Australia Pacific LNG Project

Volume 4: LNG Facility

Chapter 8: Terrestrial Ecology

Contents

8. Terrestrial ecology 1
8.1 Introduction 1
8.1.1 Purpose 1
8.1.2 Scope of works 1
8.1.3 Legislative framework 3
8.2 Methodology 5
8.2.1 Overview 5
8.2.2 Desktop review 6
8.2.3 Field survey 7
8.2.4 Interpretation and documentation 8
8.3 Existing environment 8
8.3.1 Bioregional context 8
8.3.2 Environmentally sensitive areas 8
8.3.3 Flora 9
8.3.4 Fauna 19
8.4 Potential impacts 27
8.4.1 Flora 27
8.4.2 Fauna 31
8.5 Mitigation and management 39
8.6 Environmental offsets for the Project 43
8.7 Cumulative impacts 43
8.8 Conclusion 46
8.8.1 Assessment outcomes 46
8.8.2 Commitments 54
References 55

Figures

Figure 8.1 Flora and fauna survey sites 2

Figure 8.2 Dense mangrove communities from North Passage Island (left) and part of the Port Curtis wetland area, whilst the broad mudflats in the central portion of the LNG facility site (right) provide habitat for wader birds 9

Figure 8.3 The yellow mangrove (*Ceriops tagal*) (left), pink bloodwood (*Corymbia intermedia*) (centre) and purple coral pea (*Hardenbergia violacea*) (right) 9

Figure 8.4 Environmentally sensitive areas 11

Figure 8.5 Ground-truthed regional ecosystems and significant weed species 12

Figure 8.6 Ironbark – blue gum open forests and woodlands vegetated valleys on undulating terrain (RE 12.11.14) (left) and adjacent alluvial floodplains (RE 12.3.11) (right) throughout the LNG facility site 14

Figure 8.7 Marine clay mudflats (RE 12.1.2) in the central portion of the LNG facility site (left) are largely devoid of vegetation whilst mangrove shrublands (RE 12.1.3) line the western coastline of Curtis Island (right) 15

Figure 8.8 Spotted gum – ironbark open forests (RE 12.11.6) dominate the low metamorphic rises (left) and a small paperbark swamp (RE 12.3.7) was recorded in the south-central portion of the LNG facility site (right) 15

Figure 8.9 The roots of the medicine bush (*Pogonolobus reticulatus*) are used by the Indigenous people for yellow dye (left) whilst the lemon-scented/spotted gum was sourced for tools and timber (centre). The prickly pear (*Opuntia stricta*) was observed in flower (right) in the western portion of the LNG facility site 18

Figure 8.10 Shorebird roosts and feeding areas 35

Tables

Table 8.1 Regional ecosystems of the LNG facility site 10

Table 8.2 Regional ecosystem extent on site and representation in the greater area 13

Table 8.3 Total area of REs in protected and managed areas in Queensland 16

Table 8.4 Scheduled flora species known or likely to occur in the wider study area 17

Table 8.5 Scheduled flora species with potential to occur within LNG facility site 17

Table 8.6 Regionally significant flora species identified by database searches from the wider study area 18

Table 8.7 Significant weed species potentially occurring within the LNG facility site 19

Table 8.8 Potential EVR fauna species occurring within the LNG facility site 20

Table 8.9 Potential regionally significant fauna species occurring within the LNG facility site 21

Table 8.10 Potential migratory birds occurring within the LNG facility site 23

Table 8.11 Potential introduced fauna occurring within the LNG facility site 25

Table 8.12 Faunal habitats within the LNG facility site 25

Table 8.13 Potential EVR and Back on Track fauna presence in habitats within the LNG facility site 26

Table 8.14 Proposed remnant vegetation clearing areas within the LNG facility site[1] 28

Table 8.15 Cumulative impact of vegetation clearing in the greater area on conservation status of REs present on site 47

Table 8.16 Summary of environmental values, sustainability principles, potential impacts and mitigation measures 48

8. Terrestrial ecology

8.1 Introduction

8.1.1 Purpose

This chapter identifies ecological values of the terrestrial environment on land proposed for the liquefied natural gas (LNG) facility on Curtis Island, as part of the Australia Pacific LNG Project (the Project).

The chapter assesses the potential impacts associated with the construction, operation and decommissioning of the proposed facility on these values within a national, state, regional and local context. Cumulative impacts associated with the Project and surrounding development of the designated industry precinct on Curtis Island were also considered and mitigation measures to minimise these potential impacts to the terrestrial environment are identified.

Of Australia Pacific LNG's 12 sustainability principles, the relevant sustainability principles to terrestrial ecology for the LNG facility include:

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

The ultimate objective is to design, construct and operate the LNG facility in such a manner as to ensure a minimal impact on the surrounding environment and no substantial residual risk to terrestrial ecological values of the surrounding environment. The strategies outlined in this environmental impact statement will demonstrate how these sustainability principles will be addressed.

8.1.2 Scope of works

The scope of work for the terrestrial impact assessment included:

- Identifying key flora and fauna values of the LNG facility site and wider study area through desktop and field studies. These values include ecological and vegetation communities, flora and fauna species, fauna habitat types and movement corridors, weeds and animal pest species and other sensitive ecological areas of significance.
- Identifying potential impacts on these ecological features and values resulting from activities associated with the Project.
- Identifying appropriate mitigation measures to avoid and minimise potential impacts on these ecological features and values.

Potential impacts on matters of national environmental significance are addressed with Volume 4 Chapter 23. Alternatives that have been considered in the identification and assessment of impacts on terrestrial ecological values including the two jetty berth options 2a and 1b and their respective development footprints; illustrated in Figure 8.1.

313000 314000 315000 316000 317000 318000

7374000 7373000 7372000 7371000 7370000

The Narrows

Graham Creek

Laird Point

North Passage Island

PORT CURTIS

L01 L02 L03 L04 L05 L06 L07 L08 L09

V301 V302 V303 V304 V305 V306 V307 V308 V309 V310 V311 V312 V313 V314 V315 V316 V317 V318 V319 V320 V321 V322 V323 V324 V325 V326 V327 V328 V329

LP201 LP202 LP203 LP204 LP205 LP206 LP207 LP208 LP209 LP210 LP211 LP212

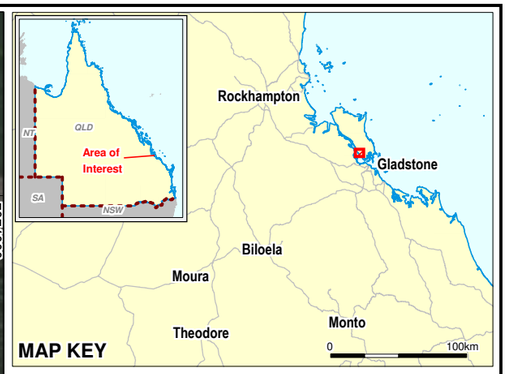
Loading Berth Option 2a

Loading Berth Option 1b

0 0.5 1km

SCALE - 1 : 20,000 (at A3)
Map Grid of Australia Zone 56
Geocentric Datum of Australia 1994

N



LEGEND

- Vegetation survey sites
- Fauna habitat sites
- Loading berth option 1b
- Loading berth option 2a
- LNG facility development footprint
- LNG facility site

Source Information

LNG facility development footprint
Digitised from Conceptual Site Plan 25509-100-10005.dgn supplied by client 24/07/2009

Satellite Imagery
Captured by GeoEye-1 on 24 March 2009

Vegetation survey sites
Located by Worleyparsons October 2009

Fauna habitat sites
Located by Worleyparsons October 2009

AUSTRALIA PACIFIC LNG PROJECT

Volume 4 Chapter 8
Figure 8.1 Flora and fauna survey sites

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8.1.3 Legislative framework

Key legislation and planning objectives relative to the protection and management of terrestrial ecology in the Project area include:

- Australian Government
  - *Environment Protection and Biodiversity Conservation Act 1999*
- Queensland Government
  - *Coastal Protection and Management Act 1995*
  - *Environmental Protection Act 1994*
  - *Sustainable Planning Act 2009*
  - *Land Protection (Pest and Stock Route Management) Act 2002*
  - *Nature Conservation Act 1992*
  - *Vegetation Management Act 1999*
  - *Water Act 2000*
- Local and regional context
  - Curtis Coast Regional Coastal Management Plan 2003
  - Calliope Shire Council planning scheme 2007

Australian Government

Environment Protection and Biodiversity Conservation Act

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides for the identification and management of matters of national environmental significance including: threatened flora and fauna species, ecological communities, migratory species protected under international treaties, internationally recognised significant wetlands and critical habitat areas. The EPBC Act is further discussed in Volume 4 Chapter 23.

Queensland Government

Environmental Protection Act

The *Environmental Protection Act 1994* provides the framework to manage the environment within the principles of ecologically sustainable development and outlines responsibility and the duty of care all persons have to the environment and the scope and content for preparing environmental protection policies.

Sustainable Planning Act

The *Sustainable Planning Act 2009* provides the framework to integrate planning and development assessment so development and its effects are managed in a way that is ecologically sustainable, and for related purposes.

Coastal Protection and Management Act

The *Coastal Protection and Management Act 1995* provides for the protection, conservation, rehabilitation and management of coastal areas. This Act provides the coordinated and integrated management and administrative framework for the ecological sustainable development of the coastal zone and outlines the requirements for developing and implementing coastal management plans.

Nature Conservation Act

The *Nature Conservation Act 1992* (NC Act) provides a comprehensive strategy for the conservation and management of Queensland's native animals and plants.

Vegetation Management Act

The *Vegetation Management Act 1999* (VMA) manages the clearing of native vegetation including remnant vegetation, high value regrowth vegetation (through the Queensland *Vegetation Management and Other Legislation Amendment Bill 2009* and vegetation in declared areas. The objective of the VMA is to prevent land degradation and loss of biodiversity caused by clearing, maintain ecological processes and reduce greenhouse gas emissions.

Land Protection (Pest and Stock Route Management) Act

The *Land Protection (Pest and Stock Route Management) Act 2002* provides for the management of pests on land and the management of the stock route network. This Act identifies state declared plants (weeds) and animal pests and the management requirements of landholders to control these species.

Water Act

The *Water Act 2000* provides for the sustainable management of water and other resources and the establishment and operation of water authorities.

Local and regional context

Curtis Coast Regional Coastal Management Plan

The Curtis Coast Regional Coastal Management Plan 2003 provides to the framework to manage the Curtis Coast region and guides the Queensland Department of Environment and Resource Management's (DERM's) decisions regarding coastal development and management.

Calliope Shire Council planning scheme

The Calliope Shire Council amalgamated with Gladstone City and Miriam Vale Shire Councils in March 2008 to form the Gladstone Regional Council. However, the Calliope Shire Council planning scheme 2007 is still in force. This scheme was gazetted in April 2007 and provides the framework for managing development by identifying assessable and self-assessable development and outcomes sought to be achieved in the local government areas.

8.2 Methodology

8.2.1 Overview

Study area

The Project area is located near Laird Point within the Curtis Island Industry Precinct on the south-western coast of Curtis Island. It is situated south of Graham Creek and wholly within the Curtis Island catchment and lies solely within the southeast Queensland (SEQ) bioregion (Figure 8.1).

The LNG facility site is characterised by undulating hills and slopes and adjacent floodplains dominated by eucalypt open forests and woodlands, opening into expansive mudflats of saltpan vegetation and mangrove shrublands along the coastline.

Vegetation transects and fauna habitat assessment survey site locations are illustrated in Figure 8.1.

Limitations

In the preparation of this assessment the following limitations were identified:

- The assessment is based upon vegetation mapping as of the version 6.0 regional ecosystem (RE) mapping data, version 6.0b RE descriptions database and version 2.0 regulated regrowth mapping data. RE extents for the catchment, subregion and bioregion are based on information provided in Accad et al. (2008).
- The existing DERM RE mapping is correct except in those locations where site specific surveys identified inaccuracies at the local scale. Existing RE mapping and noted inaccuracies with this mapping have been used to determine proposed clearing requirements for the proposed LNG facility and existing mapping was used to estimate the total area of each RE type occurring within the wider study area.
- This report focuses on land within the LNG facility and any infrastructure such as access roads outside of this area were not assessed.
- As detailed targeted field surveys were not undertaken, the precautionary approach was adopted throughout this assessment. As such, any species that could potentially occur within the wider study area (as identified through ecological databases and the habitat knowledge of the flora and fauna by the botanist and fauna ecologist) have been assumed to occur in the LNG facility site.
- The field assessment was carried out during four days in April and three days in October, both of which are, on average, milder months of the year for this area (Bureau of Meteorology Rockhampton long-term averages). No rainfall occurred during the field surveys. During the April survey creeks within the LNG facility site did contain some pooling water. During the October survey however, the LNG facility site was very dry. The conditions were not optimum for surveying frogs. Frog activity noted during the surveys was very low, with only the cane toad (*Rhinella marina*) recorded during the entire field assessment. There was some reptile activity noted during the October survey. Reptile activity during the April survey was very low.

Defining conservation significance

Terrestrial flora and fauna species, vegetation and ecological communities, wetlands and non-native species of significance includes those species and communities listed under state and commonwealth legislation, non-statutory conservation agreements, action plans and regional plans and local planning

schemes. Significant species and communities are listed below and the methodology used to define their significance is outlined in the technical report (Volume 5 Attachment 16, Sections 2.1.1 and 2.1.2):

- Threatened ecological communities are those listed under the EPBC Act as critically endangered, endangered or vulnerable
- REs are those listed under the VMA as endangered, of concern or least concern
- At threshold REs refer to those REs listed under the regional vegetation management code for southeast Queensland bioregions (Department of Natural Resources and Water (DNRW 2006) and regrowth vegetation refers to high value regrowth as described under the *Vegetation Management and Other Legislation Amendment Bill 2009*.
- EVR species are those listed under the EPBC Act and/or NC Act as critically endangered, endangered, vulnerable, near threatened or rare
- Regionally significant fauna species are defined as those species listed in the Back on Track framework and non-EVR priority taxa identified by DERM (DERM 2009a; Environmental Protection Agency (EPA) 2006b). Species not considered EVR but are listed under a non-statutory conservation agreements, action plan or regional plan are also considered regionally significant.
- Species of other conservation significance are those not considered EVR or regionally significant but are afforded extra protection under state or Commonwealth legislation including marine plants protected under the Queensland *Fisheries Act 1994* and migratory and marine protected species listed under the EPBC Act. Species identified as having cultural, economic or recreational significance are also considered under this category
- Significant weed species are those listed under the national weeds strategy, regional pest management plan or declared by the state that is under the Queensland *Land Protection (Pest and Stock Route Management) Act 2002*.

Species recognised as of international significance under the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (IUCN 2009) and under the Convention on International Trade in Endangered Species (CITES) (CITES 2009) and those listed under the DERM Back on Track framework (DERM 2009a) have also been recognised.

All other native flora species are designated as common.

