.4.6). Under this legislation, the Rodds Bay Dugong Protection Area ‘B’ permits regulated mesh netting practices.

Rasheed *et al.* (2003) reported sighting dugongs feeding on the seagrass meadows between Fisherman’s Landing and Wiggins Island. During the terrestrial ecology survey conducted on Curtis Island in April 2008, a mother and calf dugong pair was sighted in the area of Pelican Banks on the lee side of Facing Island. Hodgson’s (2004) PhD research indicated that mothers spend significantly more time feeding and surfacing and less time travelling with their calves. Mother calf pairs appear most vulnerable to boat strike as they spend more time near the surface than single individuals.

Dolphins

Dolphins are protected by the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention). Australia is signatory to the Bonn Convention and protects cetaceans under the EPBC Act as a migratory marine species. *Sousa chinensis* and *Orcaella brevirostris* (Irrawaddy dolphin) are both protected under the EPBC Act and the NC Act. *Orcaella heinsohni* is not listed; however there is concern that it may have been omitted from these lists due to its mis-identification as *Orcaella brevirostris*.

Because little is known about the distribution and abundance of dolphins, apart from isolated specific studies, information is based on records of mortalities and strandings. As such, the following information is provided:

- A pod of at least seven bottlenose dolphins (Tursiops truncates) was sighted near Hamilton Point during the May 2008 subtidal survey.
- A Sousa chinensis was found dead at the mouth of the Calliope River, another at Fisherman's Landing and another on the seaward beach of Facing Island in 2005. The Sousa chinensis found on Facing Island was found dead with net/rope marks on its body, in association with seven turtles, one dugong and 30 large fish.
- In 2003, and again in 2004, a dead Sousa chinensis was found at the mouth of the Calliope River and another on Facing Island.
- A snubfin dolphin (Orcaella heinsohni) was reported dead on Sea Hill Beach, Curtis Island on 9 August 2007.

Although *Sousa chinensis* and *Orcaella heinsohni* are known to occur within the region, it would appear that boat strike and entanglement in fishing gear and the QDPI&F Shark Control nets pose the greatest threats (EPA 2004, 2005, 2006, 2008).

Since 1968, there have been 36 reported strandings of Irrawaddy dolphins in Queensland, all from around the Townsville region. There have been no reported sightings or strandings from the Gladstone region (National Whale and Dolphin Sightings and Strandings Online Database – DEWHA. Although it is possible that Irrawaddy dolphins could utilise the Port of Gladstone region, the lack of any sightings would indicate that the area is not a significant habitat for them.

Whales

The humpback whale (*Megaptera novaeangliae*) is listed as vulnerable under the EPBC Act and a recovery plan is in place under Part 13, Division 5 of the EPBC Act to ensure the recovery of the Australian populations of humpback whales. It is estimated that when the Australian east coast whaling industry ended in 1963, the east coast population of humpbacks had been reduced to a little over 100 individuals. This population has shown steady recovery of around 10 –11% a year, and in 2006 was estimated at around 8,000 (SPRAT Database).

Results from the EPBC Act Protected Matters search list humpback whales (*Megaptera noveaeangliae*) as potentially breeding within the region. They are known to have tropical calving grounds along the mid and northern parts of the east and west coasts of Australia, and feeding grounds in the Southern Ocean. The majority of humpbacks in Australian waters migrate north to tropical calving grounds in the Great Barrier Reef complex somewhere between approximately 14°S and 27°S from June to August, and south to the Southern Ocean feeding areas from September to November.

Gladstone Harbour is not known as part of an important migration route. No reports of humpback whale sightings or strandings in Gladstone harbour could be found (National Whale and Dolphin Sightings and Strandings Online Database – DEWHA), however a dead calf washed ashore was recorded on the seaward beach at Curtis Island in 2007 (EPA 2008). While humpbacks are known to occur in the region, they are not known to enter Port Curtis.

Waders and Shorebirds

Three separate migratory wader bird surveys were undertaken in April, June and December 2008. These surveys covered migratory and non-migratory periods to ensure seasonality was considered. The December survey (BAAM, 2008) was undertaken during the wader bird migration season. Wader and shoreline birds at the LNG facility site and surrounds were surveyed over two days between 15 and 17 December 2008. Targeted surveys for wader birds were also carried out at 12 coastal sand/mudflat and mangrove sites on the south-west coast of Curtis Island.

A total of 22 wader and shorebird species were identified within or near the study area during the December 2008 survey. Eleven of these species are considered as migratory species under the EPBC Act and three species are considered to be conservation significant under state legislation. The BAAM (2008) study determined that habitat values for wader birds throughout the study area appeared to be relatively poor. Migratory species such as eastern curlew (*Numenius madagascariensis*), whimbrel (*Numenius phaeopus*) and eastern reef egret (*Egretta sacra*) were observed in the study area in low numbers. Whimbrels were also heard calling from some mangrove areas indicating that whilst this habitat was being used, it was in low usage as roost habitat. Very few wader birds were observed foraging at the study sites at low tide during the field survey period. There was a high abundance and diversity of wader bird species observed foraging on sand/mudflats at low tide on the south-east of the island adjacent to the township of South End (approximately 9 km to the east of the study area). From these observations it is considered that habitat values in the study area are relatively low for wader species. It is likely that the study site is irregularly used at times for foraging/roosting by some wader species in low numbers. The BAAM (2008) study concluded that the south-west coast of Curtis Island contains marine habitat of limited value to wader and shoreline birds.

The LNG facility site does not act as core habitat for any of these species as similar vegetation communities and topography is found elsewhere in the region. Similarly, those wetland migratory species that favour freshwater wetland habitats are unlikely to be reliant on the two small water bodies present on the site.

The three listed migratory marine species reliant on marine wetlands are Latham's snipe (*Gallinago hardwickii*), little curlew (*Numenius minutus*) and little tern (*Sterna albifrons*). Previous studies have identified the Targinie and Pelican Banks intertidal flats as being the main feeding areas for shorebirds. Figure 8.4.11 shows the locations of the major shorebird feeding and roosting areas in Port Curtis.

A total of 45 species of birds were recorded during the intertidal survey: 4 species of shorebirds (includes migratory wading birds); 7 species of waterbirds/seabirds; 6 species of mangrove specialists (i.e. birds mostly confined to mangroves); and 28 other species (Table 8.4.5). The greatest diversity of avifauna was recorded along the mangrove/hinterland margin where terrestrial (i.e. eucalypt woodland) species were observed in addition to avifauna which typically inhabit mangroves.

Generally the diversity and abundance of avifauna in mangroves was low. The Brown Honeyeater (*Lichmera indistincta*) was conspicuous in mangroves at most locations; however the six mangrove resident bird species (i.e. birds mostly confined to mangroves) were only occasionally encountered.

In areas where mangrove forests or woodlands occurred at the landward edge of the mangrove zone and next to the eucalypt woodland habitat there was considerably more bird activity with birds from both habitats seen moving within the hinterland margin.

Table 8.4.5 Avifauna Recorded from the Port Curtis Intertidal Habitat Survey

Scientific Name	Common Name	Low Tidal Mud Flats	Mangroves	Rocky Shores	Salt Flats	Hinterland Margin
Shorebirds						
Charadrius ruficapillus	Red-capped Plover	✓			✓	
Numenius phaeopus	Whimbrel	✓	✓	✓		
Haematopus longirostris	Pied Oystercatcher	✓	✓			
Burhinus grallarius	Beach Stone-curlew	✓				
Waterbirds/Seabirds						
Phalacrocorax varius	Pied Cormorant	✓	✓	✓		
Ardea alba	Great Egret	✓				
Egretta novaehollandiae	White-Faced Heron		✓			
Larus novaehollandiae	Silver Gull	✓				
Sterna caspia	Caspian Tern	✓				
Sterna nilotica	Gull-billed Tern	✓	✓	✓		
Sterna bergii	Crested Tern	✓				
Mangrove Birds						
Geopelia humeralis	Bar-Shouldered Dove		✓			
Chrsococcyx minutillus	Little Bronze-Cuckoo		✓			
Todiramphus chloris	Collared Kingfisher		✓	✓		
Gerygone levigaster	Mangrove Gerygone		✓			✓
Lichenostomus fasciogularis	Mangrove Honeyeater		✓			
Myiagra alecto	Shining Flycatcher		✓			
Other Species						
Aviceda subcristata	Pacific Baza					✓
Haliastur indus	Brahminy Kite	✓	✓	✓		
Haliastur sphenurus	Whistling Kite					✓
Pandion haliaetus	Osprey	✓	✓			
Haliaeetus leucogaster	White-bellied Sea-Eagle	✓	✓	✓		
Vanellus miles	Masked Lapwing	✓			✓	✓
Geopelia placida	Peaceful Dove					✓
Cacomantis flabelliformis	Fan-tailed Cuckoo		✓			✓
Centropus phasianinus	Pheasant Coucal					✓
Todiramphus sanctus	Sacred Kingfisher					✓
Dacelo novaguineae	Laughing Kookaburra					✓
Merops ornatus	Rainbow Bee-eater					✓
Pardalotus punctatus	Striated Pardalote					✓
Philemon buceroides	Helmeted Friarbird		✓			✓
Lichenostomus chrysops	Yellow-faced Honeyeater		✓			
Lichmera indistincta	Brown Honeyeater		✓	✓		✓

Scientific Name	Common Name	Low Tidal Mud Flats	Mangroves	Rocky Shores	Salt Flats	Hinterland Margin
Pachycephala rufiventris	Rufous Whistler					✓
Collurincla megarhyncha	Little Shrike-thrush		✓			✓
Myiagra rubecula	Leaden Flycatcher					✓
Rhipidura leucophrys	Willy Wagtail					✓
Rhipidura fuliginosa	Grey Fantail		✓			✓
Lalage leucomela	Varied Triller					✓
Cracticus nigrogularis	Pied Butcherbird		✓			✓
Gymnorhina tibicen	Australian Magpie				✓	✓
Dicrurus bracteatus	Spangled Drongo					✓
Corvus orru	Torresian Crow					✓
Dicaeum hirundinaceum	Mistletoe Bird		✓			
Hirundo neoxena	Welcome Swallow			✓	✓	✓

Connell Hatch (2006) identified a number of significant and migratory bird species were observed inhabiting the saltmarsh/saltpan communities within the vicinity of Wiggins Island, Port Curtis. Regional studies support that these communities are generally not as diverse as those found on intertidal mudflats and freshwater ecosystems (WBM, 1990). During this study the largest diversity of waterbirds / shorebirds were observed within the intertidal banks of Port Curtis, the Calliope River and freshwater ecosystems. Migratory bird species observed during this study include the Rainbow bee-eater, Whimbrel, Little Curlew and Common greenshank. Black-winged stilts and Red-capped plovers were commonly observed feeding within the samphire dominated saltpans, however no evidence of breeding was observed for any bird species during this study. The low diversity of waterbirds/shorebirds recorded during the Connell Hatch study concurs with that of the present study.

Protected Species

A number of species known to occur, or possibly occurring, in the region are protected under the EPBC Act and discussed in a stand alone report in Appendix G. Certain species found within Port Curtis are also protected under the Queensland NC Act.

Under the EPBC Act, species can be listed as threatened, migratory, cetaceans or as marine:

- Threatened species - are those species that have been identified as being in danger of becoming extinct;
- Listed migratory species - are those species that are listed under the Bonn Convention, JAMBA, CAMBA, ROKAMBA or any other international agreement, or instruments, approved by the Minister for the Environment, Heritage and the Arts;
- Cetaceans - all species of cetacean (including whales, dolphins and porpoises); and
- Listed marine species - species belonging to taxa that the Australian Government recognises as requiring protection to ensure their long-term. Listed marine species occurring in the Curtis Coast Region include sea-snakes (Families Hydrophiidae and Laticaudidae), marine turtles (Families Cheloniidae and Dermochelyidae), seahorses, sea-dragons, pipefish and ghost pipefish (Families Syngnathidae and Solenostomidae), and seabirds.

EPBC Act listed species are discussed in Appendix G.

The NC Act classifies wildlife as:

- Extinct in the wild;
- Endangered;

- Vulnerable;
- Rare;
- Least threatened; and
- Of least concern.

Table 8.4.6 is a list of rare, threatened and vulnerable species listed under the NC Act, assessed as possibly occurring within the Curtis Coast region.

Table 8.4.6 Queensland Nature Conservation Act - Rare, Vulnerable and Endangered Species

Common Name	Scientific Name	Rare	Vulnerable	Endangered
Birds				
Sooty Oystercatcher	*Haematopus fuliginosus*	✓		
Southern Giant-Petrel	*Macronectes giganteus*			✓
Northern Giant Petrel	*Macronectus halli*		✓	
Herald Petrel	*Pterodroma arminjoniana*			✓
Little Tern	*Sterna albifrons*			✓
Beach stone-curlew	*Esacus neglectus*			
Mammals				
Dugong	*Dugong dugon*		✓	
Humpback Whale	*Megaptera novaeangliae*		✓	
Irrawaddy Dolphin	*Orcaella brevirostris*	✓		
Indo-Pacific Humpback Dolphin	*Sousa chinensis*	✓		
Reptiles				
Loggerhead Turtle	*Caretta caretta*			✓
Green Turtle	*Chelonia mydas*		✓	
Salt-water Crocodile	*Crocodylus porosus*		✓	
Leatherback Turtle	*Dermochelys coriacea*			✓
Hawksbill Turtle	*Eretmochelys imbricata*		✓	
Pacific Ridley, Olive Ridley	*Lepidochelys olivacea*			✓
Flatback Turtle	*Natator depressus*		✓	
Sharks				
Grey Nurse Shark	*Carcharias taurus*			✓

Introduced Marine Pests

There are currently 26 marine species listed as being introduced into Queensland waters (NIMPIS website – http://www.marine.csiro.au/crimp/nimpis/). A marine introduced pest survey of Port Curtis was conducted in 2000 (Lewis et al. 2001) by the Central Queensland University in conjunction with the Commonwealth Scientific and Industrial Research Organisations (CSIRO) Centre for Research on Introduced Pests (CRIMP). No pest species were detected in Port Curtis, however, low abundances of ten introduced species were detected (Table 8.4.7). These species are encrusting species thought to be introduced via hull fouling on ships. The report noted that these species are widespread in ports across Australia and around the world, and are not considered to be a threat to native species, aside from direct competition for space between some bryozoans. The authors recommended that removal was not warranted.

Table 8.4.7 Introduced Marine Species, 2000 (Lewis et al. 2001)

Class	Name	Location
Ascidians	*Styela plicata*	Wharf pylons throughout Port Curtis
	Botrylloides leachi	Auckland Point, South Trees Wharf
Bryozoans	*Amathia distans*	Wharf pylons throughout Port Curtis
	Bugula neritina	Gladstone Marina, Wharf pylons throughout Port Curtis
	Cryptosula pallasiana	Wharf pylons throughout Port Curtis
	Watersipora subtorquata/acuata	Wharf pylons throughout Port Curtis
	Zoobotryon verticillatum	Gladstone Marina, Wharf pylons throughout Port Curtis
Hydrozoan	*Obelia dichotoma*	Wharf pylons throughout Port Curtis
Isopod	*Paracerceis sculpta*	South Trees Wharf
Dinoflagellate	*Alexandrium* sp.	Auckland Point, Channel Marker S19

The Port of Gladstone receives vessels from across the globe and potential does exist for exotic marine species to be introduced to Port Curtis through ballast water, hull fouling, internal seawater pipes from commercial and recreational vessels, aquaculture operations and aquarium imports.

8.4.5 Potential Impacts and Mitigation Measures

8.4.5.1 Terrestrial Flora

The development of the LNG facility will be undertaken in three phases, comprising construction, operation and decommissioning. The most significant potential for impacts on biodiversity are expected during the construction phase, with some of these effects continuing to a reduced degree into the operational phase. The potential impacts on flora and fauna from these activities and proposed mitigation measures are discussed in this section.

Vegetation Disturbance

Potential Impacts

An area of up to approximately 127 ha will be impacted by proposed vegetation disturbance associated with construction of the LNG facility and associated infrastructure. A breakdown of the disturbance to vegetation communities as a result of clearing is presented below in Table 8.4.8. This indicates the disturbance to each community as a percentage of its extent on the LNG facility and as a percentage of the community within the sub-region. The location of vegetation communities potentially affected by the LNG facility is shown on Figure 8.4.12.

Table 8.4.8 Proposed area of vegetation communities to be removed at the proposed LNG facility

Regional Ecosystem (RE)	Vegetation Community Description	VM Status[1]	Biodiversity Status[2]	EPBC Status[3]	Potential Disturbance		
					Ha	%[4]	Sub region[5] %
12.1.2	Saltpan vegetation comprising *Sporobolus virginicus* grassland and samphire herbland on Quaternary estuarine deposits	Not of Concern	No Concern at Present	Not Listed	2.8	5.9	0.02
12.1.3	Mangrove shrubland to low closed forest on Quaternary estuarine deposits	Not of Concern	No Concern at Present	Not Listed	0.5	6.3	<0.01
12.2.2	Microphyll/notophyll vine forest on beach ridges	Of Concern	Endangered	Critically Endangered	0.4	100	0.03
12.3.3	*Eucalyptus tereticornis* open forest to woodland on Cainozoic alluvial plains	Endangered	Endangered	Not Listed	39.8	87.3	0.14
12.11.6	*Corymbia citriodora* and *Eucalyptus crebra* open forest to woodland on Mesozoic to Proterozoic moderately to strongly deformed and metamorphosed sediments and interbedded volcanics	Not of Concern	No Concern at Present	Not Listed	63.6	63.7	0.04
12.11.14	*Eucalyptus crebra, E. tereticornis* grassy woodland on Mesozoic to Proterozoic moderately to strongly deformed and metamorphosed sediments and interbedded volcanics	Of Concern	Of Concern	Not Listed	19.5	22.4	0.47

[1]Refers to conservation status under the *Vegetation Management Act, 1999*

[2] Refers to Biodiversity status as recognised by the EPA

[3]Refers to conservation status under the *Environment Protection and Biodiversity Conservation Act, 1999*

[4]Indicates disturbed % of vegetation community within the LNG Facility area

[5] Indicates disturbed % of vegetation community within the Burnett-Curtis Hills and Ranges province as per Accad *et. al.* (2006)

The vegetation community of *Corymbia citriodora, Eucalyptus crebra* open forest on metamorphics ± interbedded volcanics (Not of Concern RE 12.11.6) is to be subjected to the majority of proposed disturbance (63.6 ha). This represents 63.7% of this vegetation community found on the site. However, when viewed in the broader context of regional biodiversity, this disturbance represents 0.04% of this community within the sub-region. This vegetation community has no current conservation significance under state or commonwealth legislation.

The community subjected to the second highest area of clearing is *Eucalyptus tereticornis* open forest to woodland on Cainozoic alluvial plains (Endangered RE 12.3.3). This community is listed as ‘Endangered’ under state legislation. Occurring within the three alluvial plains found on site, approximately 39.8 ha of this community will potentially be cleared. This disturbance represents 87.3% of the overall extent of this community found on the site. However when viewed in the broader context of regional biodiversity, this disturbance represents 0.14% of this community found within the sub-region.

The intertidal communities of Mangrove shrubland to low closed forest on Quaternary estuarine deposits (RE 12.1.3) and Saltpan vegetation comprising *Sporobolus virginicus* grassland and samphire herbland on Quaternary estuarine deposits (RE 12.1.2) are subject to the least disturbance in terms of a sub-regional context (0.02% and <0.01% respectively). These communities have no current conservation significance under state or commonwealth legislation.

The vegetation community of Microphyll / Notophyll vine forest on beach ridges (RE 12.2.2) is subject to the greatest disturbance when viewed as a percentage of the area found on site (100%). However, the community size to be disturbed is relatively small (0.4 ha) which represents 0.03% of this vegetation community within the sub-region. Nonetheless, this community is listed as 'Endangered' under state legislation and 'Critically Endangered' under commonwealth legislation.

The effects of the clearing for the site of the proposed dredge material placement facility at Laird Point are discussed in Section 8.17.

Mitigation Measures

The areas of vegetation to be cleared will be restricted to the minimum required. The use of tape, pegs or other markers will be employed to clearly delineate areas to be cleared, prior to commencement. Particular attention will be paid when delineating clearing areas in proximity to 'Endangered' and 'Of Concern' vegetation communities that will not be disturbed.

Where clearing of vegetation is within or in close proximity to riparian communities, adequate erosion and sedimentation mitigation measures will be utilised to ensure waterways are not impacted and riparian vegetation is not unduly affected (refer to Section 8.5 and Section 8.3 for further details).

Any clearing involving the removal of stands of woodland vegetation will be undertaken in stages to reduce disruption for fauna dispersal, thereby retaining habitat connectivity. That is, clearing will be undertaken towards the direction of any adjacent contiguous vegetation that is not to be cleared to ensure isolated stands of vegetation are not created.

A program to implement offsetting of cleared vegetation communities will be undertaken as required in accordance with current commonwealth and state legislative criteria for the offsetting of significant vegetation communities. A biodiversity offset strategy and management plan will be developed. Criteria for offset suitability will be developed in consultation with EPA and DEWHA and in accordance with best practice and in keeping with the objectives of the biodiversity off-setting policy under the provisions of the Qld VM Act 1999. Communities requiring offsetting include RE 12.2.2 and RE 12.3.3.

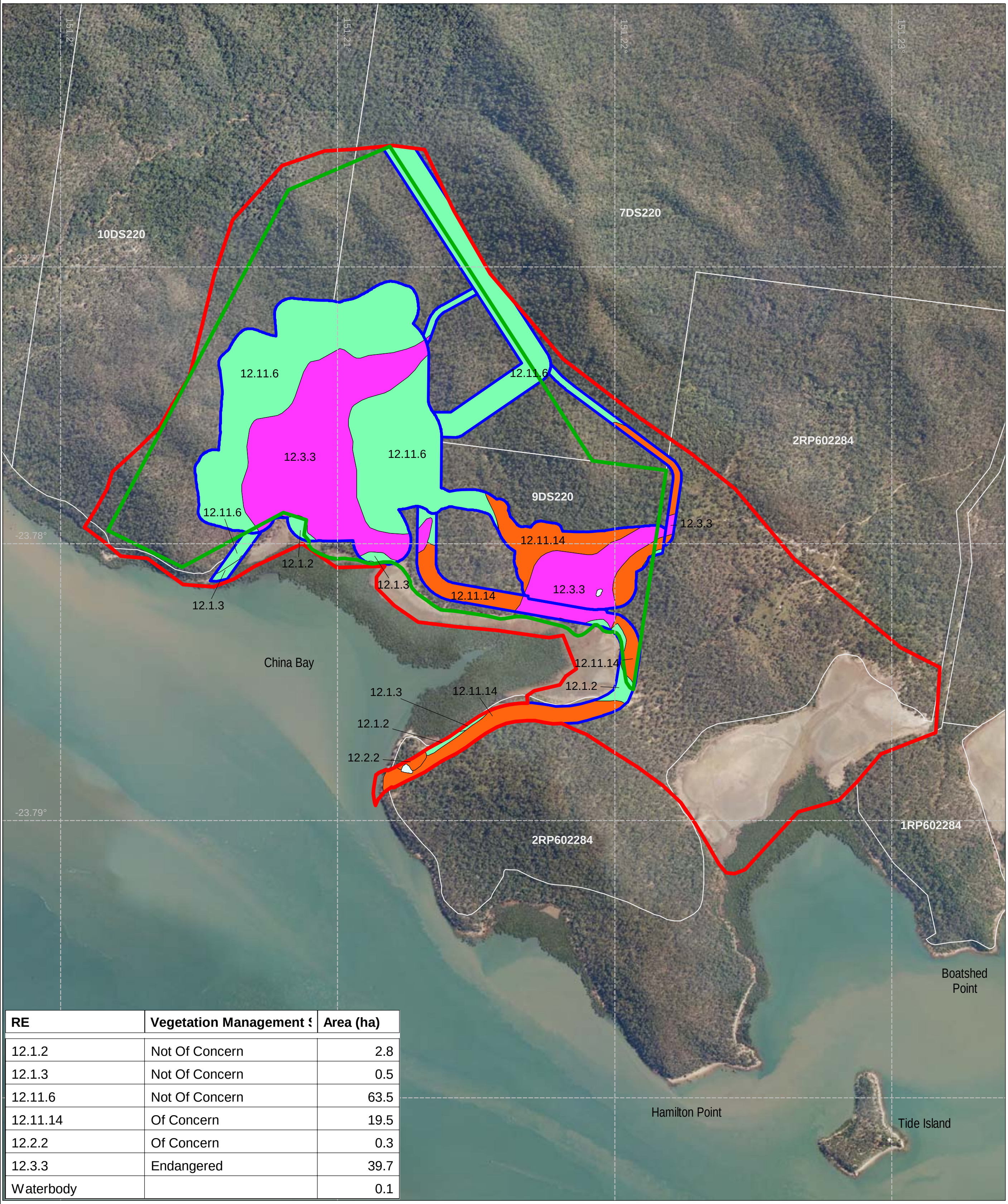
The mitigation measures to be implemented during clearing operations are detailed in Section 13.16.

Dust

Potential Impacts

Deposition of dust, sand and soil may have potential impacts on vegetation if excessive levels are sustained over extended periods. When dust settles on plant foliage, it can reduce the amount of light penetration on the leaf surface, block and damage stomata, and slow rates of gas exchange and water loss. Reduction in the ability to photosynthesise due to physical effects may result in reduced growth rates of vegetation and decreases in floral vigour and overall community health. The potential effects of dust deposition on vegetation are determined by a number of factors including:

- The characteristics of leaf surfaces, such as surface roughness, influencing the rate of dust deposition on vegetation;
- Concentration and size of dust particles in the ambient air and its associated deposition rates; and
- Local meteorological conditions and the degree of penetration of dust into vegetation.



RE	Vegetation Management S	Area (ha)
12.1.2	Not Of Concern	2.8
12.1.3	Not Of Concern	0.5
12.11.6	Not Of Concern	63.5
12.11.14	Of Concern	19.5
12.2.2	Of Concern	0.3
12.3.3	Endangered	39.7
Waterbody		0.1

N W E S

0 250m 500m

Scale 1:20,000 (A4)
Datum: GDA94

- LNG Facility Footprint
- LNG Facility
- Terrestrial Ecology Study Area
- Endangered dominant RE
- Of concern dominant RE
- Not of concern RE
- Waterbody

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

Client: LNG — URS

Project: GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Title: **VEGETATION MANAGEMENT STATUS**
LNG FACILITY
DISTURBANCE FOOTPRINT

Drawn: CA	Approved: JB	Date: 18-05-2009	Figure: **8.4.12**	Rev:B
Job No: **4262 6220**	File No: 42626220-g-1002b.wor			A4

The dominant woodland species of the vegetation communities in close proximity to the proposed LNG facility typically exhibit physiological qualities that are not sensitive to dust deposition. The sclerophyllous foliage of *Eucalyptus* and *Corymbia* species is generally pendulous (i.e. points down), with a thick smooth cuticle that does not encourage particulate matter to remain on the surface. The dominant woodland species are also generally hardy and well adapted to adverse conditions (e.g. extended dry conditions and low nutrient soils).

There is evidence however, that carbon dioxide exchange in mangroves may be inhibited by increased dust deposition. The mangrove *Avicennia marina* (grey mangrove), as found in the study area intertidal zone, has been shown to demonstrate reduced carbon dioxide exchange of the upper and lower leaf surfaces and thus reduced photosynthetic performance of leaves coated in coal dust (Naidoo & Chirkoot, 2004). This result is exacerbated by the presence of sticky brine secreted by salt glands. Although no significant long term dust deposition is anticipated on-site, the vulnerability of mangroves to dust deposition should be highlighted.

Mitigation Measures

It is not expected that potential effects of dust deposition on vegetation within close proximity to LNG facility will be significant.

Dust impacts are most likely to occur during construction due to earthmoving operations. Dust control measures are to be implemented to mitigate potential impacts where deemed necessary and practicable. Details of the proposed mitigation measures are given in Section 13.16.

Spread of Weeds

Potential Impacts

The presence of weeds on the LNG facility site and surrounding areas was found to be moderate for the region (Appendix N3). The introduction of vehicles and heavy machinery may potentially introduce new and declared weeds, and increase the risk of spreading existing weeds across the site and its surrounds. If weed problems are detected, appropriate weed management strategies will need to be implemented for eradication and continued weed monitoring.

Mitigation Measures

An effective weed control program will be implemented for the LNG facility and will include:

- Effective management strategies to control the spread of declared weed species in keeping with regional management practices or DNRW pest control fact sheets;
- Comply with Santos EHS09 Weed and Pest Animal Control procedures;
- Ongoing monitoring of the project site to identify any new incidence of weed infestation; and
- Provision of information for project staff on the identification of declared weeds and their dispersal methods.

8.4.5.2 Terrestrial Fauna

Habitat Loss and Fragmentation

Potential Impacts

The primary impact on fauna from construction of the LNG facility site is the direct loss of habitat. The development of the LNG infrastructure will initially involve site preparation and clearing. This will result in the removal of habitat features such as trees, shrubs, ground cover, rocks, timber, waterways, wetlands and other features. Impacts to fauna as a result of these measures will include mortality, injury, loss of habitat and breeding areas and the removal of movement opportunities using local movement corridors.

The construction of the LNG facility will also reduce opportunities for fauna movement in this part of the island. Whilst it will be possible for fauna to avoid construction areas by travelling to the east of the site, this may allow potential for predation or territorial conflict. In addition, the construction of peripheral facilities such as roads and fences will increase the potential for impacts to fauna movement.

Edge effects to vegetation communities adjacent to the LNG facility site will result from clearing for construction. The disturbance of soil and increased light levels will enhance the conditions for weed infestations. Reduced buffers to core habitat will result in disturbances to fauna and a possible reduction in habitat quality.

Construction of the LNG facility may remove available habitat for any local populations of water mouse (if present).

Mitigation Measures

Where native vegetation is to be cleared, the following mitigation measures are to be implemented under an EMP to minimise impacts and ensure current ecological values of habitat are maintained during the construction and operational phases of the project:

- Restrict the amount of vegetation to be cleared to the minimum footprint required and clearly mark vegetation to be retained;
- Retain habitat hollows and other habitat features wherever practicable;
- Clearing will be undertaken in stages to ensure that isolated stands of vegetation are not created and the connectivity of habitat remains intact to allow for the dispersal of fauna;
- Clearing will be undertaken towards the direction of any adjacent contiguous vegetation that is not to be cleared to ensure connectivity of habitat is not disrupted;
- Clearing near any waterways or riparian areas should include adequate sedimentation fencing to ensure sediment impacts to waterways are restricted; and
- Where suitable habitat for the water mouse could be disturbed, targeted trapping surveys will be conducted to confirm the presence/absence of the species. If habitat is found to support water mouse populations then the proponent will minimise disturbance of these areas as far as practicable.

Noise, Vibration and Lights

Potential Impacts

Secondary impacts to fauna include disturbance from noise and vibration during facility construction and operation. Fauna will generally move away from the source to avoid these impacts. However, acclimatisation by some species may occur over the long term.

There are no government policies or other widely-accepted guidelines in respect to the noise levels which may be acceptable to wildlife. The levels or character of noise that may startle or otherwise affect the feeding or breeding pattern of birds or other native fauna are also not firmly established in the technical literature. Poole (1982) and Algers *et al.* (1978) shows that birds tend to accept and/or adapt to constant steady noise levels, even of a relatively high level (in the order of 70 dBA). Poole (1982) found that continuous exposure to higher noise levels (70 dBA to 85 dBA and above) may cause some degree of behavioural changes in birds (non species-specific).

Sudden loud or impulsive or impact noises are capable of causing birds and other animals to become startled, which if occurring over the longer term, may affect feeding and breeding behaviour in some species. Conversely, there are instances where noise has been used in an attempt to deter flocks of birds (and bats) from various sites including crops, airports and waste disposal sites. The success of such trials has been limited, due possibly to the exposure of these species to common urban or rural noise levels and the more 'domesticated' nature of some of these species. Observations of behaviour patterns also indicate a higher tolerance to intermittent, moderate level noise events such as road traffic.

Interim noise data estimates that noise generated by the LNG facility construction will reach approximately 100 dBA for piling and 80-85 dBA for heavy earthmoving activities at a distance of 100 m. On this basis, it would be expected that construction and piling at the LNG facility site will potentially cause disturbance to wetland and terrestrial birds. This will most likely result in avoidance of the area for the duration of these activities. As alternative habitats are available elsewhere, an overall loss of avian diversity as a result of construction will probably not occur. Upon cessation of peak noise levels and construction activity, many, if not all species will resume utilising wetlands and woodlands around the LNG facility site. Therefore, few long-term impacts are expected.

Impacts to mammals, such as dispersal and avoidance, are expected from elevated noise levels. However, the attenuation provided by terrain and woodlands on the site will tend to reduce the distance at which impacts are felt. These impacts are considered to be minor in nature and not of concern.

Excessive artificial light during construction and operation of the LNG Facility could potentially deter fauna from using the general area. During operation, birds and microbats may benefit from increased levels of food resources as insects become attracted to lights.

Light also have the potential to affect turtles and seabirds. These potential impacts are discussed in Section 8.4.5.3.

Mitigation Measures

The following measures will be adopted to minimise impacts to biodiversity from noise, vibration and lights:

- All equipment and machinery used during construction will be maintained in good working order, and where practicable shielded to minimise noise emissions;
- Operating times will be minimised so that impacts are reduced overall, especially at night;
- Lights used at the operating LNG facility to be used sparingly, of a minimum power to fulfil safety requirements and should not be directed towards surrounding bushland; and
- Hoods or covers should be used to reduce the amount of light spilling onto these areas.

Introduced Fauna

Domesticated cattle and horses are present throughout the LNG facility site and surrounds. Impacts from grazing include erosion and weed infestations typical of pasture species. One feral cat (*Felis catus*) was observed on the site, as were numerous signs and sightings of pigs (*Sus scrofa*) and tracks from wild dogs or dingos (C*anis familiaris*). Cane toads were abundant throughout the study area. The presence of feral fauna may have impacted upon native ground dwelling fauna as indicated by the low trapping results seen from the fauna survey.

Potential Impacts

It is considered very unlikely that feral predators such as foxes, cats, pigs or dogs would utilise the bridge to cross from the mainland to Curtis Island. If in the highly unlikely circumstance that a feral predator did cross, given the current abundance and diversity of feral animals already present, any additional introductions would not create an elevation in risk to natural values and native fauna that has not already been impacted upon by the current feral presence on the island. Additionally, native and feral fauna have historically accessed Curtis Island at the lowest astronomical tide from the mainland and via other means.

Mitigation Measures

The potential bridge, being a relatively long, well-lit, artificial structure, will act as a barrier to feral animal movement due to its foreign nature and lack of suitable cover.

8.4.5.3 Marine Ecology

The following section provides an overview of potential impacts and mitigation measures for marine values associated with the LNG facility and the Port Curtis crossing section of the gas transmission pipeline. Specific impacts relating to EPBC-listed national heritage places such as the Great Barrier Reef World Heritage Area are detailed and discussed within the EPBC Act report (Appendix G). Refer specifically within Appendix G to Section 2 (Table 2-1), Section 3 (Table 3-1), Section 5 (Table 5-1), and Section 6 (Table 6-1). A summary of world heritage values as they apply to the entire GLNG Project is also provided in Section 7.1 of Appendix G.

Disturbance to Marine Habitat

Where large amounts of material are removed from the seabed, changes to the sediment composition may occur. Dredging, reclamation, mixing and deposition of sediments has the capacity to change chemical and physical relationships, and to change resulting benthic community structure. In the case of capital dredging, the depth to unconsolidated materials is reduced. Consolidated material may now be exposed and be of reduced value as infauna and epibenthic fauna habitat.

It is expected that natural siltation processes will occur over time, resulting in the introduction of finer material to the dredged areas. This will eventually lead to shifts in the structure of benthic communities currently found within the substrate.

Construction activities will create additional hard substrates and increase habitat complexity. This will increase the available space for a number of species, such as sponges, gorgonians, soft corals, oysters and other species found on hard substrates within Port Curtis, and also provide habitats and food sources for mobile species (e.g. fish, crabs) which will use these new habitats for shelter and/or food.

Direct disturbance to marine habitat will result from the following project activities:

- Construction of the LNG facility and marine facilities – disturbance of subtidal, soft bottom and rocky slope communities in China Bay and Hamilton Point; removal of saltmarsh, mangrove and intertidal habitat at shore crossings;
- Capital Dredging – removal of subtidal, soft bottom communities at China Bay;
- Dredged material placement facility – covering approximately 35 ha of saltpan, saltmarsh, mangrove and intertidal habitat;
- Bridge and access road - disturbance of subtidal, soft bottom communities between Friend Point and Laird Point; disturbance to saltmarsh, seagrass, mangrove and intertidal habitat found at Friend Point and Laird Point; and
- Gas transmission pipeline – disturbance of subtidal, soft bottom communities between Friend Point and Laird Point; disturbance to saltmarsh, seagrass, mangrove and intertidal habitat found at Friend Point and Laird Point.

LNG Facility and Marine Facilities

Potential Impacts

The construction of the LNG facility as well as the PLF and MOF will involve earthworks within the mangrove lined embayment of China Bay.

Impacts to saltmarsh and mangroves from construction of the LNG facility and haul roads to the PLF and MOF are estimated to be:

- Of the 6,736 ha of mangrove communities estimated within Port Curtis (Connelly et al, 2006) 0.5 ha of mangrove communities are estimated to be impacted, representing 0.01% of the mangrove communities within Port Curtis; and

- Of the 4,573 ha of saltmarsh and saltpan areas within Port Curtis, approximately 2.8 ha of saltmarsh is estimated to be impacted, representing 0.06% of the saltmarsh and saltpan within Port Curtis.

The area of saltmarsh and mangrove clearing required is minor in the context of the total extent available within Port Curtis and no significant impacts are expected.

Mitigation Measures

All works will be conducted in accordance with the Queensland Government's operational policy for the removal or disturbance of marine plants in accordance with the *Fisheries Act 1994* including obtaining the necessary permits to remove, destroy or damage a marine plants.

The control measures to be implemented to reduce the effects on the marine ecology are discussed in Section 13.16.

Capital Dredging

Potential Impacts

Benthic Habitats

The area of benthic substrate to be directly impacted by capital dredging is 125 ha. Substrate types are described as soft silts and clay with some sands and gravels and rock. During the sediment assessment conducted by Central Queensland University study in July 2008, sites that had significant carbon content in the sediment also expressed the highest silt mud fraction. Conversely, systems with high flow rates such as in the existing channel, generally have sediments composed of sand and gravels and therefore low cohesive properties. Direct impacts from capital dredging will include a direct loss of subtidal and soft bottom communities at China Bay and in the approach channel adjacent to Hamilton Point. Santos proposes to dispose of all dredge material onshore there will be no anticipated impacts from dredge to the Great Barrier Reef.

Section 8.7.4 shows that sediment plumes generated from capital dredging activities will result in elevated total suspended sediment (TSS) concentrations (>25 mg/L) in and around the area of proposed dredging work, with this region occupying an area of approximately 150 m by 500 m during neap tides and approximately 200 m by 150 m during spring tides. Outside this area, the maximum increase in TSS concentrations is in the order of 25 mg/L or less. When compared with typical background levels in this region of Port Curtis, it is apparent that these TSS levels, while high, are comparable to the existing levels of variability in TSS present in the region. Further afield, additional maximum TSS levels are predicted to be less than 5 mg/L, which will be close to undetectable.

Previous monitoring studies of suspended sediment plumes undertaken for typical dredging operations show localised, but short-lived, increases in suspended sediment (WBM, 2004). Recorded turbidity plumes are limited in duration and extent from the disturbed site and the measured turbidity is moderate and within the limits set by licence conditions. Visible plumes can extend for some distance however the suspended sediment concentrations are generally only slightly elevated above background levels.

The disturbance to marine habitats caused by dredging will result in the displacement of the species directly dependant on these habitats. The surface layers of the habitats to be dredged provide for a range of benthic (bottom dwelling) fauna such as worms and prawns. Some of these fauna are in turn prey species of fish and are therefore important for environmental and commercial reasons. As the majority of benthic fauna occur in the top 30 cm of the sediment, the dredging operation will be expected to completely remove all benthic fauna within the dredge site.

A number of studies have shown that the time taken for benthic sediment habitats to return to pre-disturbance states is dependent on the nature of those habitats. Naturally highly disturbed or soft habitats show rapid rates of recovery (weeks to months), but rates of recovery decrease to years in naturally stable habitats (shells and gravel) (Newell *et al.* 1998; Ellis *et al.* 2000; Thrush *et al.* 2001; Thrush and Dayton 2002).

Dredging operations result in the physical removal or destruction of habitat along the dredge path and the subsequent disturbance and smothering of substrata and organisms. Despite the immediate impact, resettlement of the disturbed area usually begins to occur almost immediately after disturbance ceases. Recovery of the communities appears to be linked to the granulometric properties of the sediments (particle size) and the different communities associated with them.

It should be noted that there are little data available on re-colonisation rates from tropical or sub-tropical Australia and no known data from Gladstone. Studies in support of the Moreton Bay Sand Extraction Study (WBM, 2004) are probably the most relevant and are expected to reflect what might occur in Gladstone. This included two dredging operations as part of a study to look at re-colonisation rates of infaunal communities. Sampling for both operations was done on three occasions: immediately prior to dredging, one week after dredging, and approximately three months after dredging. Sampling of benthic invertebrates was done at two sites within the dredged area and at two sites within each of two locations unaffected by dredging (control locations).

WBM (2004) defined re-colonisation as an increase in one or more biological variables following a perturbation. Re-colonisation occurred at all dredged sites within one week of dredging. Re-colonisation patterns observed in northern Moreton Bay were different from those described elsewhere. All taxa were described as opportunistic, and capable of rapid re-colonisation of newly disturbed areas. These are necessary life-history characteristics in an area subject to strong currents and wave action, and highly mobile sediments. Major shifts in assemblage structure were not observed immediately following dredging; rather abundances of most taxa generally declined immediately after dredging, but species composition of numerically dominant taxa remained similar. This indicates that dredging did not result in major changes in benthic community structure.

Three months after dredging, the dredged areas typically had higher numbers of taxa and individuals compared to control areas, however full recovery was not observed. In the longer-term, major changes in functional aspects of the assemblage are unlikely to occur given that assemblages are comprised of species capable of rapid re-colonisation. The increase in abundance and richness of taxa in the dredged areas three months after dredging could be due to a number of physical and biological processes, such as increased food and space resources, changes in species interactions (competition, predation), or possibly changes in recruitment dynamics.

The impacts from maintenance dredging on benthic fauna are expected to similar to those described above for the capital dredging. The top layers of sediment which contain the benthic fauna will be removed and re-colonisation can be expected to occur over the ensuing months. As the intervals between maintenance dredging campaigns are expected to be some years there would be adequate time available for re-colonisation. However with repeated maintenance dredging, the regular removal and re-colonisation of the benthic fauna is likely to lead to the development of different communities being present from those that would have existed prior to the dredging commencing.

Marine Fauna

Due to the migratory nature of whales, dolphins and turtles it is expected that they will not be impacted from increased turbidity or sedimentation generated from capital or maintenance dredging. There is however potential for direct impacts to turtles and dugong from vessel movements and general operations through boat strike, entanglement in lines or being captured by suction pressure associated with the dredge head (within approximately 1 m).

Records of interactions with marine fauna indicate that turtle captures occurred during dredging operations in Port Curtis since 2001 (Port of Brisbane, 2007). These reports indicate that six turtles were captured in 2001/02, three in 2002/03 and 2003/04, none in 2004/05 and 2005/06 and two in 2006/07. Further, the EPA reported five mortalities of turtles due to dredging in 2001, and seven in 2002 (EPA, 2004).

Dugong and turtles sighted during field surveys were in the location of Hamilton Point and hence it is considered possible that interactions between marine fauna and shipping and dredging activities may occur.

Great Barrier Reef

Impacts from the dredging operations will be limited to the vicinity of the dredging operation within Port Curtis and there will be no impacts to the Great Barrier Reef as this is located well outside of Port Curtis.

Mitigation Measures

Although there will be a direct loss of the substrate will the footprint of the dredging operation, previous studies indicate relatively rapid rates of re-colonisation by marine organisms occurs from adjacent areas from both larval dispersal and active colonisation (WBM, 2004). As similar substrate type is found both within Port Curtis and the region, the ecological importance of the habitat to be lost is considered minimal.

The likelihood of interactions between dredging operations and marine fauna will be reduced through the implementation of mitigation measures such as maintaining watch during all dredging operations, use of dredging flanges, and reducing pump and boat speeds as necessary.

In accordance with the requirements of the *Coastal Protection and Management Act*, the dredge contractor will prepare a dredge management plan (DMP) in accordance with the EPA document *Approval of a Dredge Management Plan Guideline* and relevant environmental authority approval conditions. The DMP will detail all of the management measures to be implemented.

The control measures to be implemented to reduce the effects from dredging are discussed in Section 14.15.

Dredge Material Placement Facility

Potential Impacts

The extent of clearing of mangroves and saltmarsh due to the construction of the proposed dredge material placement facility covering an area estimated at 120 ha at Laird Point is estimated to be:

- 6 ha of mangrove communities representing 0.09% of the 6736 ha of mangrove communities estimated within Port Curtis; and
- 31 ha of saltmarsh and saltpan representing 0.68% of the 4,573ha saltmarsh and saltpan within Port Curtis.

The area of saltmarsh and mangrove clearing required is minor in the context of the total extent available within Port Curtis and no significant impacts are expected.

It is proposed that beneficial reuse of dredge material will be possible for bund wall construction and possibly as road construction material. This will reduce the area required for the development of the dredge material placement facility.

Mitigation Measures

In accordance with the requirements of the *Coastal Protection and Management Act*, the dredge contractor will prepare a dredge management plan (DMP) in accordance with the EPA document *Approval of a Dredge Management Plan Guideline* and relevant environmental authority approval conditions. The DMP will detail all of the management measures to be implemented for the management and operation.

The control measures to be implemented to reduce the effects on the dredge material placement facility are discussed in Section 14.15.

Bridge and Access Road

Potential Impacts

This bridge alignment has been adopted to achieve minimal footprint over seagrass areas by aligning the western approaches as far north as possible and still achieve the following:

- Straight horizontal alignment for bridge structure; and
- Non-skewed bridge structure, i.e. bridge aligned perpendicular to tidal flow.

The western approach of the access road to the bridge is across the tidal area north of Landing Road to Friend Point. This is consistent with the draft Gladstone Land Port Rail Road Infrastructure Study in that it is aligned to the southern edge of the mudflats to:

- Minimise the length of the road element over the softer ground conditions; and
- Maximise the area of land on the northern side available for future port related activities.

The bridge will have a two-lane precast segmental box girder superstructure on cast in situ pier, pile cap and approximately twenty five 1,500 mm diameter bored piles. The benthic area disturbed by the bridge piles will be limited to less than 0.5 ha.

It is anticipated that the foundation construction activities for the potential bridge will result in disturbance of the following marine habitats:

- Subtidal, soft bottom communities in Port Curtis between Friend Point and Laird Point; and
- Loss of saltpan, saltmarsh, seagrass, mangrove and intertidal habitat at Friend and Laird Points.

The disturbance of these habitats will result in the loss or displacement of those species directly dependant on these areas. The surface layers of the areas to be affected provide habitats for a range of benthic fauna such as worms and prawns. Some of these fauna are in turn prey species of larger marine fauna and are important ecologically. As the majority of benthic fauna occur in the top 30 cm of the sediment, the pile boring activities associated with the bridge's construction will remove all benthic fauna within the construction site. However the footprint of the bridge piers will be small (<0.5 ha) and the overall effect of the loss of this small area of benthic habitat will not be significant.

The locations of the seagrass and mangroves to be affected are shown on Figures 8.4.8 and 8.4.10 respectively.

The installation of bridge piers and the construction of abutments at Friend and Laird Points will create additional hard substrates and increase habitat complexity. This will increase the available space for a number of species, such as sponges, gorgonians, soft corals, oysters and other species found on hard substrates within Port Curtis, and also provide habitat and food sources for mobile species (e.g. fish, crabs) which would colonise and use these new habitats for shelter and/or food.

Mitigation Measures

While it is recognised that there is potential for the generation of sediment plumes during construction of the potential bridge, it is likely that with appropriate management intervention such plumes will be far smaller than those which will be developed by the dredging operations already assessed. The management strategies to be implemented for the bridge construction are detailed in Section 15.15.

Gas Transmission Pipeline

Potential Impacts

It is anticipated that trenching of the gas transmission pipeline will result in some loss of the following marine habitats:

- Subtidal, soft bottom communities in Port Curtis between Friend Point and Laird Point; and
- Loss of saltpan, saltmarsh, seagrass, mangrove and intertidal habitat at Friend and Laird Points.

The loss of these habitats will also result in the loss or displacement of those species directly dependant on these areas. The surface layers provides habitats for a range of benthic (bottom dwelling) fauna such as worms and prawns. Some of these fauna are in turn prey species of larger marine fauna and are important ecologically. As the majority of benthic fauna occur in the top 30 cm of the sediment, the trenching operation will be expected to completely remove all benthic fauna within the site, however previous studies indicate rates of re-colonisation by organisms from larval dispersal and active colonisation from adjacent areas are very high (WBM 2004).

Results of trenching impacts of the gas transmission pipeline indicate that sediments will be entrained into the water column during trenching by the release from the clamshell dredge of excess water, containing high concentrations of fine sediments. A sediment entrainment rate of 50 kg per bulk m^3 of material excavated was conservatively assumed, based on typical published values for clamshell dredging operations. The results show that for this case there are elevated TSS concentrations in and around the area of proposed dredging work, with this region occupying an area of approximately 600 m by 200 m during neap tides and approximately 150 m by 150 m during spring tides. Outside these areas, maximum levels of increase of the order of 14-16 mg/L are predicted. When compared with typical background levels in this region of Port Curtis it is apparent that these TSS levels, while high, are comparable to the existing levels of variability in TSS present in the region. Unlike the case of capital dredging, these TSS levels extend much further afield; both upstream and downstream of the potential bridge, due to the much higher water velocities in this region.

Potential impacts predicted for seagrass meadows between Fisherman's Landing and Friend Point from dredging and trenching activities include smothering from increased sedimentation and decreased photosynthesis associated with a reduction in light penetration from increased turbidity. Trophic implications from smothering of intertidal seagrass may include changes to available carbon utilised by fish, crabs and prawns (Connelly *et al,* 2006).

The impacts predicted for seagrass meadows are potentially temporary in nature with regeneration of seagrass meadows predicted following completion of dredging and trenching activities. Results from a monitoring study conducted by Rasheed *et al* (2006) found that following significant declines in biomass and area of seagrass meadows within Port Curtis between 2002 and 2005, the ephemeral seagrass meadows north of Fisherman's Landing took longer to recover than other seagrass meadows within Port Curtis. It was hypothesised that the highly patchy nature with low overall biomass of the seagrass meadows north of Fisherman's Landing may have lower resilience and no substantial seed bank to support rapid regeneration of seagrass species.

Covering the buried pipeline with rocks will create additional hard substrates and increase habitat complexity. This will increase the available space for a number of species, such as sponges, gorgonians, soft corals, oysters and other species found on hard substrates within Port Curtis, and also provide habitats and food sources for mobile species (e.g. fish, crabs) which would colonise and use these new habitats for shelter and/or food.

Mitigation Measures

Potential impacts will be mitigated through measures such as timing dredging and trenching activities during spring tide cycles. Changes to foraging behaviour of dugong and turtles that feed on these meadows may occur.

In accordance with the requirements of the *Coastal Protection and Management Act*, the dredge contractor will prepare a dredge management plan (DMP) in accordance with the EPA document *Approval of a Dredge Management Plan Guideline* and relevant environmental authority approval conditions. The DMP will detail all of the management measures to be implemented for the pipeline's construction.

Best practice techniques will be adopted for dredging and pipeline construction activities in order to minimise the extent and duration of sediment plumes which may otherwise be generated during the construction phase of the project. The management strategies to be implemented for the pipeline crossing of Port Curtis are detailed in Sections 12.15 and 15.15.

Shipping

Potential Impacts

Shipping activities associated with the construction phase of the project include the dredging vessel/s, barges, ferry operations, jack-up rigs, and support vessels. Section 3.11.3 indicates that construction of Train 1 is estimated to require 2,500 barge/vessel round trip movements across Gladstone Harbour from the mainland to Curtis Island and back. This will be spread over 24 months. Marine traffic will reduce to approximately 1,200 barge/vessel round trips for the construction of subsequent trains on the assumption that the access bridge is not built.

The cross harbour traffic will reduce significantly to approximately four ferry trips per day during the operations phase assuming that the access bridge is not constructed.

The presence of dredges, barges, ferries, support vessels, etc, will likely restrict some users from areas of Port Curtis used for recreational, traditional or commercial fishing and shipping. The increase in marine traffic, particularly during the construction phase, may also result in an increased risk of collisions with marine fauna.

The impacts of shipping through the Great Barrier Reef Marine Park are discussed in Section 10.3.3.1.

Mitigation Measures

Construction of the access bridge will significantly reduce shipping impacts apart from during the construction of Train 1. Without the provision of construction worker accommodation on Curtis Island, the impacts would be even greater.

Fisheries

Potential Impacts

The waters and surrounding estuaries of Port Curtis contain benthic habitats (e.g. seagrass, mangrove, sand bars and mud flats) essential to many fisheries productivity for crustaceans, fin-fish and mollusc species found within Port Curtis. While there is some understanding of the fin-fish, crustacean and mollusc communities in Port Curtis, detailed knowledge of the feeding and other habitat requirements is unavailable.

Dredging and dredge material disposal will potentially impact on existing commercial and recreational fisheries in the short-term. Most of the economically important species will be expected to have broad diets utilising organisms found in the substrate and in the water column. Dredging and dredged material placement operations are unlikely to result in detectable medium or long-term changes in the distribution or abundance of these species in Port Curtis. Furthermore, major impacts to fishing operations are not expected. Any impacts are likely to be of a temporary nature.

Mitigation Measures

The use of buffer zones as described under the *State Coastal Management Plan* (*2.2.2 Erosion prone areas* and *2.2.3 Shoreline erosion management*) could be used in sustaining fisheries resources, water quality and the values of coastal wetland systems through maintaining connectivity between coastal and riparian vegetation and estuarine and freshwater reaches of catchments. The environmental management measures detailed in Sections 14.15 and 15.15 will assist in protecting local fishery resources.

Suspended Sediment

Potential Impacts

Sedimentation can result in mortality of some benthic flora and fauna (particularly corals). If sediment loads are high and continue over time, ecological impacts may occur. Fine fractions of sediment can migrate over significant distances. Both pelagic and benthic organisms can be impacted from increased suspended solids and subsequent deposition.

Generation of turbidity from cutter suction dredging is mostly related to the type and quantity of material to be dredged and the efficiency of the suction in removing sediments. Additionally, turbidity may be generated from the sloughing of material on vertical cuts, inefficient operational techniques, and from propeller wash from support vessels operating in shallow waters. The highest levels of turbidity are found in close proximity to the cutter.

Dredging and dredge material placement operations can result in the overflow of dredge material into the surrounding water column and/or direct disturbance of the seabed that can cause localised impacts to water quality in adjacent areas and to nearby seagrass meadows. The removal of materials with a high proportion of silts and clays can cause significant impacts that require specific mitigation actions.

Dugongs and turtles feed on seagrasses which may be impacted during dredging and/or construction activities.

WBM (2004) reviewed past monitoring studies of suspended sediment plumes undertaken for typical extraction operations in Moreton Bay, and which ware likely to be broadly similar to those experienced at Port Curtis. This showed that the direct disturbance from dredging operations can cause a localised, but short-lived increase in suspended sediment. Recorded turbidity plumes were limited in duration and extent (typically less than 200 m) from the disturbed site and the measured turbidity was moderate and within the limits set by licence conditions. Visible plumes extended for some distance, however the suspended sediment concentrations were only slightly elevated above background levels.

Section 8.7.4 shows that modelling results of the proposed GLNG Project dredging support the WBM 2004 findings for Moreton Bay where greater total suspended solids (TSS) concentrations were limited to the immediate vicinity of the dredging and were greater during neap tides when dispersion was less as a result of reduced tidal velocities. The modelling identifies an immediate impact zone of the order of several hundred metres in scale during these times, and outside this area, maximum additional TSS concentrations of less than 25 mg/L were predicted (over ambient). These values were in the order of the natural variability of TSS concentrations across Port Curtis. Concentration increases during spring tides were generally less than during neap tides.

Similar behaviour was observed in the model results for the potential bridge and gas transmission pipeline construction scenarios. The immediate impact zones were again in the order of hundreds of metres in dimension during neap tides (and considerably smaller during spring tides) with maximum additional TSS concentrations outside this zone of 14 to 16 mg/L. Impacts to seagrass meadows north of Fisherman's Landing may occur as a result of increased suspended sediment.

Based on these modelling results, the expected impacts on benthic flora and fauna from smothering of sediment from dredge plumes are expected to be minor and limited in extent.

Mitigation Measures

In accordance with the requirements of the *Coastal Protection and Management Act*, the dredge contractor will prepare a dredge management plan (DMP) in accordance with the EPA document *Approval of a Dredge Management Plan Guideline* and relevant environmental authority approval conditions. The DMP will detail all of the management measures to be implemented.

The control measures to be implemented to reduce the effects from dredging are discussed in Section 14.15.

Release of Contaminants

Potential Impacts

Dredging and disposal of contaminated sediment has the capacity to release toxicants into the water column and increase overall bioavailability of contaminants. Where sediments contain elevated nutrient concentrations, nutrient availability may increase during dredging and may cause some level of short term eutrophication.

The risk of dredging operations releasing contaminated sediments is considered to be low as the sediment testing of the material to be dredged found that the contaminant levels of the materials to be dredged are generally within the accepted guidelines (see Section 8.7).

Another potential source of contaminants is the fill material to be used for the bund wall construction for the dredge material placement facility. As all fill material will be from a "clean" source, the risk of releasing contaminants is from this source is also considered to be low.

Mitigation Measures

In accordance with the requirements of the *Coastal Protection and Management Act*, the dredge contractor will prepare a dredge management plan (DMP) in accordance with the EPA document *Approval of a Dredge Management Plan Guideline* and relevant environmental authority approval conditions. The DMP will detail all of the management measures to be implemented.

The control measures to be implemented to reduce the effects from dredging are discussed in Section 14.15.

Light

Potential Impacts

Lighting will be used on the bridge and access road, ships, the PLF and MOF structures, dredges and support vessels. Light will also occur from flaring activity during commissioning and production. This typically lasts for several hours at a time at irregular intervals throughout the year.

Lighting has been linked to disorientation in turtles, particularly during periods of nesting and hatching (Lutcavage et al. 1996; Pendoley 1997). Hatchlings move toward bright artificial light sources in both laboratory and field settings. Studies reported by Witherington (1992) on hatchling orientation relative to spectrally controlled light sources indicated that the most disruptive wavelengths were in the range of 300–500 nanometres (nm). In contrast, light emitted from a natural gas flare has peak spectral intensity in the range from 750 to 900 nm (WAPET 1995).

As shown on Figure 8.4.11, the nearest turtle nesting beaches to the LNG facility site are located on the eastern side of Curtis Island approximately 8 km from the LNG facility site. As discussed in Section 8.12, the intervening topography is such that there is no direct line of sight from the LNG facility site to these beaches. Hence no light effects from the project on turtle nesting are expected.

Mitigation Measures

The LNG facility will be designed to minimise light spill (e.g. using light hoods) and to minimise direct views of lights from outside the plant, in particular from Port Curtis and view situations located south of Port Curtis, consistent with health and safety requirements.

Oxygen Depletion

Potential Impacts

Extensive and continued smothering of an area of the seabed can result in the covered seabed becoming anoxic over time. Encapsulated organic material that is present in the surface sediments at the time of smothering will be biodegraded initially by organisms using the oxygen associated with the surface and deposited sediments. Once this store of oxygen is depleted, the sediments are anoxic and biodegradation will occur more slowly by micro-organisms using electron acceptors other than oxygen (Brock & Madigan 1991). In tidally affected waters such as Port Curtis with significant currents and flushing capacity, this risk is considerably reduced.

The observed effects of oxygen depletion in the surface sediments usually include a decrease in the number of taxa and biological diversity, however, the total number of individuals and biomass may actually remain constant, or even increase, in some instances (Neff, et al., 2000).

As discussed in Section 8.7.4, the sediment plumes and resultant deposition onto the seabed from the proposed dredging operation is expected to be limited in extent and duration. Furthermore, the relatively high tidal currents in Port Curtis will tend to limit the potential for significant deposition of dredge plume sediments in localised areas with the potential to generate anoxic conditions. They will tend to create a wider spread of sediments with lower sedimentation rates. Consequently oxygen depletion from the dredging operation is not expected.

Mitigation Measures

In accordance with the requirements of the *Coastal Protection and Management Act*, the dredge contractor will prepare a dredge management plan (DMP) in accordance with the EPA document *Approval of a Dredge Management Plan Guideline* and relevant environmental authority approval conditions. The DMP will detail all of the management measures to be implemented.

Section 14.15 lists the control measures proposed to be implemented to reduce the effects of dredging.

Introduced Marine Pests

Potential Impacts

The LNG vessels as well as the dredges and barges to be used on the GLNG Project can move rapidly between different areas of the world. In doing so, they may translocate exotic species between different geographic regions. With over 200 species of exotic marine organisms known to have been introduced into Australian waters, the introduction of foreign marine organisms through ships' ballast and hull fouling and, in the case of dredges the transport of sediments containing marine pests, is a major concern.

There are currently 26 marine species listed as being introduced into Queensland waters (NIMPIS website – http://www.marine.csiro.au/crimp/nimpis/). A marine introduced pest survey of Port Curtis was conducted in 2000 (Lewis et al. 2001) by the Central Queensland University in conjunction with the Commonwealth Scientific and Industrial Research Organisations (CSIRO) Centre for Research on Introduced Pests (CRIMP). No pest species were detected in Port Curtis, however, low abundances of ten introduced species were detected. These species are encrusting species thought to be introduced via hull fouling on ships. The report noted that these species are widespread in ports across Australia and around the world, and are not considered to be a threat to native species, aside from direct competition for space between some bryozoans. The authors recommended that removal was not warranted.

Mitigation Measures

All vessels entering an Australian port from overseas must obtain a quarantine ship clearance from Australian Quarantine and Inspection Service (AQIS); the government agency responsible for the prevention of foreign marine organisms into Australian waters. AQIS introduced new controls on ballast water discharge from 1 July 2001, whereby ships with ballast water that are considered a high risk for introduced marine species and that have not exchanged ballast water mid-ocean, are now not allowed to discharge into Australian waters (up to 12 nautical miles offshore).

A risk assessment of potential marine pest introductions will be carried out for each vessel proposed to be used on the GLNG Project. For vessels that are considered high risk, inspections of the hulls and/or hoppers may be carried out, preferably before they depart for Australian waters.

A quarantine area will be located in the MOF facility. The quarantine area will have a wash down water supply and contained runoff, collection and treatment facility. It is here that all construction modules will be washed down to remove salt spray after the ocean journey as well as any pest species. It is envisage that a hardstand area will be graded to a sump for washdown water collection and treatment, disposal or recycling. The quarantine area will also support fumigation facilities.

8.4.5.4 Cumulative Impacts

Apart from the GLNG Project there are a number of other LNG facilities that are proposed for Curtis Island (Section 1.7). There is limited information available as to the planned development of these proposed projects or the scale and timing of their development. However, a qualitative assessment can be made of the possible cumulative impacts.

Terrestrial Ecology

The south-west corner of Curtis Island where the GLNG LNG facility is proposed has been historically altered by clearing for pastoral, agricultural and forestry activities. Specific impacts have included grazing, weed invasion and selective thinning. Field studies have determined that areas of remnant vegetation impacted by the project have a relatively low habitat value and have been degraded to some degree by exotic weed invasion. In this context therefore, the construction of the LNG Facility is not expected to significantly reduce the overall conservation value of Curtis Island.

Over time, the construction of additional LNG developments in nearby areas may result in further loss of remnant vegetation and habitat. Assuming a similar low level of impact as described above for the GLNG Project, adherence by other projects to sound environmental policy and planning frameworks will assist in ensuring that such developments will not significantly impact on natural ecosystems in the region. Also it is likely that these proposed facilities will include some or all of the proposed mitigation measures proposed for the GLNG Project, thereby minimising cumulative impact on the receiving environment.

Marine Ecology

Dredging and construction activities which have the potential to impact the marine environment are planned for a number of other LNG and other projects in Port Curtis. These include the BG project (QLD Curtis LNG), the Wiggins Island project, and the Fisherman’s Landing expansion. Cumulative impacts from activities associated from these and other potential projects (Section 1.7) may be additional to the potential impacts described above. It is possible that dredging activities for these projects could occur concurrently with the dredging planned for the GLNG Project.

As discussed in Section 2.3.9, the Queensland Government and the Gladstone Ports Corporation (GPC) are presently reviewing the dredged material management plan for Port Curtis to plan for the long-term dredging and dredged material disposal that may be required to provide safe and efficient access to existing and proposed port facilities in the harbour for the foreseeable future. The plan considers dredging and dredged material disposal required for industrial and port related projects currently proposed for Gladstone. The plan will include the dredging required for the Wiggins Island Coal Terminal, the LNG precinct on Curtis Island, and the further development of Fisherman's Landing. This includes the GLNG Project.

As part of the plan, the GPC is considering a single dredge material disposal area which will be large enough to accommodate the combined dredged material from all of these projects in a manner which is consistent with GPC's long term port development objectives. The plan is at an early stage. Santos and other relevant stakeholders are participating in the development of the plan with the Queensland Government.

GPC and the Queensland Government propose to undertake an environmental assessment of the overall plan and to obtain the necessary approvals before adoption and implementation of the plan. If the plan is approved, the dredging and the associated dredge material placement for the GLNG Project will be undertaken in accordance with the plan provided the timing of the approval is consistent with the GLNG Project requirements.

Tables 8.4.9 and 8.4.10 provide a summary of potential terrestrial and marine ecology impacts and mitigation measures for the LNG facility respectively.

Table 8.4.9 Potential Terrestrial Ecology Impacts and Mitigation Measures

Aspect	Potential Impact	Mitigation Measures	Objective
Construction/Operation			
Impact on flora, fauna and vegetation communities of vegetation clearing and disturbance.	Loss or disturbance of approximately 127 ha of native vegetation.	• Areas cleared restricted to minimum required. • Use of tape, pegs etc to delineate areas to be cleared. • Appropriate erosion and sediment mitigation measures undertaken.	Minimise disturbance to native flora and fauna.
	Loss or disturbance to Endangered/Of Concern Regional Ecosystems.	• Biodiversity offset to compensate for unavoidable loss of Endangered/Of Concern RE sites. Communities requiring offsetting include RE 12.2.2 and RE 12.3.3.	Minimise disturbance to native flora and fauna.
	Loss or fragmentation of fauna habitats, resulting in loss of fauna habitat, reduction in movement opportunities and increased edge effects.	• Restriction of areas of vegetation clearance. • Retain habitat hollows and other habitat features wherever practicable. • Clearing will be undertaken in stages to ensure that isolated stands of vegetation are not created and the connectivity of habitat remains intact to allow for the dispersal of fauna. • Clearing will be undertaken towards the direction of any adjacent contiguous vegetation that is not to be cleared to ensure connectivity of habitat is not disrupted. • Clearing near any waterways or riparian areas will include adequate barriers to ensure sediment impacts to waterways are restricted.	Minimise disturbance to native flora and fauna.
Impact on flora, fauna and vegetation communities of earthworks, vehicle movements and operational activities.	Deposition of dust, sand and soil may have potential impacts on vegetation if excessive levels are sustained over extended periods. When dust settles on plant foliage, it can reduce the amount of light penetration on the leaf surface, block and damage stomata, and slow rates of gas exchange and water loss.	• Implementation of dust control measures, such as watering. • Sealing of roads and operational areas.	Minimise disturbance to native flora and fauna.

Aspect	Potential Impact	Mitigation Measures	Objective
	Disturbance to fauna from noise and vibration during facility construction and operation. Fauna will generally move away from the source to avoid these impacts. However, acclimatisation by some species may occur over the long term.	• All equipment and machinery used during construction will be maintained in good working order, and where possible shielded to minimise noise emissions. • Operating times will be minimised so that impacts are reduced overall, especially at night. • Lights used at the operating LNG facility to be used sparingly, of a minimum power to fulfil safety requirements and will not be directed towards surrounding bushland. • Hoods or covers will be used to reduce the amount of light spilling onto these areas.	Minimise disturbance to native flora and fauna.
Spread of weeds.	Introduction of vehicles and heavy machinery may potentially introduce new and declared weeds, and increase the risk of spreading existing weeds across the site and its surrounds.	• Implement weed control protocols as per Santos EHS09 Weeds and Pest Animal Control. • Effective management strategies to control the spread of declared weed species in keeping with regional management practices or DNR&W pest control fact sheets. • Ongoing monitoring of the project site to identify any new incidence of weed infestation. • Provision of information for project staff on the identification of declared weeds and their dispersal methods. • Wash down protocols for any vehicles or machinery entering and leaving site.	To minimise the spread of weeds throughout the GLNG project area.

Table 8.4.10 Potential Marine Flora and Fauna Impacts and Mitigation Measures

Aspect	Potential Impact	Mitigation Measures	Objective
Construction			
Construction of the gas transmission pipeline across Port Curtis.	Impact of the transmission pipeline crossing the seafloor, shoreline and intertidal areas on marine flora and fauna.	• To reduce sediment plumes whilst trenching by using silt curtains. • Use of buffer zones to protect shorelines and intertidal areas.	To minimise the impact of the gas transmission pipeline during construction on the Port of Curtis.
Construction of potential bridge and gas transmission pipeline across Port Curtis.	Habitat impact to soft bottom communities from construction of the potential bridge and pipeline. This will include the removal of salt pan, saltmarsh, mangrove and intertidal areas	• Habitat will be managed according to the Environmental Management Plan developed for the construction phase of works.	To minimise the impact on soft bottom communities within the vicinity of potential bridge and gas transmission pipeline.
Construction of the access road and potential bridge.	Impact to salt pan, saltmarsh, mangrove and intertidal areas from the construction of the access road to the potential bridge.	• The construction works required to install the road to the proposed bridge will be short term. • The design of the road has been based on minimising the footprint required. • Environmental Management Plan developed for the construction phase of works.	To minimise the impact on salt pan, saltmarsh, mangrove and intertidal areas during construction.
Dredging activities.	Dredge placement facility will remove 50 ha of saltpan, salt marsh, mangrove and intertidal habitat.	• Dredge Management Plan.	To minimise the disturbance of the dredge material placement facility on the surrounding habitat.
	Habitat impact to soft bottom communities at China Bay and in the approach channel due to dredging..	• Habitat will be removed according to the Environmental Management Plan developed for the construction phase of works.	To minimise the impact on soft bottom communities within the vicinity of China Bay.

Aspect	Potential Impact	Mitigation Measures	Objective
	Potential for boat strike on marine fauna, entanglement in lines, or caught in suction pressure from dredger.	• Whilst dredging use rigid or chain deflectors, operational protocols, maintain look-outs for marine fauna, stop works if marine fauna are located within 500m of work area, environmental windows and reporting to protect marine fauna.	To minimise the impact on marine fauna.
	Potential noise emissions from piling, shipping and dredging have the potential to disturb marine fauna and migratory shore birds.	• Environmental Management Plan developed for the operational phase of works will be developed.	To minimise noise generation from construction operations.
Construction of the MOF and PLF.	Habitat impact to soft bottom and rock slope communities from construction of the MOF and PLF. This will include the loss of salt pan, saltmarsh, mangrove and intertidal areas.	• Habitat will be removed according to the Environmental Management Plan developed for the construction phase of works.	To minimise the impact on soft bottom communities within the vicinity of MOF and PLF.
Lighting.	Possible disorientation of marine fauna and migratory shore birds from lighting.	• Construction activities will occur on the port side of Curtis Island, as the nearest turtle nesting beach is on the seaward side of Curtis Island, no impacts on turtle hatchlings are expected.	To minimise the impact on marine fauna and migratory shore birds.
Operation			
Process water.	Impact of process water disposed of to the marine environment.	• All process water disposed of to the marine environment will obtain licenses to discharge. • All process water disposed of to the marine environment will be in meet criteria specified in the license to discharge.	To minimise the impact of process water on the surrounding environment.

Aspect	Potential Impact	Mitigation Measures	Objective
LNG shipping activities.	Impact of LNG shipping activities introducing marine pests to Port Curtis.	• All vessels entering an Australian port from overseas must obtain a quarantine ship clearance.	To minimise the introduction of marine pests into Port Curtis.
Lighting.	Possible disorientation of marine fauna and migratory shore birds from lighting.	• Lighting will be designed in a manner to minimise disturbance to marine fauna and migratory shore birds.	To minimise the impact on marine fauna and migratory shore birds.
Noise emissions.	Potential noise emissions from piling, shipping and dredging have the potential to disturb marine fauna and migratory shore birds.	• Soft start practices should be used to reduce impacts to marine fauna.	To minimise noise generation from operations.
Decommissioning and Rehabilitation			
Rehabilitation activities.	Potential impacts on habitats and species from possible activities to rehabilitate project components which may have potential impacts on the marine environment.	• An approved rehabilitation plan to be in place before any rehabilitation activities occur.	To minimise the impact on habitats and species from rehabilitation activities.
Decommissioning activities.	Potential impacts on habitats and species from possible activities to decommission project components which may have potential impacts on the marine environment.	• An approved decommissioning plan to be in place before any decommissioning activities occur.	To minimise the impact on habitats and species from decommissioning activities.

8.4.6 Summary of Findings

8.4.6.1 Terrestrial Ecology

The fauna and flora surveys conducted within the LNG facility study area on Curtis Island found that a relatively low diversity of native fauna and moderate diversity of native flora was present. The assessment determined that habitat values are degraded due to previous activities on the site including grazing, clearing, cropping, weed infestations, selected timber felling and other human activities.

Most notable impacts for the site from the LNG facility will be to the significant regional ecosystems. The potential impacts to the ecosystems and flora and fauna diversity are expected to be manageable through implementation of appropriate planning and management strategies.

8.4.6.2 Marine Ecology

The major impacts on the marine environment are likely to be a result of dredging and dredge material disposal/placement. Direct disturbance to habitat from dredging associated with the construction phase of the proposal will occur.

The short-term disturbance to benthic habitats will result in the displacement of species directly dependant on these areas. However, the rates of re-colonisation are expected to be high. Construction activities will result in the modification of several habitats, increasing the available space for a number of sessile species, and also to provide habitats and food sources for mobile species (e.g. fish, crabs) which will use these new habitats for shelter and/or food.

It is expected that dugongs, whales, dolphins and turtles will not be affected from turbidity or sedimentation; however there is the potential for direct impacts from boat strike, entanglement in lines or being captured by suction pressure associated with the dredge head. Some impacts to commercial and recreational fishing activities are expected. These impacts are considered to be short term and only during the construction phase of the potential bridge, pipeline and marine facilities.

Limited indirect impacts can be expected from increased turbidity, sedimentation and smothering resulting in mortality of some benthic flora and fauna. There is potential for localised impacts to water quality resulting from surface water discharges from the dredge material placement facility into the surrounding water column. Localised impacts to seagrass meadows can be expected from increased turbidity and sedimentation. Negligible changes to the existing hydrodynamic and sediment transport processes are expected. Impacts from light and noise to marine fauna are considered to be negligible.

In accordance with the requirements of the *Coastal Protection and Management Act*, the dredge contractor will prepare a dredge management plan (DMP) in accordance with the EPA document *Approval of a Dredge Management Plan Guideline* and relevant environmental authority approval conditions. The DMP will detail all of the management measures to be implemented.