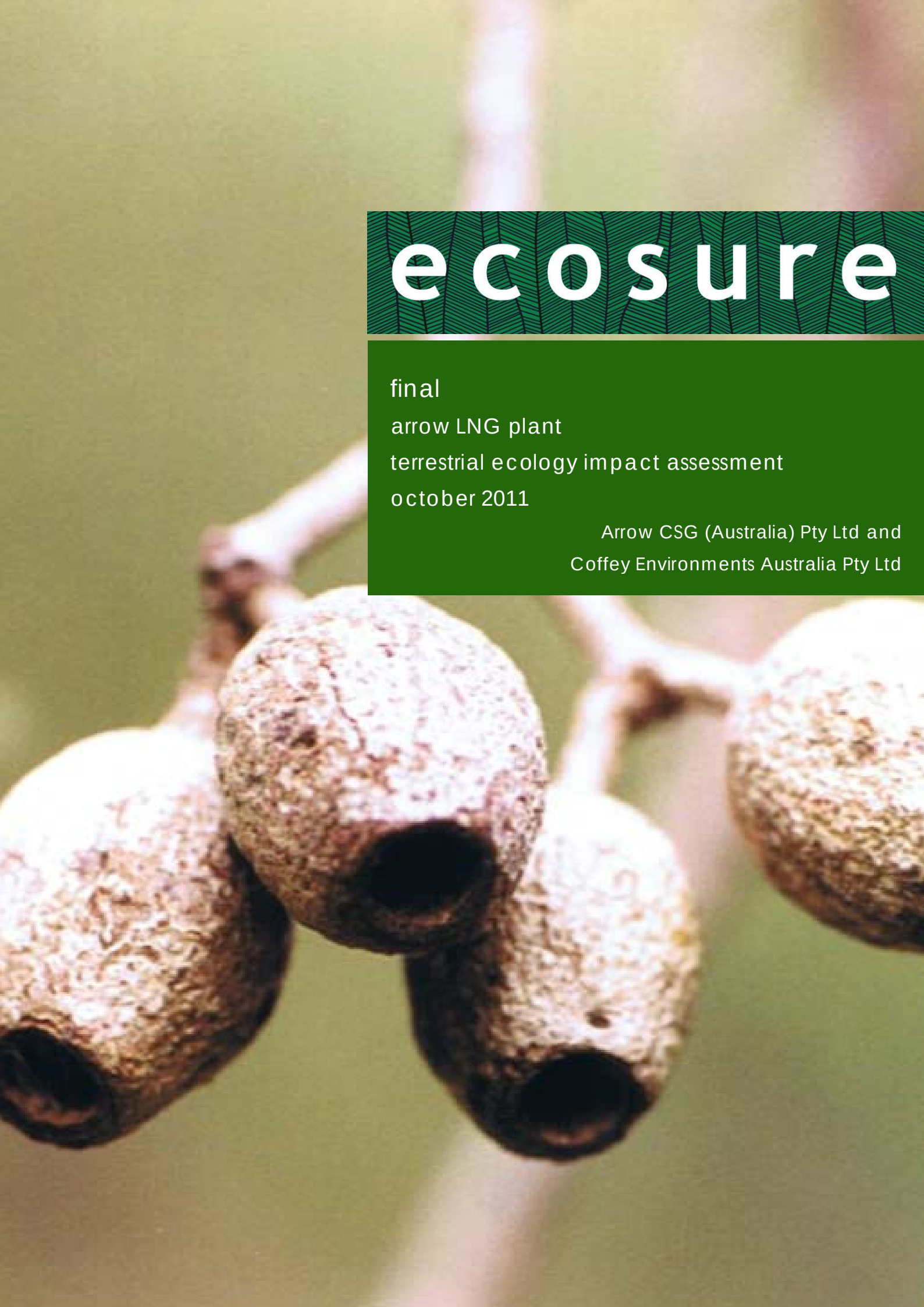
APPENDIX 9

ARROW LNG PLANT

Terrestrial Ecology Impact Assessment

arrow energy
go further



ecosure

final

arrow LNG plant

terrestrial ecology impact assessment

october 2011

Arrow CSG (Australia) Pty Ltd and

Coffey Environments Australia Pty Ltd

Executive Summary

Arrow CSG (Australia) Pty Ltd is investigating the development of a Liquefied Natural Gas (LNG) facility on Curtis Island on the central Queensland Coast, near Gladstone. Ecosure Pty Ltd (Ecosure) was engaged to conduct investigations into the impacts of the Arrow LNG Plant on the terrestrial ecology (flora and fauna) within the study area.

The assessment was based on a detailed literature review, which enabled survey effort to target those species and vegetation communities with conservation significance considered likely to occur in the study area. Ecological values were identified and assessed against the likely impact which the project may have on them. Mitigation and management measures have been proposed which will decrease the impact on ecological values.

Field surveys identified 293 native flora species and 56 introduced flora species. Of the native flora species found, none were considered threatened under Commonwealth or state legislation, however a potential new taxon was identified (*Cupansiopsis* sp. indet.). This species appears to have a naturally restricted range and is closely related to a threatened flora species (*Cupansiopsis shirleyana*).

One hundred and sixty-two terrestrial fauna species were observed during field surveys, consisting of 18 mammal, 15 reptile, nine frog and 120 bird species. Of these, ten species were observed which are listed as 'Migratory' under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Of these migratory species, one is also listed as 'Near Threatened' under the state *Nature Conservation Act 1992*. There was also one 'Vulnerable' bird species listed under the *Nature Conservation Act 1992* surveyed within the study area. Within 5 km of the study area, one mammal species which is 'Vulnerable' under Commonwealth legislation was surveyed, along with an additional four bird species listed under the *Nature Conservation Act 1992*. One of these (squatter pigeon [*Geophaps scripta scripta*]) is also 'Vulnerable' under Commonwealth legislation.

Significant flora and fauna values of the study area were found to be characterised by:

Curtis Island

- A 'Critically Endangered' vegetation community on the eastern side of Hamilton Point. Representative of littoral rainforest and coastal vine thickets of eastern Australia, this community is listed under the *Environment Protection and Biodiversity Conservation Act 1999* (regional ecosystem 12.2.2).
- Limited distribution of small pockets of semi-evergreen vine thicket on headlands and beach dunes (regional ecosystems 12.11.4 and 12.2.2 respectively) were identified. These represent potential habitat for threatened flora and fauna species and are currently afforded a *Vegetation Management Act 1999* status of 'Of Concern'.
- Two broad overland drainage basins occur within the central and northern portions of the Arrow LNG Plant site. Both of these areas supported relatively intact

sclerophyllous open forest that is representative of an 'Endangered' regional ecosystem (regional ecosystem 12.3.3).

- Mangrove and saltpan habitat (regional ecosystems 12.1.3 and 12.1.2) support marine plants and provides habitat for water mouse (*Xeromys myoides*) vulnerable under both the *Environment Protection and Biodiversity Conservation Act 1999* and the *Nature Conservation Act 1992*. These areas also provide shorebird feeding habitat for at least six observed *Environment Protection and Biodiversity Conservation Act 1999* listed migratory species.
- There were an additional three threatened fauna species under the *Nature Conservation Act 1992* found at, or within 5 km, of this site. These are grey goshawk (*Accipiter novaehollandiae*), beach stone-curlew (*Esacus magnirostris*) and powerful owl (*Ninox strenua*).
- A 'Vulnerable' mammal under the *Environment Protection and Biodiversity Conservation Act 1999*, grey-headed flying-fox (*Pteropus poliocephalus*) was observed.

Mainland tunnel entry shaft and tunnel spoil disposal area

- Predominantly intact sclerophyllous open forest is present between the landward, non-tidal edge, with most of the vegetation analogous with 'Of Concern' regional ecosystems. Small areas of 'Endangered' regulated regrowth are also present. [Note: the areas of 'Endangered' regulated regrowth were primarily located within or adjacent to stream protection zones so are therefore in part considered a 'restricted area'].
- The saltpans (regional ecosystem 12.1.2) along the mainland coastal strip form part of a shorebird feeding and roosting area. The area is likely to support more than 15 species of migratory shorebird and is therefore considered a significant shorebird habitat.
- Ten 'Migratory' bird species were observed in and around this site, along with an additional two birds threatened under the *Nature Conservation Act 1992*, beach-stone curlew (*Esacus magnirostris*) and square-tailed kite (*Lophoictinia isura*).
- Grey-headed flying-fox (*Pteropus poliocephalus*), 'Vulnerable' under the *Environment Protection and Biodiversity Conservation Act 1999* was observed within 5 km of the study area.

Temporary Workers Accommodation Facilities

- No remnant vegetation was observed within TWAF 7 and this site is considered to be of low conservation significance.
- In TWAF 8, a relatively consistent distribution of woodland to open forest was found to occur within the eastern two-thirds of the site, representative of remnant regional ecosystem 11.3.4 ('Of Concern'). Vegetation along the northern, western and southern boundaries of the site was similarly composed however generally lacked the canopy cover intercept that would satisfy the criteria for remnant status. Therefore, these areas were representative of non-remnant, high value regrowth that is characteristic of 'Of Concern' regional ecosystem 11.3.4.
- TWAF 8 contains essential habitat for coastal sheath-tail bat (*Taphozous australis*) and koala (*Phascolarctos cinereus*). It also forms part of a state wildlife corridor and

provides habitat for a range of threatened fauna. A rainbow bee-eater (*Merops ornatus*), listed as 'Migratory' under the *Environment Protection and Biodiversity Conservation Act 1999*, was observed.

Launch sites

- There is potential habitat for water mouse (*Xeromys myoides*) at launch site 1, listed as 'Vulnerable' under both state and Commonwealth legislation. Migratory shorebirds may utilise this site.

The key impacts expected as a result of the project relate to vegetation clearing, habitat fragmentation, introduced flora and fauna, changes to hydrology, increased pollution, disturbance to fauna (such as through lighting, noise and vehicles) and fauna impacts as a result of trenchfall.

The Arrow LNG Plant will implement a management hierarchy which preferentially avoids impacts, then mitigates, before offsetting any residual impacts.

The greatest residual impacts are expected to occur in the saltpans and shorebird habitat (regional ecosystem 12.1.2) at the mainland tunnel entry shaft and tunnel spoil disposal area, at the LNG Plant site within two areas of 'Endangered' vegetation (regional ecosystem 12.3.3) and edge effects on the population of *Cupaniopsis* sp. indet. at Boatshed Point.

Acknowledgements

- Chris Hansen, Hansen Botanical Assessments Pty Ltd.
- Greg Ford, Anabat analysis.
- Barbara Triggs, Hair, scat and owl pellet analysis.
- Coffey Environments Project Team.

Abbreviations and Symbols

Abbreviation	Description
±	with or without
APIA	Australian Pipeline Industry Association
BPAs	Biodiversity Planning Assessments
CAMBA	China – Australia Migratory Bird Agreement
CSG	Coal Seam Gas
CWLTH	Commonwealth
DEEDI	Department of Employment, Economic Development and Innovation (Queensland)
DERM	Department of Environment and Resource Management (Queensland)
DEWHA	Department of Environment, Water, Heritage and the Arts (now DSEWPC) (Commonwealth)
DIP	Department of Infrastructure and Planning (now DLGP) (Queensland)
DLGP	Department of Local Government and Planning (Queensland)
DSEWPC	Department of Sustainability, Environment, Water, Populations and Communities (Commonwealth)
EDL	Ecologically Dominant Layer
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency (now DERM) (Queensland)
EP Act	*Environmental Protection Act 1994* (Queensland)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
EPP (Noise)	Environmental Protection (Noise) Policy 2008 (Queensland)
EP Reg	Environmental Protection Regulation 2008 (Queensland)
ERA	Environmentally Relevant Activity
ESD	Ecologically Sustainable Development
EVNT	'Endangered', 'Vulnerable' or 'Near Threatened' fauna and/or flora, as listed under the EPBC Act and NCA
GIS	Geographic Information System (spatial data)
GPS	Global Positioning System
GSDA	Gladstone State Development Area
HAT	Highest Astronomical Tide
HVR	High value regrowth as defined under the VMA
JAMBA	Japan – Australia Migratory Bird Agreement
LNG	Liquefied Natural Gas
MOF	Materials Offloading Facility
NCA	*Nature Conservation Act 1992* (Queensland)
MNES	Matters of National Environmental Significance
QLD	Queensland
RE	Regional Ecosystem - refers to the vegetation classification scheme under the VMA
ROKAMBA	Republic of Korea – Australia Migratory Bird Agreement
RV	Remnant vegetation as defined under the VMA
SDPWO Act	*State Development and Public Works Organisation Act 1971* (Queensland)
SEVT	Semi-evergreen vine thickets
SPA	*Sustainable Planning Act 2009* (Queensland)
SP Reg	Sustainable Planning Regulation 2009(Queensland)
ToR	Terms of Reference

Abbreviation	Description
TWAF	Temporary Workers Accommodation Facility
WONS	Weed of National Significance
VMA	*Vegetation Management Act 1999* (Queensland)

Glossary

Term	Description
Arboreal termitaria	A termite nest within a tree.
Cryptic	Tends to be camouflaged or concealed.
Cumulative Impact	The combined environmental impact of projects that have been approved by the Coordinator-General of the State of Queensland or have sufficient information in the public domain (i.e. EIS) to enable an assessment of the potential impacts.
Diurnal	During day time hours
Ecosystem	The physical and biological components of an environment which function as a combined unit.
Ecological Value	A measure of how we value the environment in which we live. A quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety.
Ecologically Sustainable Development (ESD)	Development which is carried out in such a way as to minimise impacts on ecological values.
Environmental Impact Statement (EIS)	The process by which the environmental impact of a proposed development is assessed.
Environmentally Relevant Activity (ERA)	Industrial or agricultural activities with the potential to release contaminants to the environment.
Essential Habitat	Essential habitat is an area in which a threatened species is known to occur or which contains essential habitat factors for that species which include, but is not limited to: vegetation type, regional ecosystem, land zone, altitude, soils and position in the landscape (DERM, 2008).
Fauna	Animal life.
Flora	Plant life.
Gladstone State Development Area (GSDA)	A defined area of land within the Gladstone region, identified as suitable for large scale industrial development on the basis that it conforms to acceptable engineering, environmental and social criteria.
Liquefied Natural Gas (LNG)	Natural gas that has been converted to liquid form by cooling to a very low temperature. This form is easier to store and transport.
Mangal	Mangrove
Marine Plant	Follows the definition prescribed in section 8 of the *Fisheries Act 1994* which states that it is) a plant (a tidal plant) that usually grows on, or adjacent to, tidal land, whether it is living, dead, standing or fallen; (b) material of a tidal plant, or other plant material on tidal land; (c) a plant, or material of a plant, prescribed under a regulation or management plan to be a marine plant.
Matters of National Environmental Significance (MNES)	Matters protected under Commonwealth environmental law, including: listed threatened species and communities; listed migratory species; RAMSAR wetlands; Commonwealth marine environment; world heritage properties; national heritage places; Great Barrier Reef Marine Park; nuclear actions.
Mesic shift	A vegetation change relating to growing in conditions of medium water supply.
Monophagous	Eating only one type of food.
Nocturnal	Active during night time hours.
Offsets	An action in an appropriate location to counterbalance (offset) an impact on a vegetation community, species or biodiversity value.