8.2.2 Desktop review

A review of current literature and government agency databases was undertaken for the wider study area to identify the key flora and fauna values known or likely to occur within or adjacent to the LNG facility site. Literature reviewed is referenced in the technical report (Volume 5 Attachment 16, Section 2.1.3) and included:

- The Australian Government Department of the Environment, Water, Heritage and the Arts (DEWHA) protected matters search tool
- The Queensland Herbarium flora collection records (HERBRECS)
- The Queensland Museum fauna collection records
- The Birds Australia birdata database records for all of Curtis Island

- The DERM wildlife online database
- The DERM RE and regrowth vegetation mapping and current satellite imagery
- The directory of important wetlands database
- The DERM essential habitat and environmentally sensitive area mapping
- The DERM biodiversity planning assessment and associated expert panel reports
- Non-statutory conservation agreements and action plans
- Regional and local plans and planning schemes
- Previous studies of the wider study area.

It is recognised the information gained from these databases has caveats attached to it regarding the robustness or completeness of the information. HERBRECS data is based almost exclusively on plant specimens actually recorded as recent in the given locations. The absence of any specimen record for a particular species from an area does not imply that that species does not occur in the area. Data from the protected matters search tool is based on a combination of actual records, primarily from State Government databases, combined with modelled distributions of species according to their ecological characteristics.

8.2.3 Field survey

The field survey was undertaken in accordance with current methodology (refer to Volume 5 Attachment 16, Section 2.1 for information) used by government agencies over seven days from 14 to 17 April 2009 and from 7 to 9 October 2009 and included:

- Ground-truthing vegetation communities/REs on site. A total of 29 sites were surveyed (Figure 8.1) including a minimum of one site per RE type and several sites in the same RE type where local variation was observed. Data collected included confirmation of mapped RE, general description of vegetation, structural and groundcover characteristics, dominant species for each stratum, all woody flora species and their average height and abundance, patch size and shape, overall condition/integrity, extent and distribution of weeds and other disturbance and landscape, soil and geological characteristics (detailed survey data including flora species lists for each site are provided in Volume 5 Attachment 16, Appendix C)
- Targeted searches for threatened flora species identified by the desktop review from the wider study area at vegetation survey sites shown in Figure 8.1. Searches were made over an area of 200 – 300m^2 surrounding each vegetation survey site. Detailed information on vegetation at these sites is provided in the technical report (Volume 5 Attachment 16, Appendix C)
- Targeted habitat assessments (across one hectare plots) of selected sites. A total of 21 sites were visited and assessed within the LNG facility site with the primary aim to assess the presence of suitable habitat for significant fauna species and the likely presence of significant fauna species. Likelihood of occurrence considered habitat types and features, habitat integrity, habitat connectivity and the significance of habitats. Active searches for fauna species and signs of fauna activity were undertaken at each assessment location.

The location of field survey sites were largely based on existing RE mapping. GPS coordinates were taken using hand held GPS (accuracy +/- 10m) to assist in validating the existing DERM vegetation mapping and photographs of vegetation communities/habitat areas traversed.

For the purposes of this assessment, comprehensive flora and fauna species lists and detailed abundance data was not collected or considered necessary to the assessment of the potential impacts of the Project on flora and vegetation values of the LNG facility site. A list of dominant flora species in each strata was however, collected at each vegetation survey site and a list of fauna species observed during the field assessments was compiled (refer to Volume 5 Attachment 16 Appendix C Appendix D and Appendix I).

8.2.4 Interpretation and documentation

Using information gathered from ground-truthing surveys, habitat assessment and field observation data, the likelihood of potential habitat for EVR flora and fauna species occurring within the LNG facility site was determined. Likely impacts on those EVR species for which potential habitat was found to be present were analysed based on the known ecology of each species.

8.3 Existing environment

8.3.1 Bioregional context

The LNG facility lies wholly within the Curtis Island catchment in the Burnett-Curtis Hills and Ranges subregion which forms part of the SEQ bioregion. The Burnett-Curtis Hills and Ranges subregion is geologically and floristically diverse with granite hills and range to the east and low rolling hills on old sedimentary rocks to the west. Major vegetation types of this region include narrow-leaved red ironbark (*Eucalyptus crebra*) and lemon-scented/spotted gum (*Corymbia citriodora*) woodlands, eucalypt mixed open forests and araucarian microphyll rainforests.

8.3.2 Environmentally sensitive areas

The LNG facility site does not transect or lie adjacent to any National or Conservation Park, State Forest or Timber Reserve, nature refuges, critical habitat areas or Ramsar listed wetlands of international significance.

The LNG facility site lies wholly within the Great Barrier Reef World Heritage Area and the intertidal area in the central and western portions of the site form part of the Port Curtis Marine Park and wetland area. The Port Curtis wetland area is listed under the directory of important wetlands (Blackman et al. 1999) and is recognised for it diverse, structured mangrove communities, seagrass populations and importance as wader bird habitat (Figure 8.2). This area also contains marine plant populations afforded protection under the Queensland *Fisheries Act 1994* and further discussed in Volume 4 Chapter 10.

The biodiversity planning assessment has identified special biodiversity values on site including wildlife refuges and vegetation with distinct species composition associated with geomorphology and other environmental variables and essential habitat for the koala (*Phascolarctos cinereus*) although there are no historical records for koalas for the site (Figure 8.4).

Figure 8.2 Dense mangrove communities from North Passage Island (left) and part of the Port Curtis wetland area, whilst the broad mudflats in the central portion of the LNG facility site (right) provide habitat for wader birds

8.3.3 Flora

Species diversity

The LNG facility site is well vegetated with 121 flora species recorded within the site during the field survey across 51 families and 100 genera. A full list of species identified on site is provided in the technical report (Volume 5 Attachment 16, Appendix D). Of these, one, the banana orchid (*Cymbidium canaliculatum*) is listed under Appendix II of CITES. Taxonomic nomenclature used in this assessment included the Census of Queensland Flora 2007 (Bostock and Holland 2007) and superseded changes in the Queensland Herbarium Achievements 2007-2008 (EPA 2008a).

Some of the diverse flora species of the LNG facility site are shown in Figure 8.3.

Figure 8.3 The yellow mangrove (*Ceriops tagal*) (left), pink bloodwood (*Corymbia intermedia*) (centre) and purple coral pea (*Hardenbergia violacea*) (right)

Ecological/vegetation communities

The LNG facility site does not transect or lie adjacent to any threatened ecological communities listed under the EPBC Act, endangered REs or regrowth vegetation listed under the VMA or any RE with an endangered biodiversity status as recognised by the DERM. The LNG facility site is entirely covered with remnant vegetation and of the six REs present on site, two are considered of concern and four are considered least concern under the VMA and all are not considered at threshold under the regional vegetation management code (DNRW 2006). The distribution and extent of REs present on site is illustrated in Figure 8.5 and their conservation status is summarised in Table 8.1. Full

descriptions of each RE type present on site including floristic structure and composition, special habitat values and representation in protected reserves are provided in the Volume 5 Attachment 16 Appendix E.

Table 8.1 Regional ecosystems of the LNG facility site

RE code	Community description	Status[1]	
		VMA	DERM
12.3.11	Queensland blue gum, grey ironbark (*Eucalyptus siderophloia*), pink bloodwood (*Corymbia intermedia*) open forest on alluvial plains	OC	OC
12.11.14	Narrow-leaved red ironbark, Queensland blue gum woodland on metamorphics +/- interbedded volcanics	OC	OC
12.1.2	Saltpan vegetation including grassland, herbland and sedgeland on marine clay plains	LC	NC
12.1.3	Mangrove shrubland to low closed forest on marine clay plains and estuaries	LC	NC
12.3.7	Queensland blue gum, pendulous paperbark (*Melaleuca fluviatilis*) fringing forest	LC	NC
12.11.6	Lemon-scented/spotted gum, narrow-leaved red ironbark open forest on metamorphics +/- interbedded volcanics	LC	NC

[1] Status: VMA = vegetation management status, DERM = biodiversity status, OC = of concern, LC = least concern, NC = no concern at present

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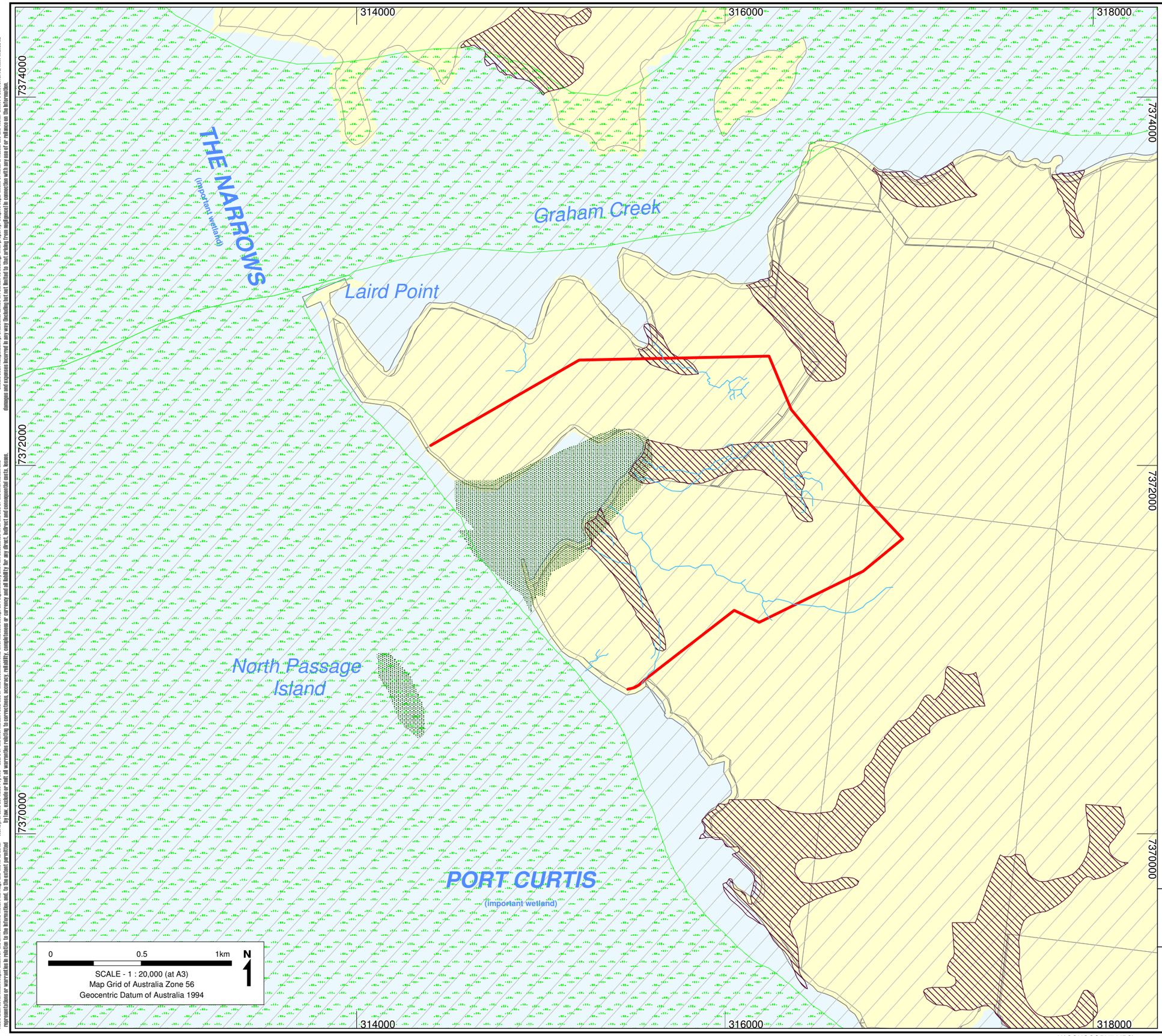

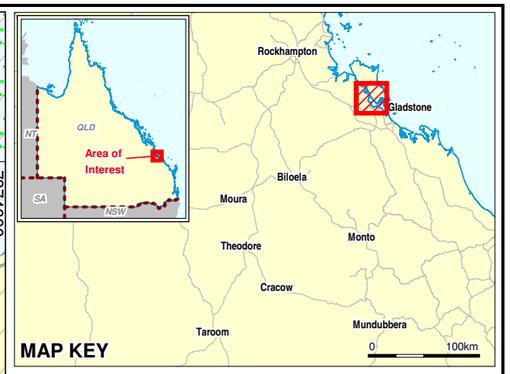

LEGEND

Drainage line
Road
Cadastral parcel

Environmentally Sensitive Areas

- **Directory of important wetlands**
- **Marine plants**
- **Marine parks and world heritage area - Great Barrier Reef**
- **LNG facility site**
- **Essential habitats**

Source Information

Cadastre and easements
Department of Natural Resources and Water, Queensland 2009

Drainage line
Determined by WorleyParsons November 2009

World Heritage Areas (Australia)
Australian Government Department of the Environment, Water, Heritage and the Arts 2009

State Marine Parks (QLD)
Environmental Protection Agency 2009

Wetlands - Directory of Important
Department of Environment and Resource Management (DERM) 2009

Essential Habitats (v3.0)
Department of Environment and Resource Management (DERM) 2009

Marine Plants
Determined by WorleyParsons October 2009

AUSTRALIA PACIFIC LNG PROJECT

Volume 4 Chapter 8
Figure 8.4 Environmentally Sensitive Areas

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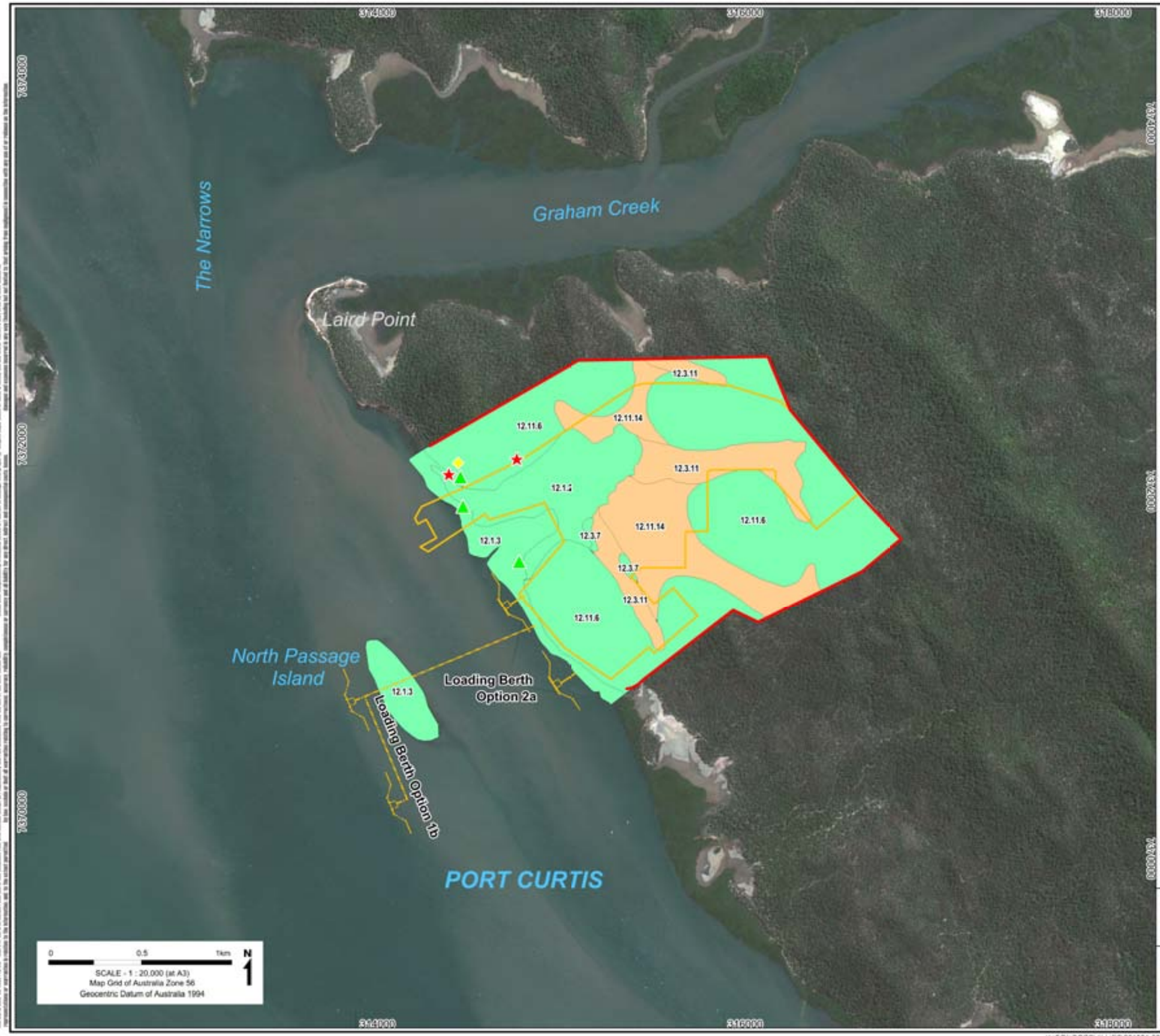

LEGEND

- Loading berth option 1b
- Loading berth option 2a
- LNG facility development footprint
- LNG facility study area

Significant weed species

- Rubber vine
- Lantana
- Prickly pear

Ground-truthed regional ecosystems

Remnant endangered regional ecosystem

- Dominant
- Sub-dominant

Remnant of concern regional ecosystem

- Dominant
- Sub-dominant
- Least concern regional ecosystem

Source Information

Ground-truthed regional ecosystems
Determined by WorleyParsons 2009

Regional ecosystems mapping (version 6) and RE descriptions (version 6.0b)
Department of Environment and Resource Management (DERM) 2009

Proposed marine structures
Extracted from Secrite CAD drawings supplied by client on 18/05/2009 and 11/09/2009

Development footprint
25509-100-P1-000-10005.dgn supplied by client 24/07/2009

Satellite Imagery
Captured by GeoEye-1 on 24 March 2009

AUSTRALIA PACIFIC LNG PROJECT

Volume 4 Chapter 8
Figure 8.5 - Ground-truthed Regional Ecosystems and Signifcant Weed Species

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Of concern regional ecosystems listed under the VMA

The LNG facility site contains approximately 73.4ha of concern RE including 28.5ha of RE 12.3.11 and 44.9ha of RE 12.11.14, which represents 2.4% and 1.0% of the total extent of these REs in the subregion, respectively (Table 8.2). Of concern REs are present in association with alluvial deposits along creeklines and on floodplains (RE 12.3.11) and foot slopes of metamorphic hills (RE 12.11.14) on site and are generally in good condition with disturbance limited to historical fires, grazing, erosion and disused vehicle tracks.

These communities are characterised by large, tall canopy trees and a shrubby understorey in places with a dense covering of native grasses and herbaceous species and small infestations of environmental weeds including balloon cotton (*Gomphocarpus physocarpus*) and flannel weed (*Sida cordifolia*) were also present (Figure 8.6).

Table 8.2 Regional ecosystem extent on site and representation in the greater area

RE code	Short description	Extent of RE on site (ha)	Extent represented in[1]		
			Catchment (%)	Subregion (%)	Bioregion (%)
Of concern REs					
12.3.11	Blue gum-ironbark forest	28.5	3.3	2.4	0.1
12.11.14	Ironbark-blue gum woodland	44.9	0.3	1.0	0.2
Least concern REs					
12.1.2	Saltpan vegetation	34.1	0.4	0.2	0.1
12.1.3	Mangrove shrubland	30.1	0.5	0.2	0.1
12.3.7	Blue gum-paperbark forest	1.4	0.1	0.01	<0.01
12.11.6	Spotted gum-ironbark forest	169.3	0.6	0.1	0.1

[1] Wider study area = 10 km buffer radius from LNG facility site, subregion = Burnett-Curtis Hills and Ranges. Subregion and bioregional extents are based on ground-truthed RE data for the LNG facility site and RE extents for the catchment, subregion and Queensland are derived from Accad et al. (2008).

Figure 8.6 Ironbark – blue gum open forests and woodlands vegetated valleys on undulating terrain (RE 12.11.14) (left) and adjacent alluvial floodplains (RE 12.3.11) (right) throughout the LNG facility site

Least concern regional ecosystems listed under the VMA

The LNG facility site contains 234.9ha least concern remnant vegetation including 169.3ha of spotted-gum ironbark forests on metamorphic hills (RE 12.11.6), 34.1ha of saltpan vegetation on mudflats (RE 12.1.2), 30.1ha of mangrove shrublands on mudflats (RE 12.1.3) and 1.4ha of paperbark forest fringing swamp (RE 12.3.7) (Figure 8.7 and Figure 8.8). This vegetation represents less than 0.3% of the total subregional extent for each of these four least concern REs (Table 8.2).

These communities range from very good condition in the east with little disturbance and weed infestations to good to average condition through the central and western portions of the site where disturbance including: grazing, erosion, fencing, historical logging and fires. Weed infestations were also more apparent in these communities including prickly pear (*Opuntia stricta*), rubber vine (*Cryptostegia grandiflora*) and lantana (*Lantana camara*) and particularly in the western portion of the Project site.

Habitat values of regional ecosystems on site

Mangrove shrublands (RE 12.1.3) and saltpan vegetation (RE 12.1.2) are recognised for their habitat value to the vulnerable false water-rat (*Xeromys myoides*) whilst blue gum-ironbark forests (RE 12.3.11) may provide habitat value for the vulnerable black-breasted button quail (*Turnix melanogaster*). Spotted gum-ironbark forests (RE 12.11.6) which dominate the project site may also provide habitat value to the vulnerable large-fruited zamia palm (*Cycas megacarpa*). Further information of REs present on site is provided in Volume 5, Attachment16, Appendix E and vulnerable species habitat in this section and Section 8.3.4.

Extent of regional ecosystems in protected and managed areas in Queensland

Regional ecosystems on site are represented in protected areas (i.e. conservation parks, national parks, coordinated conservation areas and resource reserves as defined under the NC Act) and range from poorly represented (REs 12.3.7, 12.3.11 and 12.11.14) to moderately or well represented (REs 12.1.2, 12.1.3 and 12.11.6) (EPA 2007). The extent of each of these REs represented in protected and managed areas such as state forests and forest and timber reserves at the bioregional and catchment level are provided in Table 8.3.

Figure 8.7 Marine clay mudflats (RE 12.1.2) in the central portion of the LNG facility site (left) are largely devoid of vegetation whilst mangrove shrublands (RE 12.1.3) line the western coastline of Curtis Island (right)

Figure 8.8 Spotted gum – ironbark open forests (RE 12.11.6) dominate the low metamorphic rises (left) and a small paperbark swamp (RE 12.3.7) was recorded in the south-central portion of the LNG facility site (right)

Table 8.3 Total area of REs in protected and managed areas in Queensland

RE code	Protected areas[1] (ha)		Managed areas[1] (ha)	
	Bioregion	Catchment	Bioregion	Catchment
12.1.2	5085	2845	345	48
12.1.3	6522	156	316	34
12.3.7	2237	324	7957	701
12.3.11	1971	234	14,814	221
12.11.6	18,985	3184	60,282	138
12.11.14	1587	138	6614	550

[1] Extent of representation at the bioregional (south-east Queensland) and catchment (Curtis Island) level is based on RE extents outlined in Accad et al. (2008). Protected areas refers to conservation and national parks, resource reserves and coordinated conservation areas whilst managed areas refers to state forests and forest and timber reserves.

Wetlands and waterways

Mudflats and beaches of the LNG facility site are mapped as part of state and local government wetland areas (Figure 8.4). Mudflats in the central portion of the site are largely devoid of vegetation with isolated clumps of mangrove and forb species including yellow mangrove, beaded glasswort (*Sarcocornia quinqueflora* ssp. *quinqueflora*), sea purslane (*Sesuvium portulacastrum*) and seablite (*Suaeda australis*). Salt couch (*Sporobolus virginicus*) and prickly couch (*Zoysia macrantha*) are also present forming dense groundcover along the boundary of this mudflat area.

Beaches and mudflats along the western coastline are well vegetated with dense mangrove populations including yellow mangrove, eastern white mangrove (*Avicennia marina* ssp. *australasica*), large-leaved orange mangrove (*Bruguiera gymnorhiza*) and long-styled stilt mangrove (*Rhizophora stylosa*). Isolated tuckeroo (*Cupaniopsis anacardioides*) trees are also present in this area.

Wetlands of the LNG facility site are in good condition with some evidence of disturbance including grazing and litter. Large weed infestations of prickly pear are present on the beach berms.

Several ephemeral drainage lines transect the LNG facility site and drain into the mudflats in the central portion of the site. Isolated pooling water was observed at the time of survey however, vegetation present is not restricted to an aquatic environment suggesting these areas experience little flow.

Endangered vulnerable and rare flora species

Nine flora species listed under the EPBC Act and/or NC Act were identified by database searches from the wider study area (10km radius of LNG facility site) including two species listed under the EPBC Act, two species listed under the NC Act and five species listed under both (Table 8.4). Two of these species are also listed under the DERM Back on Track program including the large-fruited zamia palm (*Cycas megacarpa*) and wedge-leaf tuckeroo (*Cupaniopsis shirleyana*) with the large-fruited zamia palm also considered of international significance with a critical rating under the IUCN and near threatened listing under Appendix II of CITES.

The current known distribution and preferred habitats of these species are provided in the technical report (Volume 5 Attachment 16, Section 3.2.3). Based on the habitat preference, the LNG facility site is expected to support suitable habitat for two of these species (Table 8.5). However, no threatened

flora species were recorded on site during the field survey and there are no historical threatened species records for the LNG facility site, suggesting it is unlikely for these species to occur on site.

Table 8.4 Scheduled flora species known or likely to occur in the wider study area

Family name	Botanical name*	Common name	Status**		
			INT	CTH	QLD
Cycadaceae	*Cycas megacarpa*[1]	Large-fruited zamia palm	E, II	E	E^{CR}
Sapindaceae	*Cupaniopsis shirleyana*[1, 3]	Wedge-leaf tuckeroo	II	V	V^{H}
Apocynaceae	*Parsonsia larcomensis*[1, 2, 3]	Mount Larcom monkey rope		V	V
Simaroubaceae	*Quassia bidwillii*[1, 3]	Quassia		V	V
Orchidaceae	*Bulbophyllum glomuliforme*[1]	Miniature moss-orchid		V	R
Orchidaceae	*Taeniophyllum muelleri*[1]	Minute orchid		V	
Rutaceae	*Bosistoa transversa*[1, 2, 3]	Three-leaved bosistoa		V	
Phyllanthaceae	*Actephila sessilifolia*[3]	Sessile-leaved actephila			R
Hernandiaceae	*Hernandia bivalvis*[3]	Grease nut			R

*Source: 1 = DEWHA protected matters search tool, 2 = Qld Herbarium HERBRECS flora collection records, 3 = DERM wildlife online database. **Status: INT = IUCN and/or CITES, CTH = EPBC Act, QLD = NC Act, II = appendix II, E = endangered, V = vulnerable, r = Rare. Superscript refers to species listed under the DERM Back on Track program: CR = critical, H = high.

Table 8.5 Scheduled flora species with potential to occur within LNG facility site

Species name	Preferred habitat
Cycas megacarpa large-fruited zamia palm	Spotted gum-ironbark woodlands and open woodlands on rocky substrates and at 40 to 680 m altitude in the Bouldercombe-Woolooga of SE-C QLD (Botanic Gardens Trust 2008).
Quassia bidwillii quassia	Lowland rainforests or rainforest margins and occasionally open forests, woodlands and mangroves in a broad range of soil types to 617m altitude in coastal regions (Department of Natural Resources (DNR) 1999).

Regionally significant species

Eight regionally significant flora species were identified by database searches from the wider study area and are summarised in Table 8.6. Of these, one species, Miquel's zamia palm (*Macrozamia miquelii*) is also recognised as internationally significant and is listed under the IUCN as lower risk (near threatened) and under Appendix II of the CITES.

The extent of distribution and habitat preferences of regionally significant flora species are provided in the technical report (Volume 5 Attachment 16, Table 3.6) and based on this information, the LNG facility site is expected to support suitable habitat for one of these species, the wanderrie grass. Wanderrie grass (*Eriachne rara*) inhabit open eucalypt woodlands and forests (Lazarides 1995) and could potentially utilise the entire LNG facility site excluding intertidal and tidal reach areas, although no regionally significant flora species were recorded in the LNG facility site during the field survey and there are no historical records for these species on site, suggesting it is unlikely for any of these species to occur within the LNG facility site.

Table 8.6 Regionally significant flora species identified by database searches from the wider study area

Family name	Botanical name*	Common name	Status**
Apocynaceae	*Parsonsia paulforsteri* [3]	Narrow-leaved silkpod	1K[a]
Picrodendraceae	*Dissiliaria muelleri* [3]	Mueller's redheart	NPT-R[b]
Rutaceae	*Bosistoa medicinalis* [3]	Eumundi bosistoa	RPC[c]
Rutaceae	*Dinosperma melanophloia* [3]	Black-barked doughwood	RPC[c]
Poaceae	*Eriachne rara* [2, 3]	Wanderrie grass	RPC[c]
Euphorbiaceae	*Croton stigmatosus* [3]	White croton	RWC[c]
Apocynaceae	*Parsonsia ventricosa* [3]	Acuminate silkpod	RWC[c]
Zamiaceae	*Macrozamia miquelii*[3]	Miquel's zamia palm	RWC[c #]

*Source: 2 = Qld Herbarium HERBECS flora collection records, 3 = DERM wildlife online database**Status: a = CSIRO ROTAP list (Briggs and Leigh 1995), b = DERM SEQ north expert panel report (EPA 2006a), c = vine forest plant atlas of SEQ (Forster et al. 1991); 1K = poorly known species known from the type collection only, 3RC- = rare species with geographical range more than 100 km and conserved with less than 1000 individuals protected in conservation reserves, 3R = rare species with geographical range more than 100 km, NPT-R = regionally significant non-EVR priority taxa, RPC = rare, poorly conserved, RWC = rare well conserved. #Species is listed under the IUCN as lower risk (near threatened) and under the CITES as near threatened.

Species of other conservation significance

Plants of cultural significance

Several plant species recorded on the LNG facility site were traditionally used by the Indigenous people of Curtis Island for food, dye, medicine, timber and tools including: mangroves, wattles, grasstrees, quinine bushes and eucalypts (Figure 8.9). A full list of these species and their uses is provided in the technical report (Volume 5 Attachment 16 Section 3.2.5). These species were found throughout the LNG facility site in varying densities.

Figure 8.9 The roots of the medicine bush (*Pogonolobus reticulatus*) are used by the Indigenous people for yellow dye (left) whilst the lemon-scented/spotted gum was sourced for tools and timber (centre). The prickly pear (*Opuntia stricta*) was observed in flower (right) in the western portion of the LNG facility site

Plants of commercial significance

The dominant canopy species recorded on the LNG facility site are considered potential commercial resources including: pink bloodwood, lemon-scented/spotted gum (Figure 8.9), narrow-leaved red

ironbark and Queensland blue gum. The Burdekin plum (*Pleiogynium timorense*) is also considered a potential commercial resource. These species may be useful resources in engineering for poles, railway sleepers and mining timbers and in construction for fencing, house frames and flooring as well as other uses including hardwood manufacture.

Plants of recreational significance

The LNG facility site may hold recreational value through fishing and boating. Mangrove shrublands along the western coastline provide shelter and breeding grounds for fish species and associated mudflats and beaches provide an opportunity to observe wader bird species in their natural habitat whilst the offshore areas provide safe mooring areas for small boats during bad weather. Laird Point, located north of the LNG facility site is expected to also provide some camping value.

Significant weed species

Seven significant weed species were identified from database searches and predictive pest mapping as potentially occurring on the LNG facility site and are listed in

Table 8.7. Of these species, three were recorded on site during the field survey including rubber vine (*Cryptostegia grandiflora*) and lantana (*Lantana camara*) in the north-western portion of the site. Prickly pear (*Opuntia stricta*) (Figure 8.9) was observed throughout the LNG facility site but mostly as isolated, juvenile individuals with one large infestation recorded in association with the mangrove shrublands along beaches on the western boundary of the site (Figure 8.5).

Table 8.7 Significant weed species potentially occurring within the LNG facility site

Common name	Botanical name	Status[1]	
		CTH	QLD
Rubber vine[2]	*Cryptostegia grandiflora*	WONS	2
Lantana[2]	*Lantana camara*	WONS	3
Groundsel[2]	*Baccharis halimifolia*		2
Prickly pear	*Opuntia stricta*		2
Creeping lantana[2]	*Lantana montevidensis*		3
Broad-leaved pepper tree	*Schinus terebinthifolius*		3
Singapore daisy	*Sphagneticola trilobata*		3

[1] Status: CTH = Australian weeds strategy (Natural Resource Management Ministerial Council (NRMMC) 2006), QLD = *Land Protection (Pest and Stock Route Management) Act 2002,* WONS = weeds of national significance, 2 = class 2 declared plant, 3 = class 3 declared plant.

[2] High priority weed species identified under the regional pest management strategy (Capricorn Pest Management Group (CPMG) 2004).

8.3.4 Fauna

Nomenclature used in this fauna assessment follows the Australian Faunal Directory (DEWHA 2009a). A review of fauna databases and recently published surveys identified a large number of fauna species recorded from, or are expected to potentially utilise habitat, within the wider area. A total of 441 fauna species were identified including: 20 insect, 26 fish, 25 amphibian, 66 reptile, 245 bird and 59 mammal species.

Endangered vulnerable rare fauna species

Database searches identified 31 EVR fauna species potentially occurring within the wider study area including four reptile, 20 bird and seven mammal species. Of these, 25 species could potentially utilise habitats within the LNG facility site, based on their habitat preferences (Table 8.8).

Table 8.8 Potential EVR fauna species occurring within the LNG facility site

Common Name	Scientific Name	Status[1]			Sightings[2]
		CTH	QLD	DERM	
Reptiles					
Ornamental snake	*Densonia maculata*	V	V		
Yakka skink	*Egernia rugosa*	V	V		
Brigalow scaly-foot	*Paradelma orientalis*	V	V		
Rusty monitor	*Varanus semiremex*		R	H	
Birds					
yellow chat (dawson)	*epthianura crocea macgregori*	CE	E		
red goshawk	*erythriotriorchis radiatus*	V	E	H	
squatter pigeon	*geophaps scripta scripta*	V	V		
kermadec petrel	*pterodroma neglecta neglecta*	V			
Little tern	*Sternula albifrons*		E	H	
Glossy black cockatoo	*Calyptorhynchis lathami*		V	H	Curtis Is
Beach stone-curlew	*Esacus magnirostris*		V	H	Site
Powerful owl	*Ninox strenua*		V		Curtis Is
Black-necked stork	*Ephippiorhynchus asiaticus*		R		
Sooty oystercatcher	*Haematopus fuliginosus*		R		Curtis Is
Australian cotton pygmy-goose	*Nettapus coromandelianus albipennis*		R		
Eastern curlew	*Numenius madagascariensis*		R		Site
Square-tailed kite	*Lophoictinia isura*		R		
Mammals					
Northern quoll	*Dasyurus hacculatus*	E			
False water-rat	*Xeromys myoides*	V	V	H	
Large-eared pied bat	*Chalinolobus dwyeri*	V	V		
Grey-headed flying-fox	*Pteropus poliocephalus*	V		CR	
Koala (seq)	*Phascolarcos cinereus*		V	H	

Common Name	Scientific Name	Status[1]			Sightings[2]
		CTH	QLD	DERM	
Coastal sheathtail bat	*Taphozous australis*		V	H	
Little pied bat	*Chalinolobus picatus*		R		
Black flying-fox	*Pteropus alecto*		V		

[1] Status: CTH = EPBC Act, QLD = NC Act, DERM = DERM Back on Track program, CE = critically endangered, E = endangered, V = vulnerable, R = rare, CR = critical, H = high.

[2] Sightings: Curtis Is = recorded by recent studies in the Curtis Island Industry Precinct, Site = recorded within the Project area during the WorleyParsons field surveys 2009.

Regionally significant fauna species

Forty-nine regionally significant fauna were identified through desktop review including three fish, nine frogs, 13 birds, 11 reptiles and 13 mammals including the yellow-bellied glider (*Petaurus australis australis*) identified as a Back on Track species. The yellow-bellied glider is listed as high under the DERM Back on Track program. Based on the habitat preference of these species, the LNG facility site is expected to provide suitable habitat for 43 of the identified species (Table 8.9).

Table 8.9 Potential regionally significant fauna species occurring within the LNG facility site

Common Name	Scientific Name	Sightings[1]
Frogs		
Salmon striped frog	*Limnodynastes salmini*	
Bleating treefrog	*Litoria dentata*	
Copper backed broodfrog	*Pseudophryne raveni*	
Desert froglet	*Crinia deserticola*	Curtis Is
Short-footed frog	*Cyclorana brevipes*	
Peter's frog	*Litoria inermis*	Curtis Is
Pearson's green tree frog	*Litoria peronii*	Curtis Is
Roth's tree frog	*Litoria rothii*	Curtis Is
Reptiles		
Cone-eared calyptotis	*Calyptotis lepidorostrum*	
Open-litter rainbow skink	*Carlia pectoralis*	Curtis Is
Frilled lizard	*Chlamydosaurus kingii*	Curtis Is
Tommy round-head	*Diporiphora australis*	Curtis Is
Broad-banded sand-swimmer	*Eremiascincus richardsonii*	Curtis Is
Fine-spotted mulch-skink	*Glaphyromorphus punctulatu*	
Common dwarf skink	*Menetia greyii*	Curtis Is
Dwarf litter-skink	*Menetia timlowi*	Curtis Is

Common Name	Scientific Name	Sightings[1]
North-eastern firetail skink	*Morethia taeniopleura*	
Black-striped snake	*Rhinoplocephalus nigrostriatus*	
Birds		
Red-backed button-quail	*Turnix maculosus*	Curtis Is
Australian bustard	*Ardeotis australis*	
Bush stone-curlew	*Burhinus grallarius*	Curtis Is
Barking owl	*Ninox connivens*	Site
Grey-crowned babbler	*Pomatostomus temporalis*	
Black-faced woodswallow	*Artamus cinereus*	
Large-tailed nightjar	*Caprimulgus macrurus*	
Olive-backed sunbird	*Nectarinia jugularis*	Curtis Is
Blue-winged kookaburra	*Dacelo leachii*	Curtis Is
Fairy gerygone	*Gerygone palpebrosa*	
Shining flycatcher	*Myiagra alecto*	Curtis Is
Dusky honeyeater	*Myzomela obscura*	
Rose-crowned fruit-dove	*Ptilinopus regina*	Curtis Is
Mammals		
Squirrel glider	*Petaurus norfolcensis*	Curtis Is
Greater broad-nosed bat	*Scoteanax rueppellii*	Curtis Is
East coast freetail bat	*Mormopterus norfolkensis*	
Rufous bettong	*Aepyprymnus rufescens*	
Black-striped wallaby	*Macropus dorsalis*	
Greater glider	*Petauroides volans*	
Yellow-bellied glider (sthn subsp.)	*Petaurus australis australis*	
Eastern chestnut mouse	*Pseudomys gracilicaudatus*	
Little red flying-fox	*Pteropus scapulatus*	
South-eastern broad-nosed bat	*Scotorepens orion*	
Common dunnart	*Sminthopsis murina*	
Little forest bat	*Vespadelus vulturnus*	

[1] Sightings: Curtis Is = recorded by recent studies in the Curtis Island Industry Precinct, Site = recorded within the Project area during the WorleyParsons field surveys 2009.

Migratory species

Fifty-two migratory species were identified through desktop review of the wider study area (Table 8.10). Based on their habitat preference, 39 of these species potentially utilise habitat within the Project area.

Table 8.10 Potential migratory birds occurring within the LNG facility site

Common Name	Scientific Name	Sightings[1]
Cattle egret	*Ardea ibis*	
Common sandpiper	*Actitis hypoleucos*	
Fork-tailed swift	*Apus pacificus*	
Eastern great egret	*Ardea modesta*	Curtis Is
Ruddy turnstone	*Arenaria interpres*	
Sharp-tailed sandpiper	*Calidris acuminata*	
Sanderling	*Calidris alba*	
Red knot	*Calidris canutus*	
Curlew sandpiper	*Calidris ferruginea*	
Pectoral sandpiper	*Calidris melanotos*	
Red-necked stint	*Calidris ruficollis*	Curtis Is
Long-toed stint	*Calidris subminuta*	
Great knot	*Calidris tenuirostris*	
Double-banded plover	*Charadrius bicinctus*	
Little ringed plover	*Charadrius dubius*	
Greater sand plover	*Charadrius leschenaultii*	
Lesser sand plover	*Charadrius mongolus*	
Oriental cuckoo	*Cuculus saturatus*	
Eastern reef egret	*Egretta sacra*	Site
Latham's snipe	*Gallinago hardwickii*	
Swinhoe's snipe	*Gallinago megala*	
Pin-tailed snipe	*Gallinago stenura*	
Oriental pratincole	*Glareola maldivarum*	
White-bellied sea-eagle	*Haliaeetus leucogaster*	Site
Grey-tailed tattler	*Heteroscelus brevipes*	Curtis Is
Wandering tattler	*Heteroscelus incanus*	

Common Name	Scientific Name	Sightings[1]
White-throated needletail	*Hirundapus caudacutus*	Curtis Is
Barn swallow	*Hirundo rustica*	
Broad-billed sandpiper	*Limicola falcinellus*	
Asian dowitcher	*Limnodromus semipalmatus*	
Bar-tailed godwit	*Limosa lapponica*	Curtis Is
Black-tailed godwit	*Limosa limosa*	
Rainbow bee-eater	*Merops ornatus*	Site
Black-faced monarch	*Monarcha melanopsis*	Curtis Is
Spectacled monarch	*Monarcha trivirgatus*	Curtis Is
Satin flycatcher	*Myiagra cyanoleuca*	Curtis Is
Little curlew	*Numenius minutus*	
Whimbrel	*Numenius phaeopus*	Site
Eastern osprey	*Pandion cristatus*	Site
Red-necked phalarope	*Phalaropus lobatus*	
Ruff	*Philomachus pugnax*	
Pacific golden plover	*Pluvialis fulva*	Site
Grey plover	*Pluvialis squatarola*	
Rufous fantail	*Rhipidura rufifrons*	Curtis Is
Caspian tern	*Hydroprogne caspia*	Site
Common tern	*Sterna hirundo*	Curtis Is
Brown booby	*Sula leucogaster*	
Wood sandpiper	*Tringa glareola*	
Common greenshank	*Tringa nebularia*	Curtis Is
Marsh sandpiper	*Tringa stagnatilis*	
Common redshank	*Tringa totanus*	
Terek sandpiper	*Xenus cinereus*	

[1] Sightings: Curtis Is = recorded by recent studies in the Curtis Island Industry Precinct, Site = recorded within the Project area during the WorleyParsons field surveys 2009.

Common fauna species

All habitats (even cleared and degraded land), provide habitat for a range of common native fauna species. Remnant vegetation provides higher habitat values and thus will have a larger range of more common and abundant species. The desktop study and field survey indicate the LNG facility site is

potentially utilised by a large number of common fauna species. A total of 256 common native fauna species were identified as potentially present by the database searches. These comprised of 20 insect, 15 amphibian, 21 fish, 51 reptile, 121 bird and 28 mammal species. The complete list of common fauna species can be found in the technical report (Volume 5 Attachment 16).

Introduced fauna species

Sixteen introduced species have been recorded within the wider study area, including two fish, one amphibian, three bird and 10 mammal species (Table 8.11).

Table 8.11 Potential introduced fauna occurring within the LNG facility site

Common Name	Scientific Name	Declared	Sightings[1]
Cane toad	*Rhinella marina*		Site
Rock dove	*Columba livia*		
House sparrow	*Passer domesticus*		
Spotted dove	*Streptopelia chinensis*		Curtis Is
Mosquito fish	*Gambusia holbrooki*		Curtis Is
Guppy	*Poecilia reticulata*		
European cattle	*Bos taurus*		Site
Dog	*Canis lupus familiaris*	Class 2*	Curtis Is
Horse	*Equus caballus*		Site
Cat	*Felis catus*	Class 2	
Brown hare	*Lepus capensis*		
House mouse	*Mus musculus*		
Rabbit	*Oryctolagus cuniculus*		
Black rat	*Rattus rattus*	Class 2	
Pig	*Sus scrofa*	Class 3	Curtis Is
Red fox	*Vulpes vulpes*	Class 2	

[1] Sightings: Curtis Is = recorded by recent studies in the Curtis Island Industry Precinct, Site = recorded within the Project area during the WorleyParsons field surveys 2009. *other than domestic dog

Fauna habitats

The environment within the LNG facility site was accessed and categorised into broad fauna habitat types. Seven different faunal habitats were identified within the LNG facility site (Table 8.12).

Table 8.12 Faunal habitats within the LNG facility site

Faunal habitat	Description
Eucalypt woodland	The lowland contains a dense grass understorey with a significant quantity of logs and tree branches. The hilltops and ridges provide areas of acacia thicket understorey, minor quantities of ground cover with significant quantities of logs, tree branches, leaf litter and

Faunal habitat	Description
	surface rocks.
Paperbark wetland	Paperbark wetland community boarders the southern side of the saltpans, with a small paperbark swamp approximately 100m south of the saltpan.
Saltpans	This habitat occurs on the large bay behind the mangrove community and includes the transitional zone from saltpan to the woodland areas.
Mangroves	Mangrove communities exist along the majority of the foreshore. They are approximately 30 to 40m wide along the foreshore and partially extend into the saltpan.
Beach / Foreshore	The Project area contains a small section of sandy beach associated with the sand bar behind the mangroves at the front of the Saltpan. The remainder of the foreshore is predominantly rocky or stony.
Tidal mud flats	The exposed mudflat between the high and low tide and includes an area behind the mangrove community at the front of the saltpan.

Significant fauna species and fauna habitats

The habitats available within the LNG facility site were assessed for their potential utilisation by EVR and Back on Track fauna species (Table 8.13).

Table 8.13 Potential EVR and Back on Track fauna presence in habitats within the LNG facility site

Common name	Faunal habitat					
	Eucalypt woodland	Paperbark wetlands	Saltpan	Mangroves	Beach/ foreshore	Tidal mudflats
Ornamental snake	✓ (creeks)					
Yakka skink	✓					
Brigalow scaly-foot	✓					
Rusty monitor				✓		
Grey goshawk	✓	✓				
Glossy black-cockatoo	✓					
Black-necked stork			✓	✓		
Yellow chat (Dawson)			✓			
Red goshawk	✓	✓				
Beach stone-curlew				✓	✓	
Squatter pigeon (southern)	✓					
Sooty oystercatcher					✓	
Powerful owl	✓	✓				

Common name	Faunal habitat					
	Eucalypt woodland	Paperbark wetlands	Saltpan	Mangroves	Beach/ foreshore	Tidal mudflats
Eastern curlew				✓		✓
Little tern					✓	✓
Square-tailed kite	✓	✓				
Black-chinned honeyeater	✓					
Large-eared pied bat	✓					
Little pied bat	✓	✓	✓	✓		
Northern quoll	✓					
Koala	✓	✓				
Yellow-bellied glider	✓					
Grey-headed flying-fox	✓	✓		✓		
Coastal sheathtail bat	✓	✓	✓	✓		
False water-rat			✓	✓		
Black flying-fox	✓	✓		✓		

8.4 Potential impacts

8.4.1 Flora

The proposed site location results in minimal edge effect and fragmentation generally associated with vegetation clearing and the design of the LNG facility is based on minimising clearing of mangrove habitat on the coastal fringe of the site. Some fragmentation of intertidal vegetation communities on site may occur as a result of the Project. However, woodlands and forests on site are expected to be more robust due to their open nature and existing disturbance.

Potential impacts of the Project on the flora values of the LNG facility site are expected to include:

- Decrease in total area of remnant vegetation in the bioregion and subregion
- Disturbance and/or degradation of vegetation communities
- Loss and/or disturbance of coastal wetland areas
- Loss or harm to EVR and regionally significant flora species and populations
- Disturbance and/or degradation of EVR and regionally significant flora habitat areas
- Loss of cultural, economic and recreational values
- Introduction and/or spread of weed species.

The Project is one of many proposed or under construction in the greater Gladstone area and the cumulative impacts of these projects is expected to increase the severity and frequency of potential impacts to flora values. The cumulative impact assessment also took into account the gas field and pipeline components of the Australia Pacific LNG Project and findings are summarised in Section 8.7.

Extent of remnant vegetation and vegetation conservation status

The Project would require the clearing of remnant vegetation on site however this does not include any threatened ecological community listed under the EPBC Act, endangered RE listed under the VMA or vegetation with high biodiversity values under the biodiversity planning assessment. No high value regrowth vegetation as defined under the VMA is present on site or would be impacted upon by the Project.

Berthing Option 2a would require the clearing of 155.9ha of remnant vegetation including 50.4ha of concern RE and 105.5ha least concern RE and representing 50.6% of the total extent of remnant vegetation on site (Table 8.14). An additional 0.7ha of mangrove shrublands (RE 12.1.3) on North Passage Island would be removed as part of Option 1b, increasing the total extent of remnant vegetation to be removed on site to 50.8%.

The Project would not clear or disturb any at threshold REs and would not result in any RE falling into a higher conservation status (refer to Table 4.2 in Volume 5 Attachment 16) that is less than 10% of the remaining pre-clearing extent (endangered) or between 10 to 30% of the remaining pre-clearing extent (of concern).

Table 8.14 Proposed remnant vegetation clearing areas within the LNG facility site[1]

RE Code	Proposed clearing in Project area (ha)	Clearing extent represented in Project area (%)	Clearing extent represented in catchment (%)	Clearing extent represented in subregion (%)	Clearing extent represented in Qld (%)
Of concern REs					
12.3.11	23.9	83.9	2.8	2.0	0.1
12.11.14	26.4	58.9	0.2	0.6	0.1
Least concern REs					
12.1.2	29.5	86.7	0.3	0.2	0.1
12.1.3 (Option 2a)	1.6	5.3	0.03	0.01	<0.01
12.1.3 (Option 1b)	2.3	7.6	0.04	0.01	<0.01
12.3.7	1.3	94.2	0.1	0.01	<0.01
12.11.6	73.1	43.2	0.3	0.04	0.03
Total (Option 2a)	**155.9**	**50.6**			
Total (Option 1b)	**156.6**	**50.8**			

[1] Subregion and Qld extents are based on ground-truthed RE data for the LNG facility site and RE extents for the catchment, subregion and Queensland are derived from Accad et al. (2008).

Vegetation fragmentation and disturbance

The Project will impact upon the overall condition and integrity of vegetation communities on site through construction and operational activities. Potential impacts to vegetation on site are expected to include a loss of and/or fragmentation of vegetation communities and an increase in edge effects associated with clearing activities, changes to hydrological regimes and an increase in erosion susceptibility.

These impacts are expected to lead to the degradation of vegetation communities on site through the following and are discussed below:

- Modification of the micro-climate
- Modification of the floristic structure and composition
- Modification of fire regimes
- Modification of hydrological flows
- Dust deposition.

Modification of the micro-climate

Fragmentation and edge creation associated with clearing activities are expected to lead to changes in the micro-climate of vegetation communities on site through changes in solar penetration, humidity, air and soil temperature and soil moisture. Modification of the micro-climate can directly affect seed viability and germination as well as growth rates and fruit production of certain plant species, as well as impact upon the distribution of animal species which facilitate seed dispersal and pollination (Rowley et al. 1993). These changes are not expected to directly impact upon the growth and development of open eucalypt communities and saltpan vegetation on site, due to the resilience/hardiness of flora species present; however, mangrove shrublands along the western boundary of the site are expected to be impacted leading to loss of individual plant species (Hale and Lamb 1997).

Modification of the floristic structure and composition

Clearing and vegetation disturbance associated with the Project is expected to also provide an opportunity for fast growing, colonising species such acacias and weed species to establish in canopy gaps and along margins of vegetation, which can lead to changes in the floristic structure and composition of vegetation communities. Colonisation of these species is expected to lead to an increase in competition for resources such as light, nutrients and space and changes to the micro-climate through shading (Sindel 2000).

In the long-term, changes to the floristic structure and composition of vegetation communities can lead to loss of native biodiversity and an increase in weed infestations, loss of fauna habitat value, increase in fire fuel loads and changes in the RE classification and subsequent conservation management requirements.

Modification of fire regimes

Weed infestations and colonisation by shrubby pioneer species have the potential to increase fire fuel loads on site and vehicle exhaust. Plant equipment such as welders during construction and operational activities may also increase the risk of fire.

High fire fuel loads and the introduction of fire risks have the potential to increase the frequency and severity of fires which can significantly impact upon the floristic composition and structure of vegetation. Eucalypt forests like those present on site are adapted to periodic fires and their species richness and diversity relies on these events to germinate seeds and reduce competition. However, fire frequency can impact these communities as too frequent burns do allow plants to reach maturity and produce sufficient seed before the next burn event which can allow faster growing species to quickly colonise and can also affect biodiversity as ecosystems generally take longer to recover from hot, high fuel load fires (Department of Environment and Conservation Western Australian 2009).

Modification of hydrological regimes

Construction activities associated with the Project are expected to require diversion of drainage lines; however, given the dry conditions on site and ephemeral nature of drainage lines present, this is unlikely to significantly impact upon vegetation on site in the short-term. Long-term modification may lead to a change in floristic composition and loss of biodiversity, particularly a loss of aquatic plant species.

Intertidal areas in the central and western portions of the site support marine plant vegetation which is dependent on specific hydrological regimes. The reclamation of this area for the construction of the Project will result in a loss of marine plant vegetation directly through removal and disturbance and indirectly through changes to the hydrological regime including extent and duration of saltwater inundation and freshwater influx. Mangrove shrublands along the western boundary outside the proposed project footprint will also be impacted upon by changes to tidal flows as the extent and duration of saltwater inundation is modified (Blasco et al. 1996).

Dust deposition on vegetation

Construction and clearing activities have the potential to generate dust which can fall onto neighbouring vegetation. Dust can scour leaf surfaces, increase leaf temperature and shading and interfere with the photosynthesis processes necessary to convert sunlight into energy, leading to a decrease in plant growth (Thompson et al. 1984). Plant species with erect, hairy or shiny leaves such as mangrove species are most susceptible to dust damage whilst studies have shown species with drooping, waxy leaves such as eucalypts are unable to retain large amounts of dust and therefore are not as affected (Chaston and Doley 2006). As such, mangrove shrublands and saltpan vegetation in the intertidal areas on site may be impacted upon by dust emissions during site clearing activities.

Coastal wetlands

Berthing Option 2a would require the clearing of 29.4ha of coastal wetland vegetation in the Port Curtis wetland area and Option 1b would require an additional 0.7ha to be removed. Construction and operational activities associated with the Project have the potential to further impact on retained and adjacent coastal wetland vegetation through modification of tidal flows, increased boat traffic and boat wash, debris and dust emissions.

EVR and regionally significant flora species and their habitat areas

No EVR or regionally significant flora species were identified on site during the field survey and there are no historical flora records for these species on site, suggesting that they are unlikely to occur on site. Nevertheless, the LNG facility site may support suitable habitat for three of these species including the large-fruited zamia palm, quassia and wanderrie grass.

The national recovery plan for the large-fruited zamia palm (Queensland Herbarium 2007) identifies critical habitat areas for the long-term survival of this species. Critical habitat areas are defined as those areas where remaining populations occur and areas adjacent to these with similar soils, geology and vegetation characteristics. So whilst the project site contains suitable habitat for the large-fruited zamia palm, it is not considered critical habitat as defined by the recovery plan as no populations have been recorded on or adjacent to the site.

Quassia has a broad habitat range and could potentially utilise the entire site whilst wanderrie grass is expected to utilise the adjacent floodplains vegetated with eucalypt woodlands and paperbark swamp (Lazarides 1995; DNR 1999). Whilst these species are unlikely to be present, construction and operational activities associated with the Project have the potential to limit these species in this area through habitat loss and degradation. Clearing, modification of fire and hydrological regimes, weed and animal pest invasion have all been identified as threatening processes for these species (Volume 5 Attachment 16, Appendix F) and have the potential to impact upon these species if they are present on site.

Potential habitat areas for these species on site are not considered to form part of any critical or essential habitat area nor is the LNG facility site considered to contribute significantly to the overall available habitat and range of these species due to their absence from the island.

Cultural, economic and recreational values

The Project is expected to result in the clearing of common plant species with cultural, economic or recreational value. Potential impacts to the cultural values of vegetation on site have been discussed in Volume 4 Chapter 18. The clearing and modification of vegetation along the western boundary of the site is expected to impact upon recreation values through the loss of fish breeding grounds and safe boat mooring opportunities. Timber resources are present on site but are not currently being utilised therefore, clearing activities are not considered significant to the overall economic value of vegetation on site.

Weeds and animal pests

The introduction and/or spread of weed species could potentially be facilitated by the movement of vehicles and plant equipment on and around the LNG facilities site during construction and operational phases. Weed species and infestations have the ability to out-compete native species for resources such as light and nutrients thereby reducing biodiversity and altering hydrological and fire regimes and geomorphic processes (Sindel 2000). They may also harm native animals and humans through consumption or contact and can facilitate animal pest movement and disease spread.

Weed infestations can also harbour animal pest species. Pest animals can cause root damage by digging and lead to a loss in biodiversity by foraging on seeds and fruit. Clearing activities and weed invasion is expected to also increase exposure to stress condition such as insect attack, wind damage and fungal attack (Rowley et al. 1993).

8.4.2 Fauna

Potential impacts on fauna in general

The LNG facility site is located on the south-western end of Curtis Island, as such, it is connected to the greater Curtis Island natural areas. There are relatively few access tracks through this area, which has limited vehicular disturbance in the area. Historic grazing and the continued influence of feral

cattle and horses affect the majority of habitats within the LNG facility site, the exception being the mangrove habitat.

Despite this disturbance, there are a range of fauna species that would potentially utilise habitat within the LNG facility site including EVR, regionally significant, migratory and common fauna species.

There is currently no significant development of this section of Curtis Island. Development in this area has the potential to impact, at differing levels, on fauna species. The construction of the LNG facility would result in the direct loss of potential habitat. Common fauna species are likely to utilise similar habitat adjacent to the area impacted. Although this may temporarily increase the competition for resources in the surrounding habitats the overall area is sufficiently large that this is unlikely to have a significant long-term impact on these species.

Nevertheless, some of the potential impacts to fauna species include:

- Unearthing of burrowing fauna species during construction
- Removal of mature vegetation and hollow bearing trees
- The disturbance to North Passage Island (Option 1b)
- Edge effects associated with a development adjoining natural areas
- Potential impacts of artificial lighting
- Potential disturbance of migratory shorebird habitat.

During construction activity, many larger and more mobile species are likely to move away from the site. Smaller burrowing species are likely to remain under the surface so are at risk of being unearthed during any construction activity.

Mature vegetation generally provides a more diverse structure and therefore more habitat opportunities. Tree hollows are utilised by a range of fauna species for their shelter and nesting requirements. Tree hollows take a considerable amount of time to form within eucalypt trees, 120 to 180 years for hollows suitable for vertebrate species (Gibbons and Lindenmayer 2002). Hollow bearing trees are common within the eucalypt woodland in the LNG facility site.

Isolated island habitats such as North Passage Island provide a relative sanctuary for nesting, roosting and foraging birds. Terrestrial predators, including feral predators, are currently not likely to be able to access North Passage Island. As such, these predators do not disturb birds utilising this habitat for roosting, nesting or foraging. The marine facility considered in Option 1b effectively creates a bridge over which terrestrial fauna can access the island. The most likely terrestrial species to access the island via the considered facility would be feral species, such as rodents and possibly cats.

Edge effects include a range of indirect impacts to remnant areas adjacent to the LNG facility site. Potential edge effects associated with the proposed LNG facility at this site are expected to include an altered hydrological regime, changes in micro-climate, avoidance by wildlife, sediment runoff, increased nutrient or pollutants, increase in the potential spread of weeds, potential increased access by feral fauna species, potential alteration to the fire regime and increased disturbance due to increased human activity.

Active management of each edge effect reduces the extent to which they influence the surrounding environment. The development, implementation and monitoring of effective management plans provides the management tool to address these impacts.

Potential impacts of artificial lighting

Concern about the effects of artificial lighting on wildlife and plants has been a relatively recent phenomenon (Longcore and Rich 2007). The disorientation caused by artificial light on species such as nocturnally migrating birds or marine turtles is well known. More subtle influences of artificial night lighting on behaviour and community ecology are less well recognised (Longcore and Rich 2004). Research and anecdotal evidence indicate potential for artificial lighting to influence the behaviour of both nocturnal and diurnal species. A well-known example of this influence is that of insect attraction to artificial light sources. There are potential benefits to insectivorous species that can exploit this opportunity. The apparent benefit of an increased food supply for insectivorous species, however, has other implications. The existing assembly of species utilising habitat within the area is expected to alter, resulting in a local increase in species able to exploit this niche. The balance between the gains of this new opportunity and potential increased predation resulting from increased exposure for these species is not well understood (Longcore and Rich 2004). The potential impacts of artificial lighting on any particular species and their severity will vary depending on the ecology of the species, their predator-prey relations, the distance of the core population from the source of light and the reaction of that species to light disturbance.

Reptiles and frogs that prey on invertebrates are likely to increase foraging activity in association with increased invertebrate activity around lights. Given the current knowledge, the relationship between increased activity and increased exposure to predation cannot be accurately assessed. Artificial lighting has, however, been implicated in the decline of reptile populations (Beier et al. 2008). The mating behaviour of frogs is potentially altered by exposure to artificial lighting. Frogs have been observed to stop mating activity when exposed to artificial lighting, with mating calls resuming once the area was shielded from the light (Longcore and Rich 2004).

Small mammals have been observed to alter foraging behaviour in response to artificial light. The behavioural changes associated with illumination are likely to be an anti-predator response because the perceived risk of predation increases with increasing light (Bird et al. 2004). Insectivorous bat species have been observed to congregate around artificial lights to feed on insects. It is, however, only the faster flying bats exploiting this niche while other slower flying insectivorous bat species tend to avoid artificially lit areas (Longcore and Rich 2004).

Artificial lighting impacts on birds include the disruption of nesting sites or the altered choice of nesting sites, disruption of roosting, the altered timing of a dawn chorus and general disturbance. The impact of artificially lit towers on nocturnal migratory birds is well documented (Longcore et al. 2008; Poot et al. 2008). Birds are known to become disoriented and entrapped by artificial lights. Once a bird is within a lighted area at night, the bird may become trapped and will not leave the lighted area (Longcore and Rich 2004). The disorientation of nocturnally migrating birds by lights results in either direct mortality or depletion of energy reserves (Poot et al. 2008). Under the conditions of the study conducted by Poot et al. (2008), the influence of light on nocturnal migrating birds was up to five kilometres. The proposed LNG facility is a different layout to the facility studied by Poot et al. (2008), which was an oil platform. The influence of the proposed LNG facility is unlikely to extend as far due to height of the facility, the location of the facility and the surrounding terrain. The study by Poot et al. (2008) does, however, illustrate the potential for influence by artificial light.

There are many potential solutions to mitigate the effects of artificial nightlight. Some species are sensitive to yellow light while other species are sensitive to blue (Longcore and Rich 2007). Turtle friendly lights have been demonstrated to affect the foraging activity of small mammals (Bird et al. 2004). Bird friendly green lighting has been demonstrated to significantly reduce the impact of artificial

light on nocturnal migrating birds; however, this light form has not been tested on other faunal groups (Poot et al. 2008).

Potential impacts to migratory shorebirds

Large numbers of migratory shorebirds over-winter in Australia or New Zealand before undertaking the return migration to breeding grounds in the Northern Hemisphere. The flight path which birds in Australia utilise is a route known as the East Asian-Australasian Flyway, of which Australia and New Zealand are encompassed in the southern end. During migration, these birds are dependent on a series of staging sites along the flyway, where they stop to feed for a short period before undertaking the next stage of migration. The loss of any one of these staging sites is considered the most significant conservation issue for these migrating birds (Geering et al. 2007).

Disturbance is identified as an increasing threat to migratory shorebirds as it causes them to waste energy, which is required for migration. Shorebirds have a limited opportunity for effective foraging, during the low tide. Disturbance during this period can prevent these birds from foraging effectively (Bamford et al. 2008).

Shorebird feeding grounds and roosting sites have been identified within the greater Port Curtis area (Figure 8.10) but the LNG facility is not located within any of these identified areas. The LNG facility site does however contain intertidal flats suitable for foraging habitat for a range of migratory shorebird species.

Of the different forms of human associated disturbance, small aircraft and helicopter disturbance is seen as the most severe and long lasting. Close approaches by various craft from the water generally disturb more birds than approaches by people from the land. This is due to the majority of the shore birds being close to the waters edge when foraging or roosting. Disturbance from the land is generally a result of movement along the tidal flat, which includes people and animals, particularly dogs (Davidson and Rothwell 1993). Studies undertaken on shorebirds in the Dutch Wadden Sea suggest that shorebirds are impacted by high sound levels the threshold being at 120 dB(A). The result of the high sound levels is that the birds move away from the area (Smit and Visser 1993). The primary mode of access to the proposed facility will be via a boat. Although a helipad will be constructed on site, there will be minimal use of helicopters.

The construction period potentially involves a high level of disturbance with increased activity and potentially loud intermittent noise. The majority of migrating shorebirds will utilise the area from November through to March each year. As such, disturbance as a result of construction activity outside of this period will not significantly impact these shorebirds.

The construction of marine facilities associated with the proposed development is likely to temporarily disrupt this migratory shorebird habitat. Once operational the shorebird habitat is not likely to alter significantly over the long term. The increased human activity however, is expected to deter some species. It is likely that there will be a reduction in the use of the area of mudflat around the facility.

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300000 310000 320000 330000 340000

7400000 7390000 7380000 7370000 7360000

The Narrows

Curtis Island

Graham Creek

LNG facilty site

MOUNT LARCOM

Gladstone

Mt Larcom

Road

BRUCE

GLADSTONE

Gladstone

Benaraby

310000 river

0 5 10km

SCALE - 1 : 200,000 (at A3)
Map Grid of Australia Zone 56
Geocentric Datum of Australia 1994

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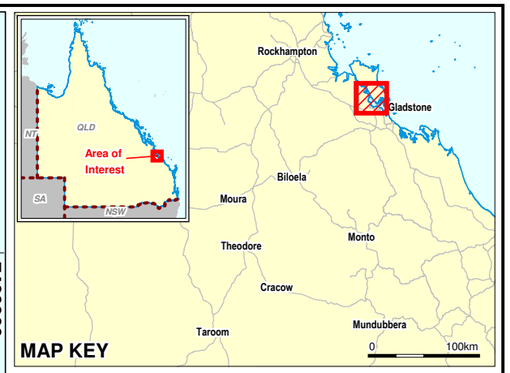

MAP KEY

LEGEND

- Major drainage
- Road
- Railway
- Reservoir
- LNG facility site

Shorebird Sites

- **Major shorebird roost sites**
- **Major shorebird feed sites**

Source Information

Shorebird sites
Department of Environment and Resource Management (DERM) 2009

Satellite imagery
Captured by GeoEye-1 on 24 March 2009

AUSTRALIA PACIFIC LNG PROJECT

Volume 4 Chapter 8
Figure 8.10 Shorebird Roosts and Feeding Areas

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Potential impacts to EVR and Back on Track fauna

Birds

Thirteen EVR bird species have been identified as potentially occurring within the LNG facility site.

Seven of these species are nomadic, highly mobile or occupy very large home ranges. These comprise the grey goshawk, glossy black cockatoo, black-necked stork, square-tailed kite, black-chinned honeyeater, squatter pigeon and little tern. There are no large stands of casuarinas within the LNG facility site to provide potential feeding habitat for the glossy black cockatoo. Given the extent of the vegetation that is expected to be cleared for construction of the proposed development, the habitat values available for each species within the proposed development site and the overall area over which individuals of these species range, it is considered that no significant impact is likely to occur to these species.

The red goshawk is sparsely distributed across its range. Individuals require very large territories and occur in areas of high biodiversity (New South Wales National Parks and Wildlife Service (NSW NPWS) 2002). Established pairs occupy the same large territories in successive years with hunting often occurring at least three kilometres away from the nest (Schodde and Tidemann 1990). There are no records of the red goshawk within the wider study area. Given however, the sparse distribution and foraging range of this species a precautionary approach has been taken and the assumption made that the LNG facility site is within the foraging range of this species. As such, there is potential for loss of foraging habitat for this species.

Field assessment of the potential habitat of the Dawson sub species of the yellow chat found that this habitat did not meet the requirements for this species. The marine plains and associated grassland on the southern side of the saltpan were identified as potentially suitable habitat for the Dawson yellow chat. Heavy grazing of these marine plains and associated grassland by horses and cattle has reduced the suitability of this habitat. It is unlikely the Dawson yellow chat will utilise this habitat.

The beach stone-curlew was regularly sighted on the beach at Laird Point and sighted once on the edge of the saltpan in the LNG facility site. This species prefers undisturbed beach habitat and is likely to move away from the development area. As such, this species is likely to be impacted through the loss of habitat.

The eastern curlew was regularly sighted on the tidal mudflats in front of the proposed development area and on the inundated sections of the saltpan. The LNG facility site covers the majority of the saltpan and as such the construction of the facility will result in habitat loss. The marine construction proposed as part of the development will result in disturbance to the tidal mudflats. Providing the area outside of this footprint is not significantly altered, there is potential for this habitat to remain a suitable foraging area for the eastern curlew.

The powerful owl has been recorded in habitat adjacent to the LNG facility site (Sandpiper 2008). This species preys on large arboreal mammals such as possums and gliders and occupies a home range between 400 to 1,500ha (Webster et al. 2004). Powerful owls require large tree hollows for breeding. The hollows sighted during the field survey were not large enough for the powerful owl but would be suitable for their prey. Possums and gliders are likely to utilise habitat within the LNG facility site. The foraging range of this powerful owl is likely to overlap the proposed development area; as such, the powerful owl is likely to be impacted by loss of foraging habitat and loss of habitat for prey species.

Reptiles

Four EVR reptile species have been identified as potentially occurring within the LNG facility site.

Field assessment of the potential habitat of the ornamental snake found that this habitat did not meet the requirements of this species. The melaleuca wetland and creek lines flowing into the saltpan were identified as potential habitat for the ornamental snake. Wet areas with deep cracking clays are associated with the known occurrences of the ornamental snake. No deep cracking clays were observed within the LNG facility site. The melaleuca wetland is heavily disturbed by cattle and is a relatively small feature within this landscape. There is a low potential of the ornamental snake occurring in this habitat.

The yakka skink has not been recorded within the wider study area however; the yakka skink is a very secretive species. It is usually found in open dry sclerophyll forest or woodland where it shelters among dense ground vegetation, large hollow logs, beneath rocks and in warrens or cavities in the soil. The Brigalow Belt Reptile Recovery Plan (Richardson 2006) indicates there have been no sightings of yakka skink within the Calliope Shire. These results, however, may be due to a lack of general survey effort within the region and the difficulty of observing this species in the field. The habitat within the LNG facility site is suitable for this species and the site is within the potential range of this species. If there is a population of yakka skink on this section of Curtis Island then it may be impacted by loss of habitat and potential unearthing during construction.

The brigalow scaly-foot is a nocturnal species found in a wide variety of dry open forest and woodland habitats. There are no records of this species within the wider study area, There is however, a known population at Lilly Hills on Boyne Island, 15km south of Gladstone (Tremul 2000). Their nocturnal habit makes their detection more difficult. If this species occurs within the LNG facility site then it is likely to be impacted through potential unearthing during construction and loss of habitat.

The rusty monitor has not been recorded within the Curtis Island Industry Precinct but has been recorded within the wider study area. The rusty monitor is found in coastal and estuarine mangroves and paperbark forests and in the associated creeks or rivers. Their diet includes other lizards, fish, crabs and invertebrates. This tree dwelling lizard shelters in hollows. Threatening processes for this species includes the loss of hollow bearing trees and cane toads (Fitzgerald 1997). The presence of cane toads on site reduces the potential of the habitat to contain the rusty monitor but does not preclude its presence. The most suitable habitat available within the LNG facility site for this species is the mangroves and associated habitat at the front of the saltpan. The development footprint does not directly impact this area. If present, the loss of hollows during construction of the marine facilities and edge effects of development near the mangrove habitat is expected to impact on this species. Edge effects relevant to this species and its prey include an altered hydrological regime and sediment or pollutant loads.

Mammals

Eight EVR and one Back on Track mammal species have been identified as potentially occurring within the LNG facility site.

The LNG facility site is potentially within the foraging range of the large-eared pied bat, coastal sheathtail bat and the grey-headed flying-fox. However, these species are unlikely to roost within the LNG facility site. Considering the extent of similar habitat within the wider study area and the foraging range of these species, it is considered that potential impact on these species is minimal.

The large-eared pied bat roosts in caves, crevices in cliffs, old mines and in the disused mud nests of the fairy martin (DEWHA 2009b). The coastal sheathtail bat roosts in caves and rock crevices along

the coast (Duncan et. al. 1999). The LNG facility site does not contain suitable roost sites for these species. The grey-headed flying-foxes utilises communal roost sites generally in riparian locations and are known to share roost sites with the black flying-fox. Flying fox roosts have been identified within the greater Gladstone region (DERM 2008). There are no identified flying fox roosts within the LNG facility site. There is a known grey-headed flying-fox roost to the south of Gladstone (Department of Environment, Climate Change and Water (DECCW NSW) 2009).

The little pied bat has not been recorded within the Curtis Island Industry Precinct but has been recorded within the wider study area. The little pied bat roosts in caves, mineshafts and tree hollows (Duncan et al. 1999). There are no known caves or mineshafts within the LNG facility site however there are suitable tree hollows. If this species occurs in the LNG facility site, there is potential for the proposed development to impact this species through loss of tree hollows (roosting) and foraging habitat within its range.

The black flying-fox has been identified within the wider study area. This species feeds on a range of fruits and nectar from eucalypts, melaleucas, turpentines, grevilleas and bottlebrushes. Day time accommodation facilities consist of up to 30,000 individuals and are often shared with other species of flying-fox. Foraging occurs within 20km of the roost (Van Dyck and Strahan 2008). Flying-fox roost sites have been identified within the greater Gladstone region with no known roosts identified within the study area (DERM 2008). Given the habitat within the LNG facility site, it is likely the proposed development will result in a loss of suitable foraging habitat for the black flying-fox. This loss of foraging habitat is likely to be restricted to the development footprint.

The northern quoll has not been recorded within the wider study area but has been identified as potentially occurring in the LNG facility site based on habitat preference. The arrival of the cane toad has severely impacted the distribution of the northern quoll, with local populations in the Northern Territory usually extinct within a year of the arrival of cane toads. There are however, some populations of northern quolls persisting in Queensland where cane toads are present. The surviving northern quoll populations in Queensland are in areas with steeper slopes, shallower soils, more rock and with fewer disturbances by fire (Woinarski et al 2008). There is an established population of cane toads within the Curtis Island development precinct, which reduces the likelihood of the northern quolls occurring. However the wider study area is consistent with the habitat for surviving populations. If there is a population of northern quoll persisting on Curtis Island then it may be impacted through loss of habitat.

The koala was identified as potentially occurring in the area through DERM essential habitat mapping (Figure 8.4). Recent field studies within the Curtis Island Industry Precinct have recorded one sighting of markings that are consistent with koala scratches (Santos Limited (Santos) 2009b). There was no evidence of koala activity found within the LNG facility site. The limited records indicate that koala activity in this section of Curtis Island is low however, a precautionary approach has been taken. If there is a population of koalas on this section of Curtis Island then they may be impacted through loss of habitat.

Recent surveys have identified the yellow-bellied glider on the mainland (Queensland Gas Company Ltd (QGC) 2009). In coastal environments, the preferred habitat for the yellow-bellied glider consists of moist gullies and creek line habitats in mature forest. Family groups of up to six individuals occupy home ranges of 20 to 85ha. These family groups require large tree hollows for dens. These hollows generally occur in trees that are at least 220 years old (NSW NPWS 2003). The hollows sighted within the proposed development area were not large enough to be suitable for yellow-bellied glider dens. If a family group were present on Curtis Island within the wider study area, then the proposed development is expected to impact this group through loss of habitat within their foraging range.

The false water-rat has not been recorded within the wider study area but has been identified as potentially occurring in the LNG facility site based on habitat preference. The false water-rat lives in mangrove wetlands and adjacent habitats. A large part of their diet consists of crabs. This species is not generally recorded during standard survey techniques (Ball 2004). The mangroves and associated habitat at the front of the saltpan have been identified as the most suitable habitat within the site for this species. The development footprint directly impacts on sections of this habitat, related to the construction of the marine facilities. The remaining habitat is potentially impacted by edge effects of development. Edge effects relevant to this species or their prey include an altered hydrological regime, sediment or pollutants, increases in feral predators and the potential for competition from introduced rodents. Further targeted searches for this species will be considered to comply with the guidelines described in the Draft EPBC Act policy statement 3.20 (DEWHA 2009c).

Potential impacts of animal pests and diseases

The transfer of vehicles, plant equipment and supplies to Curtis Island has the potential to introduce pest species to the island. For example, tramp ants are a sub-set of ants that are highly invasive and considered a significant ecological threat to Australia. They are found in ships and a diverse range of cargo (Department of the Environment and Heritage 2006). Ships entering the harbour are required to comply with Australian quarantine regulations. This reduces the potential for these species to be introduce, however outbreaks of tramp ants still occur in Australian harbours. Inspections of all vehicle, plant equipment and supplies will be required prior to delivery to the island.

Several animal pest species have been identified within the Curtis Island Industry Precinct (refer to Table 8.11). The construction of the LNG facility is expected to alter habitat within the site thereby potentially facilitating the establishment of some pest fauna species such as house mouse, black rat, cat, fox and cane toad. Pest species alter the current balance of species through predation, increased competition or poisoning species that prey on them.

Mosquitoes and midge have been identified as a potential environmental hazard for workers within the Project area.

8.5 Mitigation and management

Measures to mitigate and manage potential impacts associated with the Project on the terrestrial flora and fauna values of the LNG facility site have been identified and are discussed in this section. Mitigation and management measures have been developed with the aim of avoiding impacts where practicable and minimising the intensity of those impacts are unavoidable.

Vegetation

Vegetation clearing will be limited as far as practicable and existing tracks and cleared areas will be utilised where possible to minimise the total extent of remnant vegetation to be cleared as part of the Project. An environmental management plan (EM Plan) incorporating vegetation management issues will be developed and implemented outlining specific measures to reduce impacts during clearing activities including:

- Where practicable, construction infrastructure such as site offices will be located and construction machinery will be stored in proposed cleared areas or existing tracks and open areas with little understorey and not in retained vegetated areas

- Trees will be felled into construction areas or in natural slots between stands of trees to minimise damage to other trees during clearing activities and machinery contact with standing trees on vegetated margins and in retained vegetation areas will be avoided where practicable
- Vegetation clearing and construction activities will be restricted to dry weather conditions where practicable to reduce the potential for erosion and sediment runoff/loss of topsoil
- Erosion control measures will be implemented to reduce sediment/top soil loss through run-off. Topsoil will be retained where practicable and along with mulch and discarded vegetation debris, be spread in retained vegetated areas to ensure there is no net loss of soil quality and habitat value on site
- Cleared construction areas and vehicle tracks will be watered regularly to reduce dust emissions
- Hazardous substances and materials including fuels, oils and chemicals will be stored, handled and disposed of in accordance with standard procedures to minimise potential leakage to adjacent vegetated areas. Spill prevention and response procedures will be implemented for construction and operation. Emergency spill response teams will be trained in clean-up and reporting of spills
- Vehicles will be equipped with spark arresters (on diesel engines) and fire extinguishers and personnel will be trained in basic fire fighting. Fire breaks will be created and maintained around infrastructure and selected personnel will be trained in fire-fighting
- Designated retained vegetated areas will be actively managed throughout the Project's life to promote the native biodiversity and recruitment, encourage fauna use and reduce weed invasion
- Disturbed vegetated areas that are no longer utilised post-construction will be stabilised and landscaped as appropriate to the location and adjacent site activities.

Significant flora species

Whilst no EVR or regionally significant flora species were identified, there is still a potential for several of these species to occur within the LNG facility site. As such, pre-clearing surveys will be undertaken prior to all clearing activities within remnant vegetation on site to identify the presence of EVR and other significant flora species.

Species specific management measures will be developed and implemented where an EVR or regionally significant species is identified on or adjacent to the Project area, in accordance with any relevant recovery plans that are currently in force. These measures will be developed with the aim to protect and enhance known populations on site and may include establishing protective buffers around identified populations to exclude clearing and grazing, weed control to reduce competition and improve habitat quality and manage fire frequency.

These measures will also consider options to develop and implement translocation plans where large or significant populations of EVR flora species are expected to be cleared. Translocation strategies will include a relocation strategy to translocate existing populations to retained vegetated areas (of suitable habitat) within the LNG facility site as well as a reseeding strategy to ensure there is no net loss of significant flora species for the site (Vallee et al. 2004). They will incorporate regular monitoring programs to identify key threats and the progress of recovery and the need for additional planting or other management actions.

Weeds and plant diseases

A biosecurity management plan will be developed and implemented into all phases of the Project to minimise the potential for the introduction and/or spread of weed species and plant pests and diseases on site and to surrounding lands. The biosecurity management plan will be based upon the biosecurity management strategy below which was developed from the principles the Queensland Biosecurity Strategy 2009-14 (Department of Primary Industries and Fisheries 2008) and the Regional Pest Management Strategy 2004 – 2009 (CPMG 2004) for managing weed species and plant diseases.

The biosecurity management plan will outline target species, methods and timing of control and monitoring and awareness programs. This plan will also include:

- Training and awareness
- Vehicle washdown procedures
- Quarantine measures
- Procedures developed in anticipation of potential outbreaks of weeds or plant pests and diseases
- Management procedures for the control of weed infestations and plant pest and diseases
- Monitoring strategies.

The EM Plan (refer to Volume 4 Chapter 24) includes measures to mitigate the potential impacts of weeds and plant diseases as per the biosecurity management strategy. This plan will be used to finalise a biosecurity management plan for the LNG facility site in consultation with the relevant regulatory authorities.

Fauna

One of the primary impacts to fauna during the construction phase of the Project relates to the clearing of habitat. As such, many of the mitigation measures for fauna are designed to minimise the impact of clearing and allow fauna species to move away from the construction site. This is likely to result in increased competition for resources adjacent to the proposed development. Common fauna species are unlikely to be significantly impacted by this increased competition because the overall area is sufficiently large. Measures to reduce the overall impact on fauna include:

- Pre-clearing inspections to be conducted by a qualified fauna spotter to identify potential nesting, roosting or refuge sites. If significant nesting sites are located, clearing operation will where practicable be timed to avoid the breeding season of the identified species
- The development of clearing procedures, which allows the more mobile fauna to move away from the construction area. Were practical, clearing will be undertaken in a mosaic pattern with habitat trees felled last
- A suitably trained fauna spotter/catcher to be present during clearing operations to provide direction on the clearing procedures, to capture and relocate fauna and to treat injured fauna found during the clearing program
- The clearing of hollow bearing trees will be minimised where practical. The clearing plan will allow time for mobile species potentially utilising these hollows to move away from the clearing operation. Inspections of all hollows will be undertaken prior to removal of the tree. Tree

sections containing hollows will be retained and placed in the designated retained vegetation for utilisation by ground dwelling fauna

- A biosecurity management plan will be developed. This will include the participation in the control of other known feral populations (like cats, foxes, cane toads, cattle, horses and pigs), the prevention of new species being introduced to the area and the eradication of a new feral species outbreak associated with Project activities.
- Night lighting will be required for the safe operation of the facility, however consideration will be given to minimising the potential impacts of night lighting through the use of current technology and lighting techniques (such as, light placement, light shields, the utilisation of yellow insect lights and motion detection lighting where practical)
- Limit access to the tidal mudflat to only those activities which are essential to the construction of the facility to minimise impacts of migratory fauna.

Specifically in relation to mosquito and biting midge, a mosquito management plan will be developed prior to construction including the following strategies.

- Stagnant pools of water will be drained or filled (where practical) to minimise breeding sites
- Depressions created during the construction or operation of the facility will be filled as soon as practical
- Stored items, including waste materials, will be stored in such a manner as to avoid ponding water
- Soil erosion will be monitored and control to prevent the formation of water pooling sites in drains and water courses within the LNG facility site
- Water holding facilities within the LNG facility site will be regularly inspected for mosquito and midge activity
- Insect repellent will be available as required
- Where practical, facilities will incorporate mosquito and midge barriers, such as fly screens or utilise air conditioning.

Decommissioning

LNG facility decommissioning activities will be carried out in accordance with a decommissioning plan and will comply with regulatory requirements that are in force at the time of decommissioning and good industry practice. The overall aim of the decommissioning plan will be to ensure that the site does not pose an ongoing risk to public safety or the quality of the environment, and fulfils community expectations. The decommissioning plan will be prepared for the facility before decommissioning work starts, in consultation with regulatory authorities and relevant stakeholders.

Rehabilitation measures and associated monitoring such as those described below are expected to be included:

- Revegetate land to its former vegetation community using native species recorded in that community during the pre-construction field surveys. Species will be sourced locally to promote endemic and local provenance
- Undertake active weed management and control until vegetation becomes established

It is expected that the LNG facility will be decommissioned when its operation is no longer economically viable. Australia Pacific LNG will consult with relevant regulatory authorities in relation to proposals for facilities or infrastructure to be left in place. Some areas, such as the causeway and jetty start may not be removed as it is likely that associated flora and local benthic habitats will have adapted to their presence over the operational life of the Project and their removal would result in a greater environmental disturbance than retaining the structure in situ.

8.6 Environmental offsets for the Project

The objectives of the Queensland Government draft Policy for Biodiversity Offsets (EPA 2008b) are to improve the long-term protection and viability of the State's biodiversity, to increase the area of habitat restored and enhanced and to ensure development in Queensland is ecologically sustainable. It provides criteria for identifying and utilising biodiversity offsets to counterbalance an impact that causes a loss of biodiversity values.

Under the draft policy, biodiversity offsets must achieve an equivalent or better environmental outcome for the biodiversity values impacted and may include direct offsets (such as acquiring lands to be included in a protected estate or rehabilitation and protection of regrowth vegetation), or indirect offsets including removing threats to biodiversity values, providing fauna assisted crossings and implementing actions of a recovery plan, biodiversity action plan or management plan.

The draft Policy for Biodiversity Offsets may provide a useful guide to calculate potential offsets based on the conservation status of the values impacted. However, the policy in its present form is a consultation draft and is subject to considerable change. Therefore, it is not considered further here.

8.7 Cumulative impacts

These projects were selected based on their proximity to the proposed site and availability of information. Cumulative impacts of surrounding industry are discussed in this section and in Volume 4 Chapter 25 and encompass the following projects:

- Gladstone LNG Project (Santos 2009a)
- Queensland Curtis LNG Project (QGC 2009)
- Gladstone-Fitzroy Water Pipeline Project (Gladstone Area Water Board 2008)
- Gladstone Pacific Nickel Refinery (Gladstone Pacific 2007)
- Central Queensland Gas Pipeline (Enertrade 2006).

Flora

The majority of Curtis Island is well vegetated with similar vegetation communities to those present on site and holds significant corridor and connectivity values as surrounding industry in the greater Gladstone area has led to a significant loss of broad, contiguous tracts of vegetation. Vegetation clearing within the LNG facility site would contribute to an overall decrease in remnant vegetation extent in the greater Gladstone area. The combined vegetation removal of all projects is shown in Table 8.15. Specifically, the cumulative impacts of these projects would result in a total loss of 562.1ha of RE 12.11.6 (spotted gum-ironbark forests), 71.6ha of RE 12.11.14 (blue gum-ironbark forests) and 46.7ha of RE 12.1.2 (saltpan vegetation), which represents 0.2% of the total extent of each of these REs in Queensland and would result in the remaining pre-clearing extents of these REs to fall by 0.16%, 0.05% and 0.14% respectively. Clearing activities associated with these projects will

also result in the removal of 64.1ha of RE 12.3.11 (blue gum-ironbark forests) (0.1% of the total extent of this RE in Queensland) and 3.9ha of RE 12.3.7 (paperbark woodlands) (<0.01% of the total extent of this RE in Queensland) which represents a decrease in the remaining pre-clearing extent of 0.03% and 0.004% respectively.

Furthermore, the cumulative impacts of these projects and Berthing Option 2A would lead to a loss of 7.0ha of RE 12.1.3 (mangrove shrublands) which represents 0.01% of the total extent of this RE in the state and a loss of 0.013% in the total pre-clearing extent of this RE. Whilst the cumulative impact of Berthing Option 1B would lead to an additional loss of 0.7ha of RE 12.1.3 i.e. 0.02% of the total extent of this RE in Queensland and a total loss of 0.015% of the pre-clearing extent of this RE.

The actual contribution the Project makes to the overall loss of these REs in the greater area is low, representing less than 0.15% of the total extent of these REs in Queensland (i.e.0.14% of the combined loss of spotted gum-ironbark forests, 0.05% of the combined loss of saltpan vegetation and less than 0.03% of the combined loss of blue gum-ironbark forests, paperbark woodlands and mangrove shrublands).

The proposed Project will also contribute to the loss and fragmentation of vegetation communities in the south-western corner of Curtis Island resulting in an increase in vegetation degradation through edge effects and changes to the floristic structure and composition and hydrological regimes. Increased road and personnel traffic is expected to also promote the introduction and/or spread of weed species. The Project will also further increase the disturbance of coastal wetlands and removal of wetland vegetation leading to an overall decrease in the extent and distribution of wetlands in the greater Gladstone area and increase human and machinery movement on the island will increase the potential for weeds t be introduced from the mainland and become established.

The Project will not significantly contribute to the loss of EVR or regionally significantly flora species as there are no current or historical records on or adjacent to the site. The Project will result in the loss of potential habitat for some of these species; however, given the absence of populations on or adjacent the site and on Curtis Island as a whole, these habitat areas are not considered to contribute significantly to the long-term viability of these species.

Fauna

The clearing of habitat required for the development of the facility will contribute to the cumulative loss of habitat within the Gladstone area. There is currently no significant development on Curtis Island as such the range of disturbance factors currently affecting this area is limited. Historic use for cattle grazing and the current disturbance of the area by feral cattle and horses, has affected habitat within the study area. However, habitat within the LNG facility site is suitable for a range of EVR and common fauna species. The establishment of the Curtis Island Industry Precinct, within which this facility is located, will result in the direct loss of habitat (including features such as tree hollows, mangroves and tidal mudflats) and indirect habitat loss through increased fragmentation, artificial lighting, noise, traffic, human activity, potential sedimentation and pollutants. The cumulative impacts of the proposed developments potentially reduce the dispersal opportunities for a range of small birds, mammals and reptiles.

The effect of artificial lighting on faunal behaviour and community ecology is an increasing area of concern. The potential impacts of artificial lighting on any particular species and their severity will vary depending on the ecology of the species, their predator-prey relations, the distance of the core population from the source of light and the reaction of that species to light disturbance. The implications for terrestrial fauna of increased artificial lighting resulting from the proposed developments are unknown.

Wetlands within Port Curtis are utilised by a range of migrating shorebirds or foraging and roosting habitat. Migratory shorebirds are sensitive to disturbance that causes them to stop foraging or waste energy, which is otherwise stored for migration (Geering et al. 2007). The LNG facility site has not been identified as a major feeding or roosting ground for migratory shorebirds. However, the cumulative impact of development within the intertidal zone around Port Curtis is likely to increase disturbance to this fauna group.

The powerful owl has been observed in eucalypt woodland adjacent to the southern boundary of the proposed facility (Sandpiper 2008). Powerful owls occupy large home ranges and prey on arboreal mammals such as possums and gliders. They require large tree hollows for their own nesting requirements and for their prey species (Webster et. al. 2004). The powerful owl is listed as vulnerable under the *Nature Conservation Act 1992*. Powerful owls are known to occur at Mount Larcom west of Gladstone however, their distribution on Curtis Island is unknown. As such, the impact on the local population is unknown. The proposed developments are likely to result in loss of habitat and tree hollows for the powerful owl prey species.

The beach stone-curlew has been identified within the LNG facility site, north of the Project area at Laird Point and at various locations within the Curtis Island Industry Precinct. The beach stone-curlew is listed as vulnerable under the *Nature Conservation Act 1992*. This species inhabits isolated beaches and is sensitive to disturbance of this habitat. The cumulative impacts of the proposed developments within the Curtis Island Industry Precinct are likely to result in a loss of habitat for beach stone-curlew along this section of coastline.

8.8 Conclusion

8.8.1 Assessment outcomes

Two design options have been proposed as part of the Project for marine facilities (Options 2a and 1b). These options have the same development footprint and clearing requirements on Curtis Island but differ in the berthing configurations offshore (Figure 8.1). Option 1b would require the additional clearing and disturbance of North Passage Island (which lies directly offshore of Curtis Island) consequently resulting in an increase in the loss of mangrove shrublands and marine plants although this would not significantly impact the overall conservation status of those RE affected and is not considered to significantly reduce the suitability of this design option in terms of impact to flora ecology within the LNG facility site.

In terms of fauna ecology, Option 1b would create a bridge to allow terrestrial fauna access to North Passage Island. The island is currently utilised as foraging, roosting or nesting by a range of birds. The island provides relative protection for these birds from predation or competition from terrestrial fauna. The most likely species to access the island via a bridge are feral rodents and possibly feral cats. As such, Option 2a is a preferred option considering the fauna ecology of North Passage Island.

Summary of findings

Table 8.16 provides a summary of the potential impacts on terrestrial ecology within the LNG facility site and how mitigation measures are proposed to meet the sustainability principles of the Project.

Further study

The flora and fauna assessment for this Project used rapid survey techniques to identify the key values on site and in the surrounding lands and did not include comprehensive flora and fauna species lists and detailed abundance data. While this level of assessment is considered adequate to assess the potential impacts of the Project on these values, additional surveys are expected to be completed prior to site clearing.

Shorebird surveys are currently being conducted to assess the utilisation, by migratory shorebirds, of the mudflats around the study area.

Table 8.15 Cumulative impact of vegetation clearing in the greater area on conservation status of REs present on site

RE code	Clearing areas (ha)		Clearing extent represented in Qld (%)		Pre-clearing extent of RE (ha)	Current extent of RE (ha)	Extent of RE post-project/s (ha)		Current remaining pre-clearing extent of RE (%)	Remaining pre-clearing extent of RE post-project/s (%)	
	LNG facility	All projects	LNG facility	All projects			LNG facility	All projects		LNG facility	All projects
Of concern REs											
12.3.11	23.9	64.1	0.1	0.1	193,141	47,883	47,859	47,819	24.79	24.78	24.76
12.11.14	26.4	71.6	0.1	0.2	120,693	30,130	30,104	30,058	24.96	24.94	24.91
Least concern REs											
12.1.2	29.5	46.7	0.1	0.2	32,173	28,533	28,503	28,486	87.22	87.13	87.08
12.1.3 (Option 2a)	1.6	7.0	<0.01	0.01	53,499	50,483	50,481	50,476	94.363	94.360	94.350
12.1.3 (Option 1b)	2.3	7.7	0.01	0.02	53,499	50,483	50,481	50,475	94.363	94.358	94.348
12.3.7	1.3	3.9	<0.01	<0.01	103,884	53,259	53,258	53,255	51.268	51.267	51.264
12.11.6	73.1	562.1	0.03	0.2	378,000	241,682	241,609	241,120	63.94	63.92	63.78

LNG facility = Australia Pacific LNG Project – Curtis Island LNG facility component only.

All projects = all projects outlined in Section 4.1.1 and all components of the Australia Pacific LNG Project.

Clearing areas are based on data obtained for the Project site during the terrestrial ecology survey and information available in EIS documentation for specific projects (Enertrade 2006; Gladstone Area Water Board 2008; Gladstone Pacific 2007; QGC 2009; Santos 2009a; URS Australia 2007).

RE extents are based on ground-truthed RE data for the proposed Project site and information for the catchment, subregion and Queensland derived from Accad et al. (2008).

Table 8.16 Summary of environmental values, sustainability principles, potential impacts and mitigation measures

Environmental values	Sustainability principles	Potential impacts	Possible causes	Mitigation and management measures	Residual risk level
All phases					
Native biodiversity Habitat integrity	Minimising adverse environmental impacts and enhancing environmental benefits associated with Australia Pacific LNG's activities, products or services; conserving, protecting, and enhancing where the opportunity exists, the biodiversity values and water resources in its operational areas Identifying, assessing, managing, monitoring and reviewing risks to Australia Pacific LNG's workforce, its property, the environment and the communities affected by its activities	Increased competition for resources leading to loss of native flora biodiversity and increased fire fuel loads leading to increased fire hazard Injury to humans and wildlife and is expected to facilitate spread of pest animals and diseases	Introduction and/or spread of weeds	Finalise and implement the biosecurity management plan which includes procedures for training and awareness, quarantine measures, emergency response systems and monitoring and audit requirements	Low
Plant health Habitat integrity		Loss or harm to flora species leading to a loss in biodiversity Facilitate movement to mainland leading to a loss in primary production	Introduction and/or spread of plant pests and diseases	Finalise and implement the biosecurity management plan which includes procedures for training and awareness, quarantine measures, emergency response systems and monitoring and audit requirements	Low
Native biodiversity Habitat integrity		Increased fire hazards leading to increase in fire frequency and intensity Loss of flora species/diversity and changes to floristic structure	Fire disturbance	Create and maintain fire breaks around proposed infrastructure Train selected personnel in the use of fire fighting equipment including fire extinguishers Ensure fire extinguishers and/or fire	Low

Environmental values	Sustainability principles	Potential impacts	Possible causes	Mitigation and management measures	Residual risk level
		and composition of vegetation Facilitate the introduction and/or spread of weed species		fighting equipment such as fire blankets and water provided to all vehicles and infrastructure buildings	
Plant health Fauna health Habitat integrity		Loss or injury to flora species through stunted plant growth and degradation of flora habitat areas Indirect impacts on fauna (for example nectarivorous species)	Air and dust emissions	Water exposed ground (such as construction areas and unsealed vehicle tracks) to reduce dust emissions	Low
Plant health Habitat integrity		Degradation of flora habitat areas through contamination of soil and drainage lines Loss of flora species/diversity Contamination of invertebrate prey for species such as waders and the water mouse	Accidental release/leaks and spills of hazardous substances	Hazardous substances are stored, handled and disposed of in accordance with standard procedures and only by trained personnel Implement spill prevention and response procedures during construction and operation phases and train emergency spill response teams in clean-up and reporting of spills	Low
Construction phase					
Habitat integrity /	Minimising adverse	Loss of extent of remnant	Clearing activities	Limit clearing to as far as practicable	Medium

Environmental values	Sustainability principles	Potential impacts	Possible causes	Mitigation and management measures	Residual risk level
connectivity Extent of remnant vegetation on site Native biodiversity	environmental impacts and enhancing environmental benefits associated with Australia Pacific LNG's activities, products or services; conserving, protecting, and enhancing where the opportunity exists, the biodiversity values and water resources in its operational areas Identifying, assessing, managing, monitoring and reviewing risks to Australia Pacific LNG's workforce, its property, the environment and the communities affected by its activities	vegetation and diversity of vegetation communities on site Loss or degradation of wetland vegetation areas Degradation of retained remnant vegetation and wetland areas		Restrict clearing activities to dry weather conditions where practicable Utilise existing cleared areas such as tracks and natural open areas in vegetation and areas proposed to be cleared for construction infrastructure such as site offices and stored machinery Fell trees into construction area or in natural slots between stands of trees and avoid machinery contact with vegetation in areas of retained vegetation Identify vegetated areas to be retained and redistribute felled logs and mulch over these areas. Stabilise and landscape cleared areas outside the proposed development footprint to reduce sediment runoff and erosion Develop and implement an offsets plan to counterbalance the impact of vegetation clearing on site	
Plant health Threatened flora species populations		Loss or harm to threatened flora species populations	Clearing activities	Undertake pre-clearing surveys to identify any threatened flora species populations	Low

Environmental values	Sustainability principles	Potential impacts	Possible causes	Mitigation and management measures	Residual risk level
				Develop and implement species specific management measures for EVRs or regionally significant species identified on or adjacent to the LNG facilities area	
Hydrological regimes Habitat integrity		Changes in hydrological regimes and water quality leading to loss of flora species/diversity and degradation of habitat areas through loss of or change to hydrological flows	Clearing activities	Limit vegetation clearing as far as practicable	Low
Soil erosion and extent of top soil/seed bank Habitat integrity		Increased erosion potential Degradation of habitat areas through sediment runoff and loss of topsoil	Clearing activities	Implement erosion control measures such as sediment trap devices Landscape / revegetated cleared areas to reduce sediment runoff and erosion	Low
Fauna health Threaten fauna species populations		Potential injury or harm to fauna	Clearing activities	Pre-clearing inspection Development of a clearing plan A qualified fauna spotter/catcher present during clearing operations	Low
		Potential disturbance or altered faunal activity leading to harm	Artificial lighting	Consider utilisation of current technology and lighting techniques to minimise potential impacts of night lighting	Low

Environmental values	Sustainability principles	Potential impacts	Possible causes	Mitigation and management measures	Residual risk level
Migratory fauna species populations		Potential disturbance to migratory shorebirds	Construction activity	Limit access to the tidal mudflat to only those activities which are essential to the construction of the facility.	Low
Operational phase					
Native biodiversity	Minimising adverse environmental impacts and enhancing environmental benefits associated with Australia Pacific LNG's activities, products or services; conserving, protecting, and enhancing where the opportunity exists, the biodiversity values and water resources in its operational areas Identifying, assessing, managing, monitoring and reviewing risks to Australia Pacific LNG's workforce, its property, the environment and the communities affected by its activities	Increased degradation of retained vegetation areas through activities associated with Project operation	Human and machinery movement	Disturbed vegetated areas that are no longer utilised post-construction will be stabilised and landscaped as appropriate to the location and adjacent site activities.	Low
Native biodiversity Threaten fauna species populations		Potential to introduce new species to the area or increase the quantity of existing species	Feral animals	Develop biosecurity management plan as part of the environmental mangement plan	Low

Environmental values	Sustainability principles	Potential impacts	Possible causes	Mitigation and management measures	Residual risk level
Decommissioning phase					
Habitat integrity and connectivity Extent of remnant vegetation on site	Minimising adverse environmental impacts and enhancing environmental benefits associated with Australia Pacific LNG's activities, products or services; conserving, protecting, and enhancing where the opportunity exists, the biodiversity values and water resources in its operational areas Identifying, assessing, managing, monitoring and reviewing risks to Australia Pacific LNG's workforce, its property, the environment and the communities affected by its activities	Increased exposure of bare ground through removal/dismantlement of infrastructure	Decommissioning activities	Develop and implement a decommissioning plan in consultation with appropriate regulatory authorities and stakeholders. Plan will involve rehabilitation measures such as revegetation and weed control	Low

8.8.2 Commitments

Australia Pacific LNG will manage potential impacts to terrestrial ecology of the LNG facility and maintain the ecological processes and integrity of the area by the following:

- Submit all vegetation mapping and data to the Queensland Herbarium to update the CORVEG database
- Develop a bio-security management plan in consultation with State and local government authorities and implemented prior to the construction
- Develop a vegetation offsets program in consultation with the Queensland Department of Environment and Resource Management and the Commonwealth Department of Environment, Water, Heritage and the Arts, and will consider ecological values at a regional scale when identifying locations for compensatory offset
- Develop and implement species specific management plans for threatened flora species
- Undertake pre-clearing surveys, erosion controls measures and fauna management
- Use a sensitive lighting approach to minimise the potential impact of artificial night lighting on terrestrial fauna.

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