Term	Description
Pelagic	Living in or relating to open ocean or sea.
Potential Impacts	Impacts of the project on terrestrial ecological values without the application of mitigation.
Raptor	Bird of prey.
Receptor	An environmental feature, value, area or function which may be affected by impacts on the environment.
Rehabilitation	The restoration of ecological value following modification of the environment due to development, natural disaster or other such action.
Residual Impact	Impacts which continue to influence receptor condition following the successful implementation of mitigation measures.
Risk-based approach	Assessment method for the determination of likely impacts of the project. The risk-based methodology allows the significance level of impacts on all known or likely environmental receptors of the project area to be objectively assessed on clearly defined spatial and temporal scales.
Stag	A stag is a hollow bearing dead tree.
Terrestrial Fauna	Land-based animals.
Trenchfall	Entrapment of fauna in open trenches during construction.

Table of Contents

Tables

Figures

1 Introduction

Arrow CSG (Australia) Pty Ltd (Arrow Energy) is investigating the development of a Liquefied Natural Gas (LNG) facility on Curtis Island on the central Queensland Coast, near Gladstone.

Ecosure Pty Ltd (Ecosure) was engaged to conduct investigations into the impacts of the Arrow LNG Plant (hereafter referred to as 'the project') on the terrestrial ecology (flora and fauna) within the study area (Figure 1). This report provides a detailed assessment of the terrestrial ecological values, assesses the potential impacts of the proposed project and describes measures to mitigate these impacts.

1.1 Project Objectives

The objectives of the terrestrial ecology study are to:

- Fulfil the requirements of the Final Terms of Reference for the Shell Australia LNG Project EIS, as issued by the Coordinator-General of the State of Queensland (hereafter Coordinator-General), January 2010. These ToR remain current for the Arrow LNG Plant and has been issued by the Coordinator-General as the requirements which must be addressed in developing the project EIS.
- Discuss the legislative context of the proposed project in terms of indigenous terrestrial flora and fauna ecology. Pest flora and fauna species have been specifically assessed in the separate Pest Management Plan document (Ecosure, 2011).
- Identify the existing terrestrial flora and fauna values and sensitive environmental areas within the study area that may be affected by the proposed project.
- Evaluate the potential impacts upon terrestrial flora and fauna of the study area, including an assessment of cumulative impacts of the proposed Arrow LNG Plant.
- Provide recommendations for management strategies to avoid or minimise the potential for significant adverse impacts on terrestrial flora and fauna.

This report was prepared in accordance with Section 3.3.2 of the Shell Australia LNG Project EIS Terms of Reference (ToR) (January 2010). The ToR are cross-referenced against the content of this report in Appendix A.

1.2 Project Description

1.2.1 Proponent

Arrow CSG (Australia) Pty Ltd (Arrow Energy) proposes to develop a liquefied natural gas (LNG) facility on Curtis Island off the central Queensland coast near Gladstone. The project, known as the Arrow LNG Plant, is a component of the larger Arrow LNG Project. The proponent is a subsidiary of Arrow Energy Holdings Pty Ltd which is wholly owned by a joint venture between subsidiaries of Royal Dutch Shell plc and PetroChina Company Limited.

1.2.2 Arrow LNG Plant

Arrow Energy proposes to construct the Arrow LNG Plant in the Curtis Island Industry Precinct at the southwestern end of Curtis Island, approximately 6 km north of Gladstone and 85km southeast of Rockhampton, off Queensland's central coast. In 2008, approximately 10% of the southern part of the island was added to the Gladstone State Development Area (GSDA) to be administered by the Queensland Department of Local Government and Planning. Of that area, approximately 1,500 ha (25%) has been designated as the Curtis Island Industry Precinct and is set aside for LNG development. The balance of the Gladstone State Development Area on Curtis Island has been allocated to the Curtis Island Environmental Management Precinct, a flora and fauna conservation area.

The Arrow LNG Plant will be supplied with coal seam gas from gas fields in the Surat and Bowen basins via high-pressure gas pipelines to Gladstone, from which a feed gas pipeline will provide gas to the LNG plant on Curtis Island. A tunnel is proposed for the feed gas pipeline crossing of Port Curtis.

The project is described below in terms of key infrastructure components: LNG plant, feed gas pipeline and dredging.

LNG Plant

Overview. The LNG plant will have a base-case capacity of 16 Mtpa, with a total plant capacity of up to 18 Mtpa. The plant will consist of four LNG trains, each with a nominal capacity of 4 Mtpa. The project will be undertaken in two phases of two trains (nominally 8 Mtpa), with a financial investment decision undertaken for each phase.

Operations infrastructure associated with the LNG plant includes the LNG trains (where liquefaction occurs; see 'Liquefaction Process' below), LNG storage tanks, cryogenic pipelines, seawater inlet for desalination and stormwater outlet pipelines, water and wastewater treatment, a 110 m high flare stack, power generators (see 'LNG Plant Power' below), administrative buildings and workshops.

Construction infrastructure associated with the LNG plant includes construction camps (see 'Workforce Accommodation' below), a concrete batching plant and laydown areas.

The plant will also require marine infrastructure for the transport of materials, personnel and product (LNG) during construction and operations (see 'Marine Infrastructure' below).

Construction Schedule. The plant will be constructed in two phases. Phase 1 will involve the construction of LNG trains 1 and 2, two LNG storage tanks (each with a capacity of between 120,000 m^3 and 180,000 m^3), Curtis Island construction camp and, if additional capacity is required, a mainland workforce accommodation camp. Associated marine infrastructure will also be required as part of Phase 1. Phase 2 will involve the construction of LNG trains 3 and 4 and potentially a third LNG storage tank. Construction of Phase 1 is scheduled to commence in 2014 with train 1 producing the first LNG cargo in 2017. Construction of Phase 2 is anticipated to commence approximately five years after the completion of Phase 1 but will be guided by market conditions and a financial investment

decision at that time.

Construction Method. The LNG plant will generally be constructed using a modular construction method, with preassembled modules being transported to Curtis Island from an offshore fabrication facility. There will also be a substantial stick-built component of construction for associated infrastructure such as LNG storage tanks, buildings, underground cabling, piping and foundations. Where possible, aggregate for civil works will be sourced from suitable material excavated and crushed on site as part of the bulk earthworks. Aggregate will also be sourced from mainland quarries and transported from the mainland launch site to the plant site by roll-on, roll-off vessels. A concrete batching plant will be established on the plant site. Bulk cement requirements will be sourced outside of the batching plant and will be delivered to the site by roll-on roll-off ferries or barges from the mainland launch site.

LNG Plant Power

Power for the LNG plant and associated site utilities may be supplied from the electricity grid (mains power), gas turbine generators, or a combination of both, leading to four configuration options that will be assessed:

- Base case (mechanical drive): The mechanical drive configuration uses gas turbines to drive the LNG train refrigerant compressors, which is the traditional powering option for LNG facilities. This configuration would use coal seam gas and end flash gas (produced in the liquefaction process) to fuel the gas turbines that drive the LNG refrigerant compressors and the gas turbine generators that supply electricity to power the site utilities. Construction power for this option would be provided by diesel generators.
- Option 1 (mechanical/electrical – construction and site utilities only): This configuration uses gas turbines to drive the refrigerant compressors in the LNG trains. During construction, mains power would provide power to the site via a cable (30-MW capacity) from the mainland. The proposed capacity of the cable is equivalent to the output of one gas turbine generator. The mains power cable would be retained to power the site utilities during operations, resulting in one less gas turbine generator being required than the proposed base case.
- Option 2 (mechanical/electrical): This configuration uses gas turbines to drive the refrigerant compressors in the LNG trains and mains power to power site utilities. Under this option, construction power would be supplied by mains power or diesel generators.
- Option 3 (all electrical): Under this configuration mains power would be used to supply electricity for operation of the LNG train refrigerant compressors and the site utilities. A switchyard would be required. High-speed electric motors would be used to drive the LNG train refrigerant compressors. Construction power would be supplied by mains power or diesel generators.

Liquefaction Process

The coal seam gas enters the LNG plant where it is metered and split into two pipe headers which feed the two LNG trains. With the expansion to four trains the gas will be split into four LNG trains.

For each LNG train, the coal seam gas is first treated in the acid gas removal unit where the carbon dioxide and any other acid gases are removed. The gas is then routed to the dehydration unit where any water is removed and then passed through a mercury guard bed to remove mercury. The coal seam gas is then ready for further cooling and liquefaction.

A propane, precooled, mixed refrigerant process will be used by each LNG train to liquefy the predominantly methane coal seam gas. The liquefaction process begins with the propane cycle. The propane cycle involves three pressure stages of chilling to pre-cool the coal seam gas to -33°C and to compress and condense the mixed refrigerant, which is a mixture of nitrogen, methane, ethylene and propane. The condensed mixed refrigerant and precooled coal seam gas are then separately routed to the main cryogenic heat exchanger, where the coal seam gas is further cooled and liquefied by the mixed refrigerant. Expansion of the mixed refrigerant gases within the heat exchanger removes heat from the coal seam gas. This process cools the coal seam gas from -33°C to approximately -157°C. At this temperature the coal seam gas is liquefied (LNG) and becomes 1/600th of its original volume. The expanded mixed refrigerant is continually cycled to the propane precooler and reused.

LNG is then routed from the end flash gas system to a nitrogen stripper column which is used to separate nitrogen from the methane, reducing the nitrogen content of the LNG to less than 1 mole per cent (mol%). LNG separated in the nitrogen stripper column is pumped for storage on site in full containment storage tanks where it is maintained at a temperature of -163°C.

A small amount of off-gas is generated from the LNG during the process. This regasified coal seam gas is routed to an end flash gas compressor where it is prepared for use as fuel gas.

Finally, the LNG is transferred from the storage tanks onto LNG carriers via cryogenic pipelines and loading arms for transportation to export markets. The LNG will be regasified back into sales specification gas on shore at its destination location.

Workforce Accommodation

The LNG plant (Phase 1), tunnel, feed gas pipeline, and dredging components of the project each have their own workforces with peaks occurring at different stages during construction. The following peak workforces are estimated for the project:

- LNG plant Phase 1 peak workforce of 3,500, comprising 3,000 construction workers: 350 engineering, procurement and construction (EPC) management workers and 150 Arrow Energy employees.
- Tunnel peak workforce of up to 100.
- Feed gas pipeline (from the mainland to Curtis Island) peak workforce of up to 75.
- A dredging peak workforce of between 20 and 40.

Two workforce construction camp locations are proposed: the main construction camp at Boatshed Point on Curtis Island, and a possible mainland overflow construction camp,

referred to as a temporary workers accommodation facility (TWAF). Two potential locations are currently being considered for the mainland TWAF; in the vicinity of Gladstone city on the former Gladstone Power Station ash pond No.7 (TWAF 7) or in the vicinity of Targinnie on a primarily cleared pastoral grazing lot (TWAF 8). Both potential TWAF sites include sufficient space to accommodate camp infrastructure and construction laydown areas. The TWAF and its associated construction laydown areas will be decommissioned on completion of the Phase 1 works.

Of the 3,000 construction workers for the LNG plant, it is estimated that between 5% and 20% will be from the local community (and thus will not require accommodation) and that the remaining fly-in, fly-out workers will be accommodated in construction camps. The 350 EPC management workers and 150 Arrow Energy employees are expected to relocate to Gladstone with the majority housed in company facilitated accommodation.

The tunnel workforce of 100 people and gas pipeline workforce of 75 people are anticipated to be accommodated in the mainland in company facilitated accommodation. The dredging workforce of 20 to 40 workers will be housed onboard the dredge vessel.

Up to 2,500 people will be housed at Boatshed Point construction camp. Its establishment will be preceded by a pioneer camp at the same locality which will evolve into the completed construction camp.

Marine Infrastructure

Marine facilities include the LNG jetty, materials offloading facility (MOF), personnel jetty and mainland launch site.

LNG Jetty. LNG will be transferred from the storage tanks on the site to the LNG jetty via above ground cryogenic pipelines. Loading arms on the LNG jetty will deliver the product to an LNG carrier. The LNG jetty will be located in North China Bay, adjacent to the northwest corner of Hamilton Point.

MOF. Delivery of materials to the site on Curtis Island during the construction and operations phases will be facilitated by a MOF where roll-on, roll-off or lift-on, lift-off vessels will dock to unload preassembled modules, equipment, supplies and construction aggregate. The MOF will be connected to the LNG plant site via a heavy-haul road.

Boatshed Point (MOF 1) is the base-case MOF option and would be located at the southern tip of Boatshed Point. The haul road would be routed along the western coastline of Boatshed Point (abutting the construction camp to the east) and enters the LNG Plant site at the southern boundary. A quarantine area will be located south of the LNG plant and will be accessed via the northern end of the haul road.

Two alternative options are being assessed, should the Boatshed Point option be determined to be not technically feasible:

- South Hamilton Point (MOF 2): This MOF option would be located at the southern tip of Hamilton Point. The haul road from this site would traverse the saddle between

the hills of Hamilton Point to the southwest boundary of the LNG plant site. The quarantine area for this option will be located southwest of the LNG plant near the LNG storage tanks.

- North Hamilton Point (MOF 3): This option involves shared use of the MOF being constructed for the Santos Gladstone LNG Project (GLNG Project) on the northwest side of Hamilton Point (south of Arrow Energy's proposed LNG jetty). The GLNG Project is also constructing a passenger terminal at this site, but it will not be available to Arrow Energy contractors and staff. The quarantine area for this option would be located to the north of the MOF. The impacts of construction and operation of this MOF option and its associated haul road were assessed as part of the GLNG Project and will not be assessed in this EIS.

Personnel Jetty. During the peak of construction, base case of up to 1,100 people may require transport to Curtis Island from the mainland on a daily basis. A personnel jetty will be constructed at the southern tip of Boatshed Point to enable the transfer of workers from the mainland launch site to Curtis Island by high-speed vehicle catamarans (Fastcats) and vehicle or passenger ferries (ROPAX). This facility will be adjacent to the MOF constructed at Boatshed Point. The haul road will be used to transport workers to and from the personnel jetty to the construction camp and LNG plant site. A secondary access for pedestrians will be provided between the personnel jetty and the construction camp.

Mainland Launch Site. Materials and workers will be transported to Curtis Island via the mainland launch site. The mainland launch site will contain both a passenger terminal and a roll-on, roll-off facility. The passenger terminal will include a jetty and transit infrastructure, such as amenities, waiting areas and car parking. The barge or roll-on ,roll-off facility will have a jetty, associated laydown areas, workshops and storage sheds.

The two location options for the mainland launch site are:

- Launch site 1: This site is located north of Gladstone city near the mouth of the Calliope River, adjacent to the existing RG Tanna coal export terminal.
- Launch site 4N: This site is located at the northern end of the proposed reclamation area for the Fishermans Landing Northern Expansion Project, which is part of the Port of Gladstone Western Basin Master Plan. The availability of this site will depend on how far progressed the Western Basin Dredging and Disposal Project is at the time of construction.

Feed Gas Pipeline

An approximately 8-km long feed gas pipeline will supply gas to the LNG plant from its connection to the Arrow Surat Pipeline (formerly the Surat Gladstone Pipeline) on the mainland adjacent to Rio Tinto's Yarwun alumina refinery. The feed gas pipeline will be constructed in three sections:

- A short length of feed gas pipeline will run from the proposed Arrow Surat Pipeline to the tunnel launch shaft, which will be located on a mudflat south of Fishermans Landing, just south of Boat Creek. This section of pipeline will be constructed using conventional open-cut trenching methods within a 40-m wide construction right of way.
- The next section of the feed gas pipeline will traverse Port Curtis harbour in a tunnel

to be bored under the harbour from the mainland tunnel launch shaft to a receival shaft on Hamilton Point. The tunnel under Port Curtis will have an excavated diameter of up to approximately 6 m and will be constructed by a tunnel boring machine that will begin work at the mainland launch shaft. Tunnel spoil material will be processed through a de-sanding plant to remove the bentonite and water and will comprise mainly a finely graded fill material, which will be deposited in a spoil placement area established within bund walls constructed adjacent to the launch shaft. Based on the excavated diameter, approximately 223,000 m^3 of spoil will be treated as required for acid sulfate soil and disposed of at this location.

- From the tunnel receival shaft on Hamilton Point, the remaining section of the feed gas pipeline will run underground to the LNG plant, parallel to the above ground cryogenic pipelines. This section will be constructed using conventional open-cut trenching methods within a 30-m wide construction right of way. A permanent easement up to 30-m wide will be negotiated with the relevant land manager or owner.

Should one of the electrical plant power options be chosen, it is intended that a power connection will be provided by a third party to the tunnel launch shaft, whereby Arrow Energy would construct a power cable within the tunnel to the LNG plant.

Other infrastructure, such as communication cables, water and wastewater pipelines, may also be accommodated within the tunnel.

Dredging

Dredging required for LNG shipping access and swing basins has been assessed under the Gladstone Ports Corporation's Port of Gladstone Western Basin Dredging and Disposal Project. Additional dredging within the marine environment of Port Curtis may be required to accommodate the construction and operation of the marine facilities. Up to five sites may require dredging:

- Dredge site 1 (dredge footprint for launch site 1): The dredging of this site would facilitate the construction and operation of launch site 1. This dredge site is located in the Calliope River and extends from the intertidal area abutting launch site 1, past Mud Island to the main shipping channel. The worst-case dredge volume estimated at this site is approximately 900,000 m^3.
- Dredge site 2 (dredge footprint for launch site 4N): The dredging of this site would facilitate the construction and operation of launch site 4N. This dredge site would abut launch site 4N and extend east from the launch site to the shipping channel. The worst-case dredge volume identified at this site is approximately 2,500 m^3.
- Dredge site 3 (dredge footprint for Boatshed Point MOF 1): The dredging of this site would facilitate the construction and operation of the personnel jetty and MOF at Boatshed Point. This dredge site would encompass the area around the marine facilities, providing adequate depth for docking and navigation. The worst-case dredge volume identified at this site is approximately 50,000 m^3.
- Dredge site 4 (dredge footprint for Hamilton Point South MOF 2): The dredging of this site would facilitate the construction and operation of the MOF at Hamilton Point South. This dredge site would encompass the area around the marine facilities, providing adequate depth for docking and navigation. The worst-case dredge

volume identified at this site is approximately 50,000 m^3.

- Dredge site 5 (dredge footprint for LNG jetty): The dredging of this site will facilitate the construction of the LNG jetty at Hamilton Point. This dredge site extends from the berth pocket to be dredged as part of the Western Basin Strategic Dredging and Disposal Project to the shoreline and is required to enable a work barge to assist with construction of the jetty. The worst-case dredge volume identified is approximately 120,000 m^3.

The spoil generated by dredging activities will be placed and treated for acid sulfate soils (as required) in the Port of Gladstone Western Basin Dredging and Disposal Project reclamation area.

1.3 Study Area

The study area is illustrated within Figure 1 and occurs within or adjacent to a range of land tenures and land uses, including:

- The Gladstone State Development Area (GSDA).
- Targinie State Forest.
- Garden Island Conservation Park.
- Large areas of coastal wetlands, marine and intertidal habitat.
- Medium to large scale industry (such as refineries) and associated infrastructure (such as conveyor belts and railways).
- Freehold and leasehold land, used primarily for grazing of livestock (mostly cattle), small-scale cultivation (mostly mango orchards) and/or rural residential tenements.
- Other tenures such as state land, road reserves and infrastructure easements (such as rail, gas, power).

The study area contains a diverse range of habitats ranging from intertidal vegetation, sclerophyllous woodlands, open forest, semi-evergreen vine thicket to highly disturbed farmland.

This ecological assessment takes into account only the terrestrial section of the study area. The marine area, which is defined as the area located below the highest astronomical tide (HAT), was not included in the terrestrial ecology assessment. Mangrove and salt marsh communities were however assessed as a habitat for migratory birds and other terrestrial fauna species such as the water mouse (*Xeromys myoides*). Marine species, such as whales, dugong (*Dugong dugong*), marine benthic fauna, were not included in this survey however were included in the Marine and Estuarine Ecology Impact Assessment (Coffey Environments, 2011a).

For this study 'the region' refers to the northern extent of the Burnett-Curtis Hills and Ranges sub-region of the southeast Queensland bioregion and southeastern extent and northeastern extent of the Marlborough Plains and Mount Morgan Ranges sub-regions of the Brigalow Belt bioregion as defined in Sattler and Williams, (1999) Under the Australia Natural Resources Atlas these subregions are defined as SEQ1, BBN14 and BBS4 respectively

(DEWHA, 2009c). The Marlborough Plains and Mount Morgan Ranges sub-regions are located within the Brigalow Belt North and Brigalow Belt South bioregions respectively.

1.4 Project Area

The project area is the actual footprint of the project. For this assessment, the project area has been considered to be synonymous with the area of disturbance.

The balance of the project area is located upon the southwestern extent of Curtis Island and includes Hamilton Point, Boatshed Point and the area southwest of Ship Hill. On the mainland, the tunnel entry shaft and tunnel spoil disposal area is southeast of Boat Creek and on the coastal side of Gladstone-Mount Larcom Road. TWAF 7 is on the Calliope River to the north of Gladstone-Mount Larcom Road and TWAF 8 lies to the west of Targinie State Forest. Launch site 1 is northeast of TWAF 7 and is located at the entrance to the Calliope River.

Construction of the proposed LNG plant north of Boatshed Point will intersect the existing ephemeral stream that drains the southern slopes of Ship Hill and adjacent ridges. Alluvium (2011) has advised that diversion of the watercourse east and west of its current alignment will be required to intercept the stream and associated side gullies, and overland flows. Two conceptual routes have been nominated, one around the north and west of the LNG plant and the other to the north and east of the LNG plant.

It is anticipated both diversions will be required, as the major north–south ridge running through the LNG plant site effectively creates two sub-catchments of the ephemeral watercourse. The terrain adjacent to the western, northern and eastern boundaries of the LNG plant bench necessitates different arrangements (cross sections) for the diversions. The stream diversion to the west (where outside of the study area) is unlikely to result in any physical disturbance beyond some increase to overland flows. As a result, this area has not been included within this terrestrial ecology impact assessment.

The study and project area are shown in Figure 1.

Figure 1 Study and Project Area Map

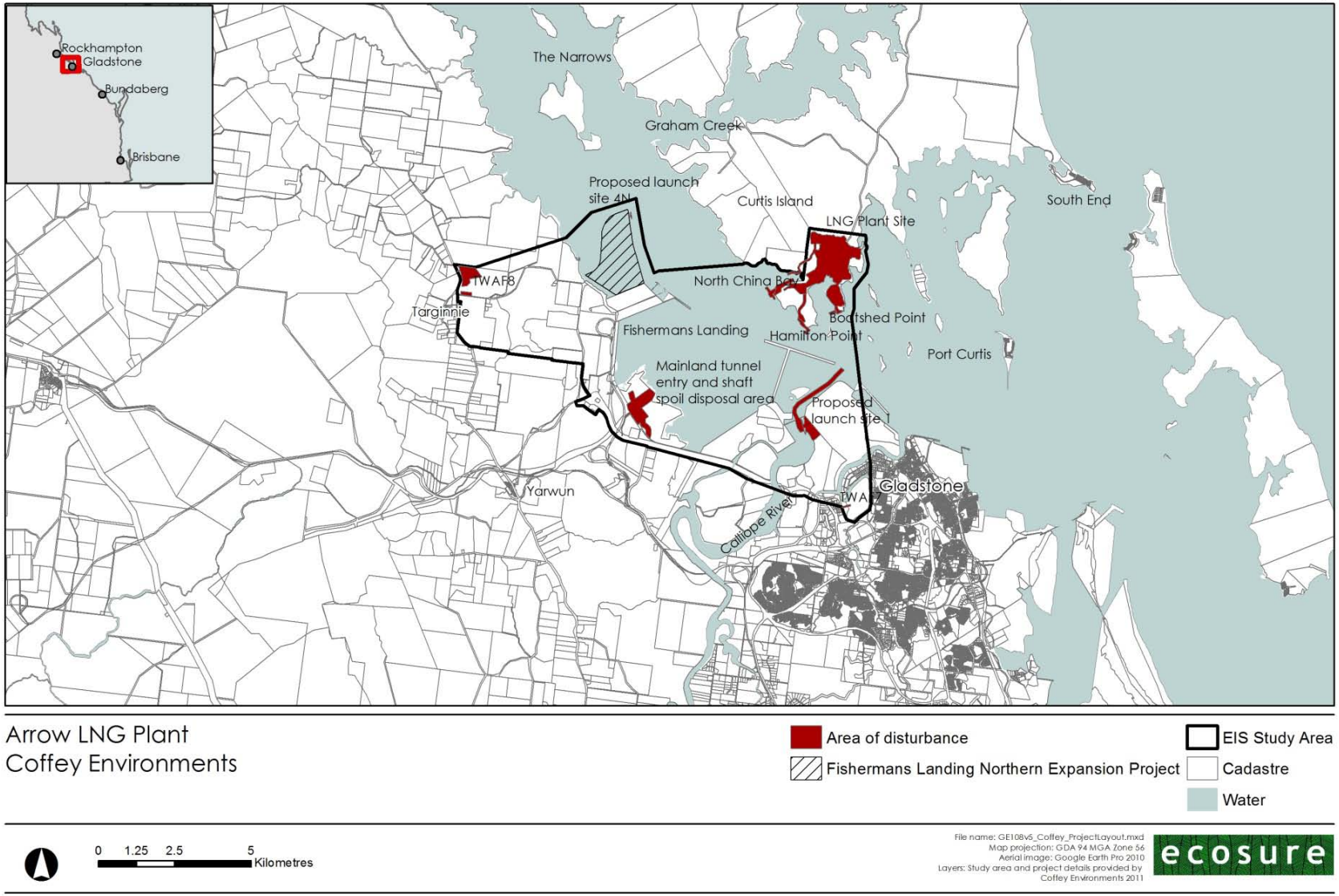


Figure 1 Study and Project areas

2 Legislative Context and Standards

The project is subject to a range of legislative instruments and policy requirements which direct the environmental approvals process for the project.

2.1 Legislation

A number of Commonwealth, state and local legislation, plans and policies are relevant to the terrestrial ecology within the study area (Table 1).

Table 1 Relevant legislative instruments.

Legislative Instrument	Administering Authority	Description
Commonwealth		
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	Department of Sustainability, Environment, Water, Populations and Communities(DSEWPC)	Aims to protect the environment, in particular, Matters of National Environmental Significance (MNES). If a development proposal is identified as potentially having a significant impact upon a MNES it must be referred to DSEWPC (an EPBC referral).
State		
Sustainable Planning Act 2009 (SPA) Sustainable Planning Regulation 2009 (SP Reg)	Department of Local Government and Planning (DLGP)	Replaced the *Integrated Planning Act 1997* (18 December 2009). Seeks to achieve sustainable planning outcomes through: · Managing the process by which development takes place. · Managing the effects of development on the environment. · Continuing the coordination and integration of local, regional and state planning.
State Development and Public Works Organisation Act 1971 (SDPWO Act)	DLGP	This act supports Queensland's economic and social development. Its purpose is to provide for state planning and development through a coordinated system of public works organisation and for environmental coordination. State development areas are created under S77 of the Act. Their creation promotes economic development and provides for the development of industrial land and infrastructure corridors. The Gladstone State Development Area (GSDA) was declared in December 1993.
Environmental Protection Act 1994 (EP Act) Environmental Protection Regulation 2008 (EP Reg)	Department of Environment and Resource Management (DERM)	Provides for the protection of Queensland's environment whilst allowing for ecologically sustainable development (ESD). Encompasses: · Environmental Impact Statement (EIS) process for mining or petroleum activities. · Regulation of 'Environmentally Relevant Activities' (ERAs) through the EP Reg. · Environmental management and general environmental duty provisions. · The Regulation provides criteria for mining activities and defines relevant environmentally sensitive areas.

Legislative Instrument	Administering Authority	Description
Environmental Protection (Noise) Policy 2008 (EPP (Noise))	DERM	The purpose of the EPP (Noise) is to achieve the objectives of the EP Act in relation to the acoustic environment.
Vegetation Management Act 1999 (VMA) Vegetation Management Regulation 2000	DERM	Regulates the clearing of native vegetation on freehold and leasehold land. Operational work that is the clearing of native vegetation (under SPA) requires assessment against the provisions of the VMA. See Appendix F for more detail on regional ecosystems, which are given a conservation classification under the Vegetation Management Regulation 2000.
Nature Conservation Act 1992 (NCA) Nature Conservation (Wildlife) Regulation 2006	DERM	Based on principles to conserve biological diversity, ecologically sustainable use of wildlife and ecologically sustainable development. Places requirements on any person taking, using or interfering with protected fauna. Defines what constitutes a protected area (i.e., National Park) and states how these areas should be managed. The Nature Conservation (Wildlife) Regulation 2006 defines the conservation status of native wildlife species in Queensland (i.e., 'Endangered', 'Vulnerable', 'Near Threatened', 'Least Concern').
Coastal Protection and Management Act 1995	DERM	Provides for the protection and management of the coastal zone, primarily through Coastal Management Plans (considered State Planning Policies under SPA).
Land Act 1994	DERM	Provides for the management of non-freehold land by promoting the allocation of land for the purpose of sustainability, development, community, environmental protection.
Land Protection (Pest and Stock Route Management) Act 2002	Department of Employment, Economic Development and Innovation (DEEDI)	Regulates the use of Queensland's stock route network which incorporates road and infrastructure corridors. Also provides a framework for the management of weeds and pest animals. See Sections 4.4 and 4.8 below, along with Ecosure (2011) for more detail on classes of pests under this act.
Fisheries Act 1994	DEEDI	Regulates fisheries, coastal areas important as fisheries habitat, and marine plants.

2.2 Plans, Policies and Environmental Management

2.2.1 Industry Specific

The Australian Pipeline Industry Association (APIA) Code of Environmental Practice – Onshore Pipelines (2005) (Ecos Consulting, 2009): the code identifies best practice management measures to mitigate or eliminate the environmental impacts of pipeline construction and operation.

2.2.2 Development and Planning Documents

Draft Policy Statement: Use of environmental offsets under the *Environment Protection and Biodiversity Conservation Act 1999* (Department of the Environment and Water Resources, 2007): this draft policy statement outlines the Australian Government's position on the use of environmental offsets under the EPBC Act. The aim is to ensure the consistent, transparent

and equitable use of environmental offsets under the Act. This policy is likely to apply to the project in order to compensate for impacts on MNES (see Section 7.1 for more detail).

Nature Conservation (Koala) Conservation Plan 2006 and Management Program 2006-2016 (EPA, 2006a): provides a statutory and policy framework for the purpose of conserving koalas (*Phascolarctos cinereus*) in the wild in Queensland.

Regrowth Vegetation Code – on freehold and indigenous land and leasehold land for grazing - Version 1 (DERM, 2009a): guides the application for clearing and/or management of regulated regrowth vegetation. This policy is likely to apply to the project to compensate for impacts on regrowth vegetation (see Section 7.1 for more detail).

Policy for Vegetation Management Offsets (DERM, 2009b): describes how, in certain circumstances, vegetation offsets provide a mechanism for development and infrastructure projects to proceed whilst ensuring the long-term conservation of remnant regional ecosystems. It sets criteria and provides guidance for what would constitute an acceptable offset. This policy is likely to apply to the project to compensate for impacts on remnant vegetation (see Section 7.1 for more detail).

Fish Habitat Management Operational Policy FHMOP 005 (Dixon and Beumer, 2002): this policy provides information on Queensland Fisheries (DEEDI) requirements for mitigation and compensation where fish habitat loss is proposed. This policy is likely to apply to the project to compensate for impacts on fish habitat (see Section 7.1 for more detail).

Draft Policy for Biodiversity Offsets (EPA, 2008a): guides the application of biodiversity offsets to address biodiversity impacts. This policy is triggered through the NCA. This policy is likely to apply to the project to compensate for impacts on values such as wildlife protected under the NCA (see Section 7.1 for more detail).

Queensland Coastal Plan (DERM, 2011a): seeks to ensure that coastal qualities are preserved and infrastructure and livelihoods are protected from coastal hazard impacts. This Plan lists specific management actions which should be carried out on Curtis Island, for instance: 'to the extent practicable, land managers are to manage vehicles to minimise impacts on coastal resources on and adjacent to beaches, in north and east Curtis Island'.

Central Queensland Regional Growth Management Framework (Central Queensland Regional Planning Advisory Committee, 2002): is a broad-based regional plan focussing on regionally significant issues across environmental, economic and social dimensions. The project seeks to complement and enhance other planning processes and strategies across the region by providing a vehicle through which the region's vision and aspirations can be articulated to state and federal governments.

Curtis Coast Regional Coastal Management Plan (Environmental Protection Agency, 2003): provides for the protection and management of the coastal zone within the Curtis Coast region.

Development Scheme for the Gladstone State Development Area (Queensland Government, 2008): provides for the designation of land within the specified area as of state

economic importance, facilitating the development of major industry.

'The Gladstone Plan' – Planning Scheme for the City of Gladstone (Sinclair Knight Mertz, 2006): provides the framework for managing development within the Gladstone region in a way which advances the purposes of the *Sustainable Planning Act 2009*.

2.2.3 Recovery Plans

Several recovery plans or conservation advice statements apply to threatened flora and fauna species which are known to/may occur in the study area. Action plans and conservation statements review the conservation status of major taxonomic groups or individual species, identify threats and recommend actions to minimise those threats. A series of action plans for threatened fauna have been prepared by the Commonwealth Government. Those potentially relevant to the study area include terrestrial mammals (Lee 1995; Maxwell and Morris, 1996), bats (Duncan and Montgomery 1999), birds (Garnett and Crowley, 2000), frogs (Tyler, 1997), reptiles (Cogger and Eggler, 1993) and butterflies (Sands and New, 2002). Two recovery plans have been prepared which may also be relevant - for yellow chat (*Epthianura crocea Macgregori*) (Capricorn subspecies) (Houston and Melzer, 2008) and black-breasted button-quail (*Turnix melanogaster*) (Mathieson and Smith, 2009).

Relevant to threatened flora likely to occur in the study area, an action plan has been prepared for cycads (Queensland Herbarium, 2007) and conservation advice statements have been produced for the balance of species afforded a conservation status under the EPBC Act.

National recovery plans exist for Endangered Ecological Communities, including semi-evergreen vine thicket of the Brigalow (North and South) and Nandewar Bio-regions (McDonald, 2010).

2.2.4 Conservation Plans

A wildlife conservation plan sets out the research and management actions necessary to support the survival of one or more migratory, marine, conservation dependant or cetacean species listed under the EPBC Act which are not considered endangered or vulnerable, but would benefit from a nationally coordinated approach to conservation. Two conservation plans may be relevant to this project:

- Wildlife Conservation Plan for Migratory Shorebirds (Department of Environment and Heritage, 2006a).
- Queensland Government Nature Conservation (Koala) Conservation Plan 2006 and Management Program 2006-2016 (Environmental Protection Agency, 2006a).

2.2.5 Significant Impact Guidelines

Significant impact guidelines provide overarching guidance to determine whether an action is likely to have a significant impact on a MNES. These guidelines replace the EPBC Act administrative guidelines on significance (July 2000). The following significant impact guidelines have been identified as relevant to MNES within the study area:

- Draft EPBC Act Policy Statement 3.20: Significant impact guidelines for the Vulnerable water mouse *Xeromys myoides (*DEWHA*,* 2009a*)*.
- Draft EPBC Act policy statement 3.21: Significant impact guidelines for 36 migratory shorebird species (DEWHA, 2009b).
- Significant Impact Guidelines 1.1: Matters of National Environmental Significance (DEH, 2006b).
- EPBC Act Policy Statement 3.2: Grey-headed Flying Fox (DEH, 2003).

2.2.6 Biodiversity Planning Assessments

The Biodiversity Planning Assessments (BPAs) undertaken by DERM identify areas of state, regional and local biodiversity significance (Environmental Protection Agency, 2002a). BPAs determine biodiversity significance by assessing a range of ecological criteria including ecosystem diversity, condition, connectivity, tract size and habitat value (Environmental Protection Agency, 2002a). Criteria may also include expert panel recommendations for areas which are known to support ecological features such as rare species or wildlife refugia (EPA, 2006b).

2.3 Conservation Status

The conservation status of species listed in this report may be described as Critically Endangered, Endangered, Vulnerable, Rare or Near Threatened and/or Migratory. The conservation status of listed species is defined by the EPBC Act and/or the Nature Conservation (Wildlife) Regulation (2006) (Qld).

Migratory birds listed in the following international agreements and protected under the EPBC Act are termed *migratory* in this report:

- Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment. China – Australia Migratory Bird Agreement (CAMBA).
- Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment. Japan – Australia Migratory Bird Agreement (JAMBA).
- Agreement between the Government of Australia and the Government of the Republic of Korea - Australia Migratory Bird Agreement (ROKAMBA).
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

Regionally important flora species are those identified by the bioregional Biodiversity Planning Assessments for the Brigalow Belt South and Southeast Queensland Bioregions (EPA, 2002a; DEWHA, 2009c).

3 Study Method

3.1 Overview

The impacts from the project on terrestrial ecology were considered through a literature review, flora and fauna surveys and assessments of potential, residual and cumulative impacts. This involved:

1 **Identifying baseline environmental conditions.** Review of existing information and flora and fauna surveys to identify any significant terrestrial ecological values within and/or immediately adjacent to the project area' (**Section 4**).

2 **Assessing potential impacts** of the proposed project on the ecological values. (**Section 5**).

3 **Determining appropriate mitigation measures** to minimise impacts on the existing environment (**Section 6**).

4 **Assessing residual impacts,** assuming the implementation of all recommended mitigation measures (**Section 7**).

5 **Estimating cumulative impacts** based on the potential impacts of other projects in the vicinity of the development area (**Section 8**).

3.2 Nomenclature

For flora, the application of scientific names in this report follows Bostock and Holland (2007). In the first occurrence in the text, scientific names of flora will be followed by their common name (if one exists). As not all flora species have a common name, and there are often many local variations to common names given, flora will be referred to by their scientific names throughout this report. Common names were derived from Harden *et al.* (2006a and 2006b), Brooker and Kleinig (2004), Maslin (2001), Hacker (1990), Sharp and Simon (2002), and Auld and Medd (2002).

Nomenclature used in this report for fauna species follows Christidis and Boles (2008) for birds, Van Dyck and Strahan (2008) for non-flying mammals, Churchill (2008) for bats, Wilson and Swan (2010) for reptiles and Tyler and Knight (2009) and Cogger (2000) for amphibians. Migratory and resident bird species are described by the generic terms 'shorebirds' and 'waders' from the following families: Burhinidae, Charadriidae, Glareolidae, Haematopodidae and Scolopacidae. In the first occurrence in the text, common name of fauna will be followed by their scientific names. In all consecutive occasions, only the common name will be used. This method aids in the ease of report comprehension.

Use of an asterisk (*) indicates the species is not native to Queensland. A full list of scientific names for all flora and fauna species in this report is presented in Appendices B and C.

3.3 Literature Review

Existing information regarding terrestrial flora and fauna ecology within the study area was collated and systematically reviewed. Relevant aerial photography was also interpreted. Refer to Section 2.1 and 2.2 and the reference list for documents reviewed in the preparation of this report.

A 30 km buffer was applied to the study area for the purpose of database searches and the literature review. The intention was to identify significant species from a legislative perspective with the potential to occur within the study area. The literature review enabled survey effort to be targeted towards species and communities with conservation significance which were considered likely to occur in the study area.

3.3.1 Existing Data

Relevant environmental databases were analysed to identify significant flora and fauna species and environmentally sensitive areas potentially occurring in the study area. Database searches undertaken are listed in Table 2.

Table 2 Database searches.

Data Source	Administering Authority	Description
EPBC Protected Matters Search Tool	DSEWPC	The EPBC Protected Matters Search Tool provides a report on MNES significance that may occur within a designated area. Information is gathered from a range of data sources and may be projected from instruments such as recovery plans, state vegetation maps, remote sensing imagery and other sources.
DERM *Wildlife Online* database (Wildnet)	DERM	The Wildlife Online database records observations of all species identified at known locations within Queensland.
DERM Biodiversity Planning Assessment GIS database	DERM	The Biodiversity Planning Assessments (BPAs) database provides vegetation mapping data at the landscape scale, generated or approved by the Queensland Herbarium, to assist in the assessment of biodiversity values. A designation of State or Regional biodiversity value is assigned to special areas containing significant biodiversity features (such as rare species or wildlife refugia).
DERM Wetland*Info* database	DERM	The interactive mapping site (Wetland*Maps*) provides wetland mapping and wetlands inventory data in a GIS format.
Queensland Herbarium *HerbRECS* database	Queensland Herbarium	*HerbRecs* catalogues specimen-backed records from incidental and systematic collections at known locations.
Queensland Museum Collection database	Queensland Museum	The database shows the collection location of specimens in the museum collection.
Birds Australia Atlas GIS database	Birds Australia	The Atlas database stores data from more than 420,000 bird surveys conducted by volunteers throughout Australia. The precise location of bird surveys is recorded, allowing data to be extracted for specific areas.

Data sets used in the literature review, and for map development are presented in Table 3 below, along with their limitations. These accepted data sets are provided by State and Commonwealth government departments. Where possible, ground truthing during field surveys was used to verify this data.

Table 3 Data sets used and their limitations.

Data Set	Limitations
World Heritage Area	All data used was provided by Coffey Environments and the metadata did not provide information on data limitations.
Regional Ecosystems Essential Habitat Regrowth	The positional accuracy is primarily dependant on the accuracy of the Herbarium Regional Ecosystem Mapping. The Regional Ecosystem version depends on the release date of the relevant Biodiversity Planning Assessment. On average it is expected that the accuracy is: Polygons 100 m – 500 m; Traverses 10 m – 300 m; Sites 10 m – 100 m (based on 1:100 000 RE mapping). Conversion between different GIS formats and different projections can result in errors in the GIS coverage. For this work it was estimated that this buffer area error was approximately 0.3% of the total area.
Essential Habitat	This dataset is based on RE mapping (see above) and Wildnet data. Due to time lags from creating the dataset and its availability for use, the data is not the most recent and can be outdated.
BPA wildlife corridors	This dataset is based on RE mapping and Wildnet data. Due to time lags from creating the dataset and its availability for use, the data is not the most recent and can be outdated.
Significant Species – some data from Wildnet	Data is not always collected by experts, which provides a window for error. An area may have been surveyed for a targeted species, so may not have captured everything within the area. A species may be present within an area, but not listed within this dataset.
Queensland State Significant Wetlands	All data used was provided by Coffey Environments and the metadata did not provide information on data limitations.
Conservation Parks	All data used was provided by Coffey Environments and the metadata did not provide information on data limitations.
State Forest	All data used was provided by Coffey Environments and the metadata did not provide information on data limitations.
Queensland Regional Ecosystems	The positional accuracy is primarily dependant on the accuracy of the Herbarium Regional Ecosystem Mapping. The Regional Ecosystem version depends on the release date of the relevant Biodiversity Planning Assessment. On average it is expected that the accuracy is: Polygons 100 m – 500 m; Traverses 10 m – 300 m; Sites 10 m – 100 m (based on 1:100 000 RE mapping). Information is based on aerial images and data is not ground truthed, so can be inaccurate. Ecosure ground truthed the project site and so were able to rectify these potential errors.
Areas of Biodiversity Significance - South East Queensland	All data used was provided by Coffey Environments and the metadata did not provide information on data limitations.
Areas of Biodiversity Significance - Brigalow Belt	All data used was provided by Coffey Environments and the metadata did not provide information on data limitations.

3.3.2 Relevant Projects and Studies

The terrestrial ecology of the Gladstone area has been extensively studied in recent years. The study area for this project was broadly characterised based on such studies and published data (sourced from scientific literature). This literature review also encompassed projects considered in the baseline assessment and cumulative impact assessment (see Section 3.7). This includes other LNG projects as well as other projects within the GSDA including water, nickel, aluminium, coal, steel and oil facilities and associated infrastructure.

3.4 Flora Field Survey

The literature review identified several information gaps which required further investigation to enable the assessment of potential impacts. These included vegetation communities which required ground truthing to confirm their presence, type, status and extent. A risk based approach was adopted for determining where detailed surveys would be completed based on the likely incongruence of actual vegetation communities with state

maps and where the project was likely to cause greatest impact. Targeted surveys for significant flora species, which the literature review indicated as likely or possibly present, were also required.

The survey program was undertaken in four stages and included a preliminary field investigation in December 2009, a detailed field survey in July 2010 (refer to Limitations, Section 3.6) and supplementary surveys in September 2010 and February 2011.

All surveys were performed in accordance with the *Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland, Version 3.1* (Neldner et al., 2005). Appendix F provides general information on the vegetation management and biodiversity status of regional ecosystems under Queensland legislation.

3.4.1 Assessment Sites

The allocation of sites in accordance with the sampled vegetation type is presented in Table 4. Sites were either within regional ecosystems, regulated regrowth vegetation, or non-remnant vegetation. Detailed information relating to the assessment sites is provided in Appendix D.

Table 4 Site selection – across all survey events.

Type of vegetation assessment site	Total	DERM mapped Regional Ecosystems	DERM mapped regulated regrowth vegetation
Secondary	11	10	1
Tertiary	23	22	1
Quaternary	39	36	3

The validation of regional ecosystem and high value regrowth vegetation mapping was conducted at a total of 73 vegetation assessment sites, with multiple sites assessed within most RE types. A combination of secondary, tertiary and quaternary vegetation assessment sites were conducted in compliance with Neldner et al. (2005) using a specific proforma. The data that was collected using these assessment types is described below. Secondary sites utilise a 0.1 ha quadrat, while Tertiary and Quaternary sites are plotless.

Secondary Assessment Sites

Data collected included:

- Date and precise location (with reference to handheld global positioning system {GPS}).
- Soils, slope, aspect and landform observations.
- Ground-layer, mid-stratum and canopy species composition and relative abundance.
- Structural characteristics.
- Condition and disturbance (including distribution of weed species, land use impacts, natural recruitment, tree health).
- Quantitative and qualitative species composition within a 1000 m^2 quadrat, and documentation of ancillary species identified within the immediate area during foot traverses through the vegetation type.

- Basal area and stem count of vegetation.
- Detailed photographs of the community (north, east, south, west, groundcover and soils).

Tertiary Assessment Sites

Data collected included:

- Date and precise location (with reference to handheld GPS).
- Soils, slope, aspect and landform observations.
- Ground-layer, mid-stratum and canopy species composition and abundance.
- Structural characteristics.
- Condition and disturbance (including distribution of weed species) photographs of the community.

Quaternary Assessment Sites

Data collected included:

- Date and precise location (with reference to handheld GPS).
- Mid-stratum and canopy species composition and abundance.
- Structural characteristics of ecologically dominant layer.
- Condition.
- Limited photographs of the community.

In addition to secondary, tertiary and quaternary vegetation assessment sites, portions of the study area were traversed on foot and the Random Meander technique applied (Cropper, 1993). This methodology was applied to ensure adequate site coverage and to establish a comprehensive floral species list for the study area. This method also facilitated the detection of threatened species.

It is anticipated that in combination with the detailed desktop review, the survey effort allowed adequate assessment of the composition and distribution of existing vegetation types within the study area. However, a considerably larger number of replicate sites would need to be surveyed to satisfactorily prepare a *Property Map of Assessable Vegetation* for the entire study area footprint. This map is required to amend vegetation management maps (DERM, 2009c).

3.4.2 Coordinate System and Map Datum

Positional data was collected with either a handheld *Garmin eTrex Vista HCX* or *Garmin GPSmap 60CSx* GPS, with an accuracy of 4 to 10 m. Locations were recorded using the UTM coordinate system. All locations presented in this report are within zone 56 K. The map datum used was GDA94.

3.4.3 Floral Inventory and Relative Abundance

A comprehensive flora species list, including native and introduced species, was compiled for the study area (Appendix B). Relative abundance of flora species was assessed on a site by site basis and abundance estimates were applied to species within each stratum of the community.

The ecologically dominant layer (EDL) was given greatest attention, as these species define the community and enable the determination of the regional ecosystem type (Neldner et al., 2005). The status (*remnant*/*non-remnant*) of existing vegetation is determined by comparing the existing predominant canop*y* with the *undisturbed* predominant canopy. The Queensland Herbarium defines the predominant canopy in the VMA, as the EDL; namely, that stratum of the vegetation which contains the most above ground biomass. The EDL can be defined in terms of growth form, height, cover density and species. In the majority of cases, the EDL is equivalent to the upper stratum as defined by Walker and Hopkins (1990).

Abundance assessments of canopy species were quantitative (the basal area of stems per hectare was calculated using the Bitterlich stick methodology {Grosenbaugh, 1953, Loetsch *et al*., 1973}) at all tertiary and secondary sites. This method was applied in conjunction with an estimation of crown cover (based on the crown or line intercept methodology {Greig-Smith, 1964, Neldner et al., 2005}). This allowed a descriptive measure of cover which, combined with growth form and median height, and defined the structure of the vegetation community based on structural formation classes described by Walker and Hopkins (1990). Table 5 defines these classes.

Table 5 Structural formation classes for woody plant communities qualified by height (classes defined by growth form, height and cover).

Vegetation cover equivalents	**Foliage projective cover**	70-100%	30-70%	10-30%	<10%
	Crown separation	Closed or dense	Mid-dense	Sparse	Very sparse
	Field criteria	Touching-overlap	Touching – slight separation	Clearly separated	Well separated
	Crown separation ratio[1]	<0	0-0.25	0.25-1	1-20
	Crown cover %[2]	100-81%	81-52%	52-20%	20-0.2%

Growth form and height	**Growth Form[3]**	**Structural Formation Classes (qualified by height)**			
	Trees > 30m	Tall closed-forest	Tall open-forest	Tall woodland	Tall open-woodland
	Trees 10 – 30m	Closed-forest	Open-forest	Woodland	Open-woodland
	Trees < 10m	Low closed-forest	Low open-forest	Low woodland	Low open-woodland
	Shrubs 2 – 8m	Closed-scrub	Open-scrub	Tall shrubland	Tall open-shrubland
	Shrubs 1 – 2m	Closed-heath	Open-heath	Shrubland	Open-shrubland
	Shrubs <1m	-	-	Dwarf shrubland	Dwarf open-shrubland

[1] Equivalent to Specht (1970) projective foliage cover classes from Walker and Hopkins (1990).

[2] Equivalent crown cover from Walker and Hopkins (1990).

[3] Growth form of the EDL.

Source: Neldner and Wilson (2003)

The crown cover definitions and associated crown separation descriptions were also applied to the lower strata to allow a consistent description of spatial distribution of the respective vegetative layers.

The landform description used to determine field validated vegetation communities was based on simple erosional landform patterns characterised by relief and modal slope as described by Speight (1990).

For compilation of detailed floristic inventories at all secondary level assessment sites, the relative abundance of species was based on the Braun-Blanquet technique (Mueller-Dombois & Ellenberg, 1974, Whittaker, 1975) as follows: 1 = sparse, <5%; 2 = any number, <5%; 3 = 5 – 24%; 4 = 25 – 49%; 5 = 50 – 74%; 6 = 75 – 100%.

3.4.4 Vegetation Mapping

Regional ecosystems (REs) are vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil type. REs are designated by the Queensland Herbarium (part of the DERM).

The statutory status of an RE is defined under Section 22 of the *Vegetation Management Act 1999* as 'Endangered', 'Of Concern' or 'Least Concern'. This status is based on an assessment of the pre-clearing and remnant extent of a RE and is listed in the Vegetation Management Regulation 2000. The vegetation management status only applies to remnant vegetation. High value regrowth and regrowth watercourse vegetation are collectively known as 'regulated regrowth'. Appendix F provides further discussion on RE's, their legislative status (including both vegetation management status and biodiversity status) and regulated regrowth. Appendix F also provides details on the terms 'Endangered', 'Of Concern' or 'Least Concern' and the percentages of a vegetation type required for it to fit into each category.

DERM mapped RE's were validated in the field using the transect data described above and geological mapping. Where required, the boundaries of vegetation types were mapped in the field using a hand-held GPS and/or aerial photograph interpretation. Aerial photograph analysis was used where vegetation boundaries were easily distinguishable (such as mangrove low closed forest).

3.4.5 Ancillary Information

Other field characteristics such as areas of weed infestation, habitat areas for rare and threatened species and regional connectivity were recorded and described. Photographic records were taken throughout the study area, capturing each community type, habitat type, potential impact areas and the broader landscape.

3.4.6 Licensing and Permits

All field investigations were carried out under a current Scientific Purposes Permit (Queensland Environmental Protection Agency WISP06018509) for ecological surveys.

3.4.7 Preliminary Field Investigation

The preliminary field investigation was conducted on 14th to 16th December 2009. This was representative of a late dry season survey. The study area was cursorily sampled with particular focus on areas identified subject to moderate to very high levels of regulatory constraint.

Access was limited to public roads on the mainland, designated areas of the Arrow LNG Plant site on Curtis Island and mangrove habitat accessible by boat from Gladstone Harbour. Quaternary level vegetation assessment was undertaken at 18 sites (Appendix D). This type of assessment provided a reasonable opportunity to observe the coarse structural composition and habitat potential of most vegetation communities within the study area. This allowed the rapid validation of the general accuracy of vegetation mapping applicable to the study area.

3.4.8 Detailed Flora Survey

The detailed flora survey was conducted between 12th and 22nd July 2010. The detailed flora survey methods were developed to:

- Validate existing Queensland Herbarium regional ecosystem (RE) and regulated regrowth mapping and better define the distribution and proportionate composition of REs within observed mixed polygons.
- Target rare and threatened flora species and their habitats as identified from database searches (Refer to Section 3.3.1).
- Target threatened ecological communities as listed under the EPBC Act.
- Produce a comprehensive quantitative floral inventory for all vegetation assessment sites and the study area as a whole.

Assessment sites were preferentially located within DERM mapped remnant and regulated regrowth vegetation. The variation and condition of the REs within these areas was specifically targeted. Additional areas of regulated regrowth and non-remnant vegetation were also surveyed in order to ensure coverage of the entire study area and sampling of all potential habitat types.

Secondary level vegetation assessments were completed at 11 sites. One quaternary and 16 tertiary level vegetation assessment sites were also surveyed during this period. The lower levels of sampling (tertiary and quaternary surveys) were conducted to supplement information relating to the vegetative structure and to assist in mapping the extent and distribution of the identified REs and regulated regrowth within the study area.

3.4.9 Supplementary Surveys

During pre-clearing vegetation assessments relating to geotechnical investigations on Curtis Island (outside of the scope of this report), specimens of an anticipated threatened flora species (possibly a previously unrecorded species of *Cupaniopsis*) were identified within the Arrow LNG Plant project area. The Queensland Herbarium requested further research and sampling to enable positive identification and establish population size and regional distribution. Following discussions between the Queensland Herbarium, Arrow Energy and Coffey Environments, two Ecosure ecologists surveyed the study area between 1st and 4th September 2010. The purpose of this supplementary survey was to describe the population of this species within the study area as well as to determine the extent of its presence in the immediate surrounding region. Vegetative and reproductive material was also collected to assist the Herbarium with resolution of taxon status.

An additional supplementary survey was undertaken between 19th and 20th February 2011. This survey focused on the mainland tunnel entry shaft and tunnel spoil disposal area, the headland between North China Bay and Hamilton Point and two sites on the mainland which were identified as potential locations for TWAFs. Specifically, the areas included in this survey were:

- The entire headland between North China Bay and Hamilton Point on Curtis Island [Lot 5 on SP235936, 238.08 Ha].
- Mudflats and fringing mangal (mangrove low closed forest) and saltmarsh in the vicinity of the the proposed mainland tunnel entry shaft and tunnel spoil disposal area [Lot 1 on SP235026, 210.5 Ha].
- TWAF 7 [Lot 200 on CTN2173, 71.6 Ha].
- TWAF 8 [Lot 46 on SP235946, 50.99 Ha].

These sites were either additions to the study area or they were revisited due to further definition in the extent and location of project infrastructure. A total of 20 quaternary and seven tertiary vegetation assessment sites were surveyed.

3.4.10 Flora Survey Effort

Approximately 350 person hours were spent by a team of two across the four survey events. This time was spent in the study area as well as in the surrounding region.

3.5 Fauna Field Survey

The review of existing information allowed the prioritisation of habitat areas and locations for the field survey program. The fauna survey methods were developed to:

- Undertake targeted surveys for species listed under the EPBC and NCA identified from the review of existing information as potentially occurring within the study area.
- Produce a faunal inventory representing of the vertebrate fauna assemblages present at selected survey sites and the study area as a whole.
- Conduct fauna surveys in the broad habitat types present within the study area.

- Identify and assess the habitat values of selected survey sites and the study area as a whole, in relation to fauna presence and distribution.

Species recorded within 5 km of the study area have been assumed to occur within the study area, where suitable habitat exists.

3.5.1 Licences and Permits

All field investigations were completed under a current Scientific Purposes Permit (DERM - WISP06018509) for ecological surveys and Animal Ethics Committee Approved Application Number CA 2009/02/327 (DEEDI).

3.5.2 Preliminary Field Investigation

A preliminary field investigation was conducted on 14th to 16th December 2009. The study area was cursorily sampled with particular focus on areas identified as subject to moderate to very high levels of regulatory constraint. Access was limited to public roads on the mainland, designated areas of the Arrow LNG Plant site on Curtis Island and mangrove habitats which were accessible by boat from Port Curtis. Incidental observations of terrestrial fauna were also recorded.

3.5.3 Targeted Fauna Survey

A targeted fauna survey was undertaken on 4th to 6th February 2010 to provide data representative of wet season conditions. Due to torrential rain prior to and during the visit, access was severely restricted within the study area and the survey was abandoned after three days. As a result of lack of wet season surveys, it is likely that the detectability was reduced for amphibians, reptiles, some migratory bird species and most mammals.

Targeted surveys were completed between 12th and 24th July 2010 to provide data representative of dry season conditions. A range of survey techniques were used (DEWHA, 2010a; 2010b; 2010c).

Fauna survey sites were selected to sample the range of remnant, regrowth and cleared habitats present throughout the study area (Appendix E). The spatial distribution of sites was determined by reviewing aerial photography and vegetation mapping, and subsequently refined during several reconnaissance trips to the study area. The survey methods used at each site were chosen according to the habitat type, condition, ecological value and the likely presence of rare or threatened species.

Diurnal bird search

Area searches for diurnal birds were performed during the early morning and late afternoon. Surveys at each site were a minimum of 40 minutes in duration and occurred within four hours of sunrise. Afternoon surveys were conducted in the two hours prior to sunset. Birds were identified by either direct observation or call recognition.

Nocturnal bird call playback

Nocturnal bird call playback surveys were undertaken for owls. Calls were broadcast from a megaphone in a systematic order with several minutes separating the calls of each species and a listening period for response calls. After calls were played, the site area and close surrounds were scanned with a spotlight for a period of five to ten minutes. Once a species was identified, no further calls of that species were played for the remainder of the survey period. Nocturnal birds targeted due to their conservation significance and likelihood of occurring included powerful owl (*Ninox strenua*) and rufous owl (*Ninox rufa*). Species with conservation significance in other states, such as barking owl (*Ninox connivens*) and grass owl (*Tyto longimembris*) were also targeted.

Diurnal herpetofauna search

Searches for diurnal herpetofauna (reptiles and frogs) were typically conducted during the late morning and early afternoon. Surveys at each site were a minimum of 30 minutes in duration. Reptiles and frogs were identified from direct observation and were captured and released, where required, to assist in identification. Active searches included rolling logs and rocks, searching under exfoliating bark on both live and dead trees as well as fallen logs, and raking leaf litter and ground debris at the base of trees and shrubs.

Walking spotlight surveys

Walking spotlight surveys were performed within forested areas. Surveys were conducted on foot using a 30-Watt spotlight and low-wattage head torches. Fauna species were identified by direct observation and calls, and were captured and released, where required, to assist in identification. Where applicable, approximately half of the survey effort was dedicated to searches for arboreal fauna (such as possums and gliders) and the remainder of the period spent searching for ground-dwelling fauna (such as frogs, geckoes, snakes and terrestrial mammals).

Driving spotlight surveys

Driving spotlight surveys were undertaken from a four-wheel drive vehicle along vehicular tracks within the study area. Searches were conducted by the passenger using a 30-Watt spotlight. These surveys were primarily targeting the larger ground-dwelling and arboreal nocturnal fauna. Incidental observations of herpetofauna were also recorded.

Ultrasonic microchiropteran call detection

Surveys for microbat fauna were undertaken by both passive and active recordings using an Anabat ZCAIM SD1 recorder. The Anabat ZCAIM SD1 device records the ultrasonic calls of microbats. For passive monitoring, the Anabat ZCAIM SD1 device was installed for at least one night (dusk to dawn) during the survey period. Active monitoring involved recording calls whilst conducting walking transits or from the vehicle as it was driven slowly along roads and tracks, usually in association with walking and driving spotlight surveys.

Trapping for small mammals

Targeted trapping for small mammals, namely water mouse was undertaken using type A Elliott traps (foldable, aluminium box trap).

Where practicable, a maximum of 50 Elliott traps was deployed along a transect, typically in a zig-zag fashion along the edge of low, mangrove shrubland. Traps, baited with pilchards (DEWHA, 2009a), were spaced approximately 10 m apart. These targeted surveys for water mouse involved trapping at low tide during the night for a minimum of two hours, primarily in mangrove habitats. Traps were closed throughout the day and where required, fresh bait was applied to traps each evening. Traps were checked and cleared each night on the incoming tide (high tide) and the following morning.

Inferential evidence

Inferential evidence of fauna was gathered and/or identified throughout the study area. This involved active searches for fauna tracks, scats and scratches on the trunks of trees and other evidence of fauna occurrence such as nests and sloughed (shed) skins. Only when evidence was considered definitive, was a species was recorded as occurring within the study area. Any scats, hairs or pellets collected were identified in the field or sent for laboratory identification and content analysis by Barbara Triggs (Triggs, 2004).

Incidental species records

Incidental records of species observed within 5 km of the study area were included where habitat was considered suitable/similar.

3.5.4 Fauna Survey Effort

A total of 36.1 person hours were spent undertaking structured survey activities within the current study area (Table 6). In addition, 83 trap nights occurred in the study area. A trap night refers to one trap set for one night. One trap left open for four nights, or four traps left open for one night, would both equate to four trap nights. Fauna survey sites are illustrated in Appendix E.

Table 6 Fauna survey effort.

Method	Structured Survey Effort	Survey Location
Bird survey	15.3 person hours	All sites
Nocturnal bird call playback	0.8 person hours	Curtis Island LNG facility
Diurnal herpetofauna search	6.6 person hours	Curtis Island LNG facility, Boatshed Point, Hamilton Point, mainland tunnel entry shaft and tunnel spoil disposal area
Spotlight walking survey	2.4 person hours	All sites
Spotlight driving survey	8.6 person hours	All sites
Ultrasonic microchiropteran call detection: · Active monitoring · Passive monitoring	 2.4 person hours 22 person hours	Boatshed Point, Curtis Island LNG facility
Trapping for small mammals:	83 trap nights	Hamilton Point

3.5.5 Opportunistic Surveys

Opportunistic surveys were undertaken on 19th to 22nd May 2010 and on 1st to 4th September 2010. The May survey was undertaken whilst conducting ecological assessments for preliminary geotechnical works and the September survey was whilst performing the supplementary survey for the threatened flora species (refer Section 3.4.9). These two surveys covered both Curtis Island and parts of the mainland.

3.6 Limitations

This assessment is designed to be a robust and accurate representation of the terrestrial ecological values within the study area. It has utilised an integrated approach to include literature review, previous surveys, database searches and field surveys. Despite this objective, and as with all ecological investigations, the field survey was subject to several limitations. Chief amongst these are field surveys which were cut short by climatic events and land access issues. In addition the following should be considered potential limitations to this assessment:

- **Climate:** significant rainfall events prevented detailed wet season surveys planned for February 2010. This period was chosen primarily as an optimal period for vegetative vigour and inflorescence set, particularly for herbaceous and graminoid (grass) species. This is also the period when vertebrate fauna (such as elapid snakes, small mammals, bats, frogs) activity is generally greatest and migratory birds more likely to be present. As such, it is expected that the detectability of amphibians, reptiles, some migratory bird species and most mammals, was reduced.
- **Timing of flora survey:** detailed surveys were completed during the dry/cool season therefore missing optimal conditions for the aforementioned species. Orchids, annual grasses and annual herbs may have also been under-represented due to different flowering seasons. Despite this, the vast majority of perennial groundcover species were able to be positively identified from retained reproductive parts.
- **Timing of fauna survey:** the detailed survey period coincided with a period of poor flowering, particularly on Curtis Island. Flowering plants provide important food sources such as nectar, pollen and invertebrates for gliders, flying-foxes, microbats and a range of bird species. Diversity and abundance of these species would therefore have been expected to be greater if surveys were conducted during peak flowering.
- **Anthropogenic impacts:** fuel reduction burning within the GSDA sector of Curtis Island (to the west of Ship Hill) was completed in January 2010 and impacted upon part of the study area. Surveys in July 2010 recorded considerable recovery in the form of coppice shooting and seedling growth, which was necessary for positive identification of individual taxa. These fire regimes were not considered a limitation for the detailed flora survey, although they had altered the dynamics of sampled vegetation types. The burns may also have limited favourable conditions and resources for certain fauna groups (e.g., ground-dwelling small mammals and reptiles).
- **Cryptic species:** fauna selected as target species for the survey are cryptic and require considerable effort to detect (e.g., water mouse, yakka skink (*Egernia rugosa*), black-breasted button-quail). As these species were not detected during

the survey effort, identifying the presence of suitable habitat within the study area became the priority.

- **Method**: survey activities were targeted towards finding species of conservation significance, which were identified through the literature review as being likely to occur. This is in line with the risk based approach taken for the impact assessment. Using survey methods such as funnel traps and pitfalls with drift fences would not necessarily have increased the likelihood of detecting listed species, since all of the targeted species were detectable using other methods.

- **Geographical coverage**: survey effort was targeted to sample all habitat types within the study area and may have missed some areas. The mainland launch site options (launch site 1 and launch site 4N) were not included within the field surveys. Launch site 4N is largely going to be dredged land and so is outside the scope of this report. Launch site 1 may have some vegetation and fauna value and should be investigated prior to construction commencing.

- **Data limitations:** database searches and records for target and expected species have variable accuracy (see Section 3.3.1 for further detail).

3.7 Impact Assessment

Impact assessment is used to identify the potential threat that project activities pose to the ecological values of the study area and beyond. Impact assessment involves determining the sensitivity of each ecological value and the magnitude of impact on each value.

Ecological values are essentially a measure of the value placed on the environment. The project area was divided into 49 assessment units (Figure 2), or 'ecological values', based on the field-validated vegetation community type within each of the five main project areas; Curtis Island, the mainland tunnel entry shaft and tunnel spoil disposal area, TWAF 7, TWAF 8 and launch site 1. Areas that were field-validated as non-remnant vegetation within the project area were grouped within the mainland tunnel shaft area and TWAF 8, but on Curtis Island were grouped depending on whether or not they were in the construction footprint. The attributes of each vegetation community (including species, community and function) were considered to form the collective ecological value.

The method used to assess the impacts of this project on the ecological resources and inherent environmental values has been based on Coffey Environments (2011b).

Value is derived from species, community and function. This considers threatened species known or likely to occur within an assessment unit, along with vegetation community, presence of known wildlife corridors, essential habitat, or other recognised ecological features.

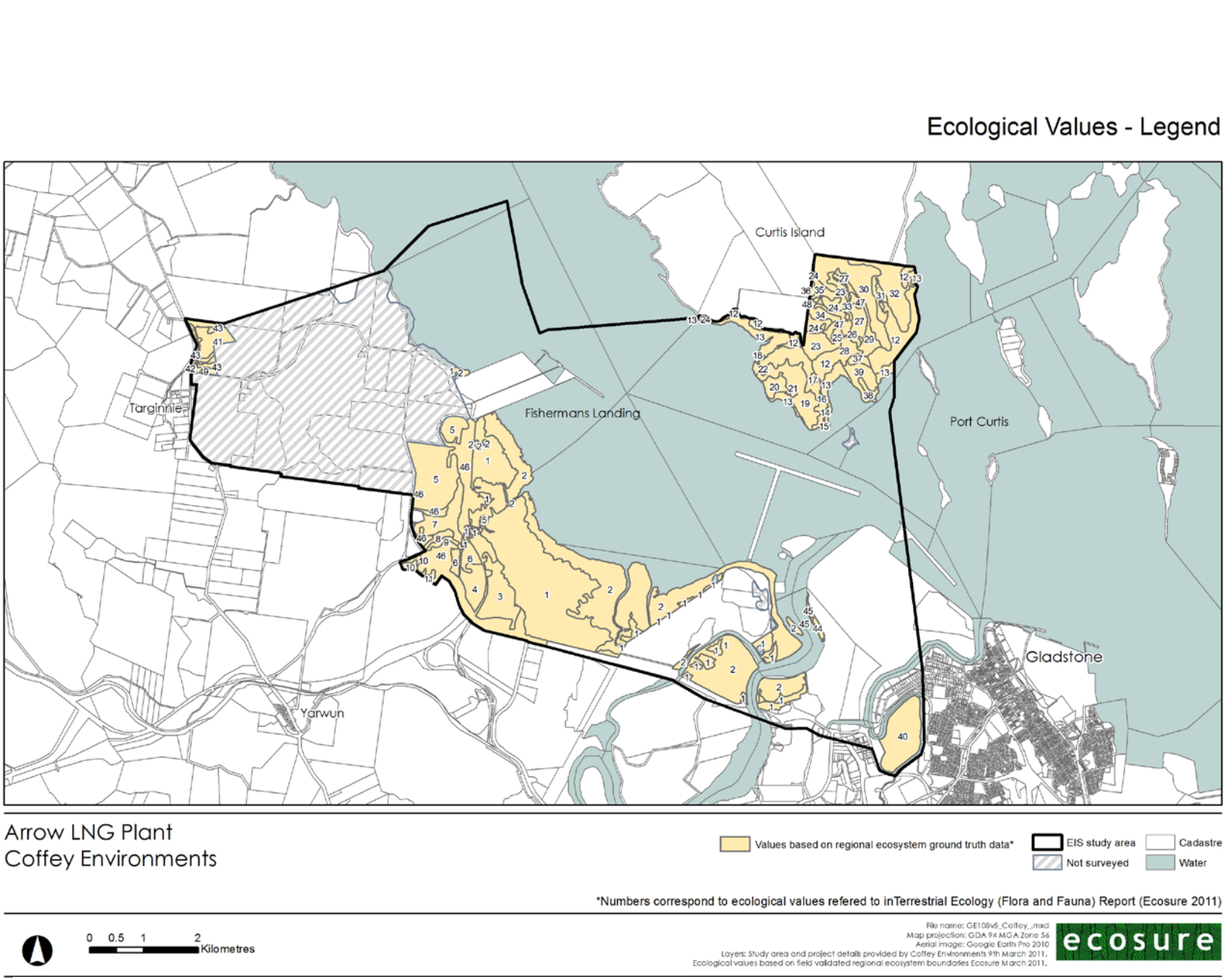


Figure 2 Ecological Values – Legend

3.7.1 Sensitivity

The sensitivity of each ecological value was determined through the assessment of five main attributes:

- Conservation status.
- Intactness.
- Uniqueness (or rarity).
- Degree of non-resilience to change.
- Degree of difficulty in replacing.

Each value and each attribute was scored (negligible, low, medium, high, very high) to determine an overall sensitivity score. The determination of the overall sensitivity score was based on the majority weighting of each criteria (Table 7).

Table 7 Determination of overall sensitivity score, using individual attribute scores.

Sensitivity Score	Attribute Score
very high	2+ very high
high	3+ high OR 1 very high plus 2+ medium OR 2 high plus 2 medium
medium	2 high plus lows/very low OR 3+ moderate OR 1 high plus 1 moderate OR 1 high plus 4 low
low	1 moderate plus 4 low or lower
very low	low plus 3+ very low

Conservation status

The criteria for the determination of an ecological value's conservation status included statutory designations (established during the review of existing information) and assessment of biodiversity values (established during the literature review and field surveys) (Table 8). In some instances, the likelihood of a species of conservation significance being present, due to the presence of suitable habitat, may increase the conservation status by an order or magnitude. Species were included which are known to occur, or which have a high or moderate chance of occurring, in the study area (see Tables 16, 19 and 20).

Table 8 Sensitivity categories for the conservation status of ecological values.

Conservation Status	Relevant Value
Very High (VH)	· Great Barrier Reef World Heritage Area. · Conservation Reserves. · Marine Protected Areas (including the Great Barrier Reef Marine Park). · National Parks. · Critically Endangered Ecological Communities (Commonwealth). · Endangered Ecological Communities (Commonwealth). · Endangered Regional Ecosystems (Queensland). · Regulated Regrowth, analogous with Endangered Regional Ecosystems, in a "restricted area" (Queensland). · Significant Coastal Wetlands (Queensland).

Conservation Status	Relevant Value
High (H)	· Core habitat of listed fauna species. · Marine Plants (as defined by the Fisheries Act). · 'Of Concern' Regional Ecosystems (Queensland) · Regulated Regrowth, analogous with Endangered Regional Ecosystems, **not** in a "restricted area" (Queensland). · Presence of listed flora species (Commonwealth and State). · Essential Habitat (Queensland).
Medium (M)	· State Forest where listed for conservation. · Non-core habitat of listed fauna species. · 'Least Concern' Regional Ecosystems (Queensland). · Regulated Regrowth, analogous with 'Of Concern' or 'Least Concern' Regional Ecosystems, in a "restricted area" (Queensland). · Habitat for listed flora species (Commonwealth and State). · Flora or fauna at or beyond their distributional range.
Low (L)	· Regulated Regrowth, analogous with 'Of Concern' or 'Least Concern' Regional Ecosystems, not in a "restricted area" (Queensland).
Very Low (VL)	· Non-remnant vegetation.

Intactness

This is an assessment of how intact the ecological value is in its existing condition, and how representative it is of that value. A value would score very high for this criteria where it is in pristine condition and is equivalent to the benchmark for that regional ecosystem. It would score very low where it is fragmented and contains very few of the characteristics typical of that regional ecosystem.

Uniqueness (or rarity)

This is an assessment of the occurrence, abundance and distribution of the ecological value within and beyond its reference area (e.g., bioregion/biosphere). A value would be considered to have a very high uniqueness where it is the only known example of that value within the Gladstone region. A value would have a very low uniqueness where it is considered common within the Gladstone region.

Non resilience to change

An ecological value is less sensitive the higher its resilience to change is. This criteria is a measure of how a value can adapt to change without adversely affecting its conservation status, intactness, uniqueness or rarity. A value with a very high score for this criteria would be extremely sensitive to change. It may require 25 years or more to naturally return to a state comparable to the original. A value with a low score may be able to naturally return to original state within less than one year. A value with a very low score for this criteria would be insensitive to change and any impact would be minimal.

Difficulty in replacing

The more difficult it is to find a representative or equivalent ecological value to replace any losses, the higher the sensitivity of that value. A value with a very high score would be one that was almost impossible to offset. A value with a very low score would have readily available areas which could be used as offsets within the Gladstone region.

3.7.2 Magnitude of Impact

The magnitude of an impact from the project on each ecological value was determined by assessing three main attributes:

- Geographical extent.
- Duration.
- Severity.

Each ecological value and each attribute was scored (negligible, low, medium, high, very high) to determine an overall magnitude of impact score (Table 9).

Table 9 Determination of overall magnitude score using attribute scores.

Magnitude Score	Attribute Score
very high	2+ very high
high	2+ high OR 1 very high
medium	1 high
low	1 medium plus 2 low/negligible
negligible	1 low plus 2 negligible

Geographical extent

An assessment of the spatial extent of the impact where the extent is defined as site, local, regional or widespread (meaning state-wide or national or international). The geographical extent would be defined as very high where the project impact has a national or international effect. The magnitude would be negligible where the impact was wholly contained within the project area.

Duration

The duration is the timescale of the effect i.e., if it is short, medium or long term. The duration would be very high where it is expected to last in perpetuity. High duration may be considered greater than five years, and medium would be from one to five years. It would be low where it is expected to last less than one year and negligible where it is expected to last less than a day.

Severity

This is an assessment of the scale or degree of change from the existing condition, as a result of the impact. This may be positive or negative. The severity would be considered to be very high where there is an extensive impact that could potentially lead to extinction, system collapse, etc. A high severity impact would potentially result in irreversible or long-term loss or damage. A moderate severity impact may result in a permanent reduction in local/regional biodiversity values. A low severity impact would result in limited loss or disturbance and impacts on biodiversity which would be considered limited and/or temporary. A negligible severity would relate to an impact with undetectable or minor impacts. A negligible severity may also have a positive impact on the ecological value. This

might include activities such as the control of pest species or habitat rehabilitation.

3.7.3 Significance of impact

The sensitivity of ecological values and the magnitude of each impact was assessed to determine the significance of the project's impact on the terrestrial ecology of the study area. A five level scoring system (negligible, low, medium, high, very high) was applied to each category of sensitivity and magnitude of impact. A matrix (Table 10) was then applied to determine the significance level.

Table 10 Matrix of impact significance.

	Sensitivity of Ecological Value				
Magnitude of impact	Very High	High	Medium	Low	Very low
Very High	Major	Major	High	Moderate	Moderate
High	Major	High	Moderate	Moderate	Minor
Medium	High	Moderate	Moderate	Minor	Negligible
Low	Moderate	Moderate	Minor	Minor	Negligible
Negligible	Moderate	Minor	Negligible	Negligible	Negligible

The sensitivity of the ecological value is generally fixed and not influenced by the project; the magnitude of impact may be influenced by engineering design or option selection.

The levels of impact significance, determined using Table 10, are defined below:

Major impact significance

An impact on an ecological value that is irreplaceable due to its uniqueness or rarity, which is long term, irreversible and/or widespread. This level of impact is likely to be a key factor in the decision-making process and/or raise considerable stakeholder concern. Avoidance is the only effective mitigation.

High impact significance

This occurs when the proposed activities are likely to exacerbate existing threatening processes, affecting the intrinsic characteristics and structural elements of the ecological value. Whilst replacement of unavoidable losses is possible, avoidance through appropriate design responses is preferred to preserve intactness or conservation status.

Moderate impact significance

Occurs where, although reasonably resilient to change, the ecological value would be degraded/further degraded due to the scale and nature of the works, or its susceptibility to further change. The abundance of the ecological value ensures it is adequately represented in the region and that replacement, if required, is achievable.

Minor impact significance

Occurs where an ecological value is of local importance and temporary and transient changes will not adversely affect its viability, provided standard environmental controls are implemented.

Negligible impact significance

This is an impact which will not result in any noticeable change in an ecological value's intrinsic value. Typically occurs where the activities take place in industrial or highly disturbed areas. This may also encompass an ecological value of any level of sensitivity within the study area, however not within the project footprint.

3.7.4 Residual Impact

Residual impacts are the potential impacts remaining after the application of mitigation measures and any design response. The extent to which potential impacts may be reduced was determined from an assessment of the significance of residual impacts. This is a measure of the effectiveness of the design response or mitigation measures in reducing the magnitude of the potential impacts, as the sensitivity of the ecological value does not change. If, even after proposed mitigation measures were applied in this assessment, they did not sufficiently reduce the significance, additional mitigation measures were recommended.

3.8 Assessment of Cumulative Impact

The objective of the cumulative impact assessment was to determine the cumulative impacts of approved or proposed developments within the region, including the extent to which the Arrow LNG Plant may contribute to the overall impact on relevant ecological values. The method for assessing cumulative impact is based on Coffey Environments (2011c).

3.8.1 Baseline Projects and Industry

The baseline for assessment of cumulative impacts included all existing developments constructed and operating in the Gladstone region, and those projects that have taken a financial investment decision at the 17th February 2011. In addition to existing industry, the projects set out in Table 11 were included in the baseline.

Table 11 Baseline projects, for the purpose of cumulative impact assessment (from Coffey Environments, 2011c).

Name of project	Proponent(s)	Status	Description
Queensland Curtis LNG Project	QGC Pty Limited (BG Group business)	· EIS and Supplementary EIS complete. · Project approved with conditions by the Coordinator-General. · Project approved with conditions by DSEWPC. · Financial Investment Decision taken 31 October 2010.	· Development of coal seam gas (CSG) resources in the Surat Basin. · Construction of gas pipeline from the gas fields to Gladstone. · Development of a liquefied natural gas (LNG) facility (12 million tonnes per annum (Mtpa)) and export terminal on Curtis Island.
GLNG Project	Santos Limited (and partners Petronas, Total and KOGAS)	· EIS and Supplementary EIS complete. · Project approved with conditions by the CG. · Project approved with conditions by DSEWPC. · Financial Investment Decision	· Development of CSG resources in the Surat Basin. · Construction of gas pipeline from the gas fields to Gladstone. · Development of a 10 Mtpa LNG facility and export terminal on Curtis Island.

Name of project	Proponent(s)	Status	Description
		taken 13 January 2011.	
Yarwun Alumina Refinery Expansion Project	Rio Tinto	· EIS approved in 2007. · Under construction.	· Expansion of Yarwun Alumina Refinery, increasing output by 2 Mtpa to 3.4 Mtpa by 2011.

3.8.2 Projects Included in Cumulative Impact Assessment

The cumulative impact assessment included projects that have been approved by the Coordinator-General or have sufficient information in the public domain (i.e., EIS) to enable an assessment of the potential impacts. Projects met the following criteria:

- The project is located in the Gladstone region.
- The project is being assessed by one of the following:
  - The SDPWO Act and has been declared by the Coordinator-General as a 'project of state significance' for which the status of the EIS is either complete or, as a minimum, has an Initial Advice Statement published on the DLGP website.
  - The Environmental Protection Act and has completed an EIS or has an Initial Advice Statement (or similar) listed on the DERM website.
- The project is envisaged in statutory planning documentation.

Projects considered in the cumulative impact assessment and the criteria that warranted their inclusion, are described in Appendix G.

4 Existing Environment

4.1 Flora

4.1.1 Overview

During field surveys 349 terrestrial flora species were recorded, consisting of 293 native species and 56 exotic species, of which three are currently described as declared pests and/or weeds of national significance (WONS) (Appendix B). The majority of native flora species recorded during the field survey are listed as 'Least Concern' under the Nature Conservation Act and/or are widespread in the region.

With regards to plant communities of cultural, commercial or recreational significance, there are no commercial crops within the study area except for small scale mango orchards in the vicinity of TWAF 8. The mangrove communities in the study area may be considered of recreational significance for the role they play as a fish nursery. Species are likely to be present which are culturally significant. These species will be addressed in the Cultural Heritage Management Plan for this project.

4.2 Vegetation Communities of Conservation Significance

A regulated vegetation community refers to vegetation which is:

- Considered representative of remnant, high value regrowth or regrowth watercourse vegetation.
- Analogous with a described RE.
- Afforded a conservation status under Commonwealth and/or state legislation.

4.2.1 Regulated Vegetation - Commonwealth

A review of the EPBC Protected Matters Search Tool noted that the study area may contain four threatened ecological communities. Ecological community status and likelihood (based on the literature review) was:

- Brigalow (*Acacia harpophylla* dominant and co-dominant) ('Endangered') – unlikely to occur in the study area.
- Littoral rainforest and coastal vine thickets of eastern Australia ('Critically Endangered') – known to occur in the study area.
- Semi evergreen vine thickets (SEVT) of the Brigalow Belt (North and South) and Nandewar Bioregions ('Endangered') – likely to occur in the study area.
- Weeping myall woodlands ('Endangered') – unlikely to occur in the study area.

Field surveys confirmed the presence of one threatened ecological community listed under the EPBC Act. This was littoral rainforest and coastal vine thickets of eastern Australia

(representative of RE 12.2.2). Section 4.2.3 provides details of the occurrences of this ecological community within the study area.

External to the study area, however within the general region, communities of SEVTs of the Brigalow Belt (RE 11.11.18 and RE 11.3.11) were observed on the foothills and lower slopes associated with the northwestern and northern flanks of Mt Larcom.

4.2.2 Regulated Vegetation – State

The literature review revealed that the study area is vegetated with variable degrees of remnant vegetation and regulated regrowth (DERM, 2009c) (Figure 3). The majority of remnant vegetation is currently mapped as occurring on Curtis Island. Vegetation types range from sclerophyllous woodlands to tall open forests, SEVT to beach scrub and estuarine scalds to mangrove shrublands.

The diversity of regional ecosystems reflects the relatively diverse geology and altitudinal gradient across the study area, as well as the geographical location. The study area is located at the interface of three sub-regions belonging to the southeast Queensland, Brigalow Belt South and Brigalow Belt North bioregions.

Of the 13 DERM mapped REs, two are afforded a VMA status of 'Endangered', five a status as 'Of Concern' and six a status as 'Least Concern' (Table 12). Field validated RE's are discussed in Section 4.2.3.

Table 12 Regional Ecosystems currently mapped by DERM within the study area (detailed description from DERM, 2011b).

Regional ecosystem	Short description	Detailed description	Vegetation management status	Biodiversity status
11.3.4	*Eucalyptus tereticornis* and/or *Eucalyptus spp*. tall woodland on alluvial plains.	*Eucalyptus tereticornis* woodland to open-forest. Other tree species that may be present and locally dominant include *E. camaldulensis, Corymbia tessellaris, E. coolabah, C. clarksoniana, E. populnea or E. brownii, E. melanophloia, E. platyphylla or Angophora floribunda. E. crebra and Lophostemon suaveolens* may be locally dominant (subregion 14). A shrub layer is usually absent, and a tall grassy ground layer is often prominent, and may include any of *Bothriochloa bladhii subsp. bladhii, Aristida spp.*, *Heteropogon contortus, Dichanthium spp. and Themeda triandra*. Heavily grazed areas tend to have shorter or annual grasses such as *Dactyloctenium radulans or Bothriochloa spp.* Occurs on Cainozoic alluvial plains and terraces. Occurs on variety of soils, including deep cracking clays, medium to fine textured soils, and deep texture-contrast soils.	'Of Concern'	'Of Concern'
11.3.29	*Eucalyptus crebra, E. exserta, Melaleuca spp*. woodland on alluvial plains.	*Eucalyptus crebra, E. exserta, Corymbia dallachiana, C. intermedia woodland* usually with a low tree understorey of *Melaleuca viridiflora* and *M. nervosa.* Occurs on broad plains and fans formed from Quaternary alluvium.	'Least Concern'	'No Concern at present'

Regional ecosystem	Short description	Detailed description	Vegetation management status	Biodiversity status
		Usually associated with bleached sodic duplex soils.		
11.11.15	*Eucalyptus crebra* woodland on deformed and metamorphose d sediments and interbedded volcanics.	*Eucalyptus crebra* with or without (+/-) *Corymbia erythrophloia* +/- *E. populnea* +/- *E. melanophloia* +/- *C. tessellaris* +/- *C. clarksoniana* woodland often with a shrubby layer. *Eucalyptus exserta* and *E. platyphylla* present in central coastal part of bioregion. Occurs on undulating rises and low hills, often with distinct strike pattern formed on moderately to strongly deformed and metamorphosed sediments and interbedded volcanics and Permian sediments.	'Least Concern'	'No Concern at present'
11.11.18	SEVT on old sedimentary rocks with varying degrees of metamorphism and folding.	SEVT. Occurs on undulating plains, rises and gentle slopes of ranges formed on moderately to strongly deformed and metamorphosed sediments and interbedded volcanics.	'Endangered'	'Endangered'
12.1.2	Saltpan vegetation including grassland, herbland and sedgeland on marine clay plains.	Saltpan vegetation comprising *Sporobolus virginicus* grassland and samphire herbland. Grasses including *Zoysia macrantha subsp. macrantha* sometimes present in upper portions of tidal flats. Includes saline or brackish sedgelands. Occurs on Quaternary estuarine deposits. Marine plains/tidal flats.	'Least Concern'	'No Concern at present'
12.1.3	Mangrove shrubland to low closed forest on marine clay plains and estuaries.	Mangrove shrubland to low closed forest. Occurs on Quaternary estuarine deposits.	'Least Concern'	'No Concern at present'
12.2.2	Microphyll/not ophyll vine forest on beach ridges.	Microphyll/notophyll vine forest. Characteristic species include *Cupaniopsis anacardioides, Flindersia schottiana, Alectryon coriaceus, Elaeocarpus obovatus, Polyalthia nitidissima, Diospyros spp., Pleiogynium timorense* and *Mallotus discolor*. *Melaleuca spp.* and eucalypt emergents may be present, e.g. *Melaleuca dealbata* and *Corymbia tessellaris*. Occurs on Quaternary coastal dunes and beaches.	'Of Concern'	'Endangered'
12.3.3	*Eucalyptus tereticornis* woodland to open forest on alluvial plains.	*Eucalyptus tereticornis* open-forest to woodland. *Eucalyptus crebra* and *E. moluccana* are sometimes present and may be relatively abundant in places, especially on edges of plains and higher level alluvium. Other species that may be present as scattered individuals or clumps include *Angophora subvelutina* or *A. floribunda, Corymbia clarksoniana, C. intermedia, C. tessellaris, Lophostemon suaveolens* and *E. melanophloia*. Occurs on broad Quaternary alluvial plains where rainfall is usually less than 1000 mm/y.	'Endangered'	'Endangered'

Regional ecosystem	Short description	Detailed description	Vegetation management status	Biodiversity status
12.3.7	*Eucalyptus tereticornis, Melaleuca viminalis, Casuarina cunninghamia* na fringing forest.	Narrow fringing community of *Eucalyptus tereticornis*, *Melaleuca viminalis, Casuarina cunninghamiana* +/- *Waterhousea floribunda*. Other species associated with this RE include *Melaleuca bracteata, M. trichostachya, M. linariifolia* and *M. fluviatilis* in north of bioregion. *Lomandra hystrix* often present in stream beds. Occurs on fringing levees and banks of rivers and drainage lines of alluvial plains throughout the region.	'Least Concern'	'No Concern at present'
12.3.11	*E. tereticornis, Eucalyptus siderophloia, Corymbia intermedia* open forest on alluvial plains near coast.	Open-forest to woodland of *Eucalyptus tereticornis, E. siderophloia* and *Corymbia intermedia*. *Corymbia tessellaris, Lophostemon suaveolens* and *Melaleuca quinquenervia* frequently occur and often form a low tree layer. Other species present in scattered patches or low densities include *Angophora leiocarpa, E. exserta, E. grandis, C. trachyphloia, C. citriodora, E. latisinensis, E. tindaliae, E. racemosa, Melaleuca sieberi and M. viridiflora. E. seeana* may be present south of Landsborough. Occurs on Quaternary alluvial plains and drainage lines along coastal lowlands. Rainfall usually exceeds 1000 mm/y.	'Of Concern'	'Of Concern'
12.11.4	SEVT on metamorphics ± interbedded volcanics.	Low microphyll vine forest and SEVT. Characteristic species include *Backhousia kingii, Pleiogynium timorense, Aidia racemosa, Archidendropsis thozetiana, Atalaya rigida, Barklya syringifolia, Bridelia leichhardtii, Elaeodendron melanocarpum, Choricarpia subargentea, Flueggea leucopyrus, Homalium alnifolium* and *Terminalia porphyrocarpa. Melaleuca bracteata* is often present along watercourses. Occurs on Palaeozoic and older moderately to strongly deformed and metamorphosed sediments and interbedded volcanics.	'Of Concern'	'Of Concern'
12.11.6	*Corymbia citriodora, Eucalyptus crebra* open forest on metamorphics ± interbedded volcanics.	Open-forest to woodland of *Corymbia citriodora* generally with *Eucalyptus crebra*. Other species such as E*ucalyptus fibrosa subsp. fibrosa, E. exserta*, *E. tereticornis, E. moluccana, E. melanophloia, Angophora leiocarpa* may be present in scattered patches or in low densities. Understorey grassy or shrubby. Occurs on Palaeozoic and older moderately to strongly deformed and metamorphosed sediments and interbedded volcanics. Drier habitats than RE 12.11.5.	'Least Concern'	No Concern at present
12.11.14	*Eucalyptus crebra, E. tereticornis* woodland on metamorphics ± interbedded volcanics.	*Eucalyptus crebra, Eucalyptus tereticornis* grassy woodland. Other species including *Eucalyptus melanophloia, Corymbia clarksoniana, C. erythrophloia, C. tessellaris* and *Angophora spp.* may be present in low densities or in patches. Mid-layer generally sparse but can include low trees such as *Acacia bidwillii, Capparis ssp., Dodonaea triquetra, Alphitonia*	'Of Concern'	'Of Concern'

Regional ecosystem	Short description	Detailed description	Vegetation management status	Biodiversity status
		excelsa and *Xanthorrhoea spp*. Occurs on mid and lower slopes on Paleozoic and older moderately to strongly deformed and metamorphosed sediments and interbedded volcanics.		

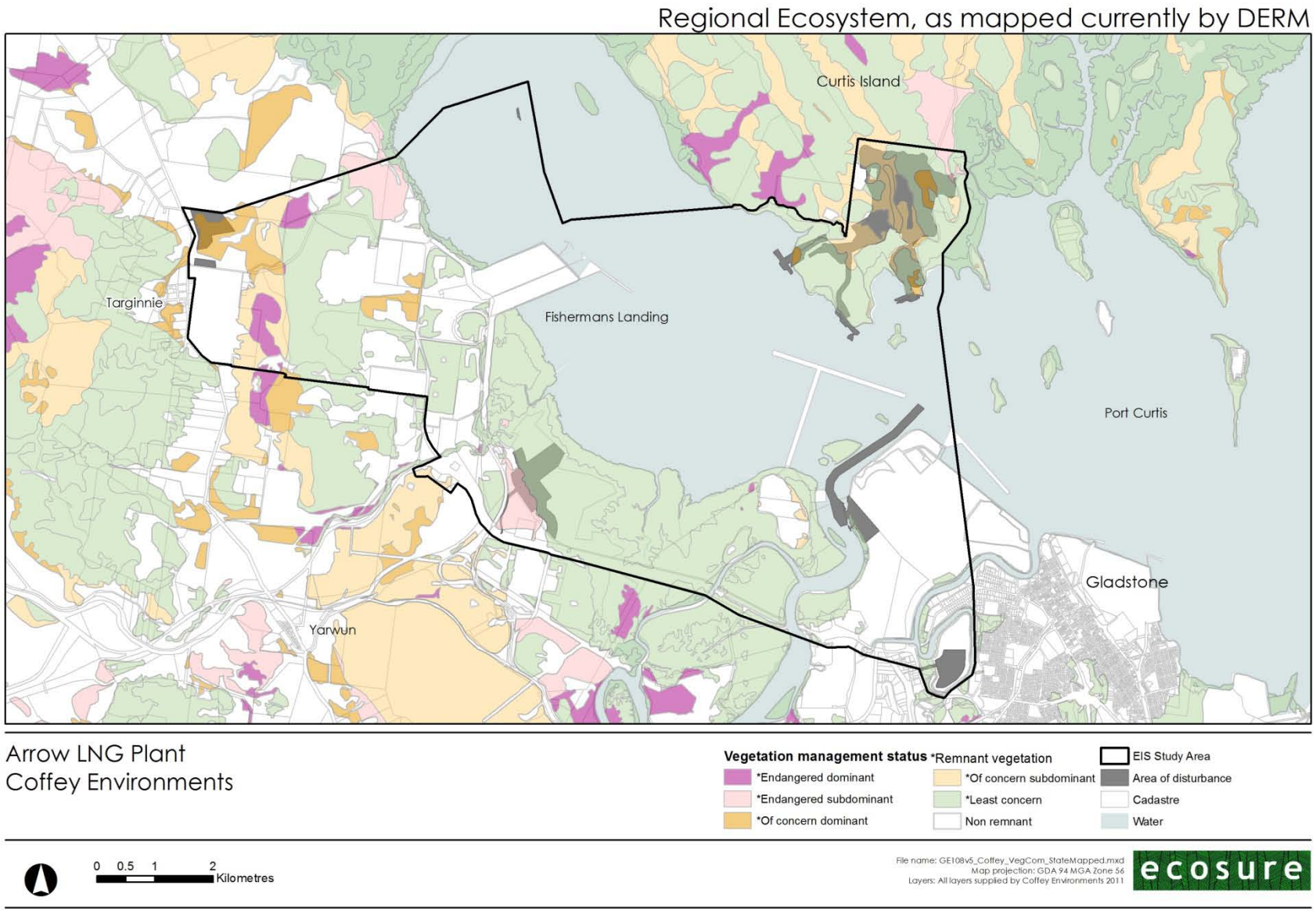


Figure 3 Queensland vegetation communities, as mapped by DERM.

4.2.3 Field-validated Regulated Vegetation

Flora field surveys identified a number of vegetation communities which were inconsistent with those currently mapped at the Commonwealth and state level. The field-validated vegetation communities discussed below (and herein) account for any discrepancies in distribution, type and proportionate composition. The field-validated Commonwealth vegetation community is shown in Figure 4 and the Queensland field-validated vegetation communities are shown in Figures 5-7.

No groundwater dependent ecosystems were observed within the study area, nor are they considered likely to occur. Vegetation communities present in the study area which are characterised by wet or damp conditions are expected to be fed by surface water sources.

Curtis Island Arrow LNG Plant, Hamilton Point and Boatshed Point

The Arrow LNG Plant site is located in the southwest corner of Curtis Island and comprises a range of landforms including undulated rises and low hills, narrow floodplains and incised drainage lines. The site is flanked by numerous headlands and broad salt pans. The remnants of a farmhouse and cattle yards were identified in the centre of the site, and historic clearing and attempts to manage woody regrowth was readily evident on the surrounding rises and neighbouring floodplain. The balance of the site supported a relatively intact and moderately healthy distribution of remnant vegetation.

Regional ecosystem 12.1.3

This vegetation community has a VMA status of 'Least Concern' and a biodiversity status of 'No Concern at Present'.

Aside from parts of Hamilton Point, Boatshed Point and Garden Island, the general area surrounding the LNG plant and associated infrastructure is entirely fringed by mangal (mangrove) shrublands to low, closed forest and broad saltpans. The mangrove and low, closed forest along the northern, eastern and western shores of the Hamilton Point and Boatshed Point headlands were surveyed by boat and from the adjacent shoreline. The greater balance of the mangrove community was dominated by a dense cover of *Rhizophora stylosa* (stilted mangrove) and occasional *Avicennia marina* ssp. *australasica* (grey mangrove) and possessed a median height ranging from 4 to 9 m depending on the degree and frequency of tidal inundation. Species such as *Bruguiera gymnorhiza* (orange mangrove), *Ceriops tagal* var. *australis* (yellow mangrove), *Lumnitzera racemosa* (black mangrove), *Excoecaria agallocha* (milky mangrove) and, to a lesser extent, *Osbornia octodonta* (myrtle mangrove) and *Aegiceras corniculatum* (river mangrove) were generally encountered as scattered individuals on the landward fringing edge. A distinct community of *Ceriops tagal var. australis* shrubland was also identified on the landward side of the northern mangrove community in the vicinity of North China Bay.

Regional ecosystem 12.1.2

This vegetation community has a VMA status of 'Least Concern' and a biodiversity status of 'No Concern at Present'.

Sporobolus virginicus grassland and samphire forbland were generally limited to very narrow bands between the HAT and the edge of the mangroves. As such, these areas were invariably too small and/or narrow to map. Extensive mudflats were identified on the eastern sides of both Boatshed Point and Hamilton Point headlands. A moderate-sized mudflat was also recorded on the leeward side of mangal forest associated with North China Bay. The mudflats were sparsely vegetated with a variable distribution of *Sesuvium portulacastrum* (sea purslane), *Halosarcia pergranulata* (black-stemmed samphire), *Halosarcia indica* (brown-headed samphire) and *Sarcocornia quinqueflora* (beaded samphire). Species such as *Sporobolus virginicus* (saltwater couch), *Fimbristylis ferruginea* (fringe rush), *Fimbrystylis polytrichoides* (fuzzy rush) and occasional *Limonium solanderi* were generally restricted to narrow distributions between the salt pans or mudflats and the limit of the HAT. Emergent *Excoecaria agallocha* were also commonly associated with this vegetation type.

Regional ecosystems 12.11.4, 12.11.6 and 12.11.14

RE12.11.4 has a VMA status of 'Of Concern' and a biodiversity status of 'Of Concern'.

RE 12.11.6 has a VMA status of 'Least Concern' and a biodiversity status of 'No Concern at Present'.

RE 12.11.14 has a VMA status of 'Of Concern' and a biodiversity status of 'Of Concern'.

Plate 1 RE 12.11.6 on Hamilton Point (Ecosure, 2010)

The greater balance of the study site on Curtis Island supported intact remnant vegetation that was representative of *Corymbia citriodora ssp. citriodora* (lemon-scented gum) open forest on metamorphic rises and low hills (RE 12.11.6) (Plate 1) or *Eucalyptus crebra* (narrow-leaved red ironbark) ± *Eucalyptus tereticornis* (Queensland blue gum) woodland to open forest on metamorphic rises and colluvium (RE 12.11.14). The latter was found to possess a markedly variable dominance within the canopy layer, wherein the dominant canopy species in a number of areas was limited to only one of the aforementioned species. For example, this vegetation type provided the predominant vegetative cover on the greater balance of Boatshed Point and was dominated by *Eucalyptus crebra*. The low tree layer

and tall shrub layer of both vegetation types were dominated by juvenile canopy species, *Acacia disparrima ssp. disparrima* (hickory wattle) ± *Melaleuca nervosa ssp. nervosa* (paper-barked tea tree). The low shrub layer of both vegetation types was invariably dominated by *Pogonolobus reticulatus* (medicine bush), *Acacia disparrima* and *Xanthorrhoea latifolia* (forest grass tree). The groundcover layer of both vegetation types was generally dominated by *Digitaria diffusa* (a finger grass), *Eragrostis spartinoides, Cymbopogon refractus* (barbed wire grass), *Chrysopogon fallax* (golden beard grass), *Aristida spp.* and *Xanthorrhoea latifolia*.

The distributions of both RE 12.11.6 and RE 12.11.14 ranged from open grassy woodlands to shrubby open forests. The latter were more prevalent on the steeper inclines of Hamilton Point and southern slopes of Ship Hill. In general, RE 12.11.6 was primarily found to be in good overall condition with low weed incursion, moderate canopy health and adequate levels of canopy recruitment. Conversely, approximately half of all field-validated areas of RE 12.11.14, in particular a series of protected gullies on the western coast of the Hamilton Point headland and southern slopes of Ship Hill, were found to be heavily degraded within the shrub and groundcover layers and supported numerous canopy trees in poor condition. The areas of RE 12.11.14 that were identified on the northern and eastern slopes of the Hamilton Point headland, Boatshed Point and balance of the LNG Plant site had been moderately affected by recent and historic high intensity fuel reduction burns. Considerable dieback of mid-stratum canopy species and exotic flora infestations were frequently recorded.

Vine forest was also recorded on the crest and southeast facing slopes of the Boatshed Point headland (Plate 2). The overall composition of the vine forest community was found to be moderately variable due to aspect, soil depth, slope and exposure to salt-laden winds. Sclerophyllous species such as *Eucalyptus crebra, Acacia disp*arrima and, to a lesser extent, *Corymbia intermedia* (pink bloodwood), were frequently encountered and may represent opportunistic establishment following historical clearing and persistence due to historic and current fire regimes. The ecologically dominant layer of this community generally contained

Plate 2 Rocky shoreline on Boatshed Point (Ecosure, 2010)

Jagera psuedorhus (foambark), *Cupaniopsis anacardioides, Cryptocarya triplinervis var. pubens* (three-veined laurel), *Harpullia pendula* (tulipwood), *Pouteria sericea* and

associated *Pleiogynium timorense, Exocarpus latifolius, Acronychia laevis, Turraea pubescens* (witch hazel) and *Aidia racemosa* (archer cherry). The lower shrub layer was dominated by juvenile canopy species and associated *Alyxia ruscifolia, Cupaniopsis sp.* indet. and *Alectryon tomentosa* (hairy alectryon). The groundcover layer was generally dominated by **Rivinia humilis* (baby pepper) and associated *Ottochloa gracillima, Achyranthes aspera* (chaff flower), **Passiflora suberosa* and occasionally *Peperomia bland var. floribunda* (peperomia). This vegetation type was representative of RE 12.11.4 and occupied a different spatial extent than currently mapped. The flanking vegetation was generally consistent with RE 12.11.14 (*E. crebra* and/or *E. tereticornis* woodland) but supported a mid-stratum dominated by a fragmented distribution of *Alphitonia excelsa* and vine forest generalists. While outside the study area, the distributions of DERM mapped RE 12.11.4 on Garden Island were found to be more representative of RE 12.11.14.

Regional ecosystem 12.3.6

This vegetation community has a VMA status of 'Least Concern' and a biodiversity status of 'No Concern at Present'.

Two small areas of woodland which were dominated by *Eucalyptus tereticornis* and *Melaleuca quinquenervia* (broad-leaved paperbark) were identified in the discharge portion of broad drainage basins on the eastern side of Hamilton Point and northwestern side of Boatshed Point. The distribution on Hamilton Point was found to be heavily degraded with **Lantana camara* and appeared overgrazed by wild horses.

Regional ecosystem 12.3.7

This vegetation community has a VMA status of 'Least Concern' and a biodiversity status of 'No Concern at Present'.

Two ephemeral overland drainage corridors, ranging from narrow to moderate sized basins, were identified between the foothills at the southern extent of Ship Hill. The largest of these plains was fringed on the western side by a deeply incised drainage line, flanked by mature *Eucalyptus tereticornis* and *Corymbia tessellaris* (carbeen). The mid-stratum of this vegetation type was dominated by a mid-dense distribution of *Lophostemon suaveolens* (swamp box), *Acacia disparrima* and associated *Livistona decipiens* (weeping cabbage palm). The groundcover layer was invariably degraded and dominated by *Bothriochloa decipiens* (pitted bluegrass), *Digitaria diffusa, Ottochloa gracillima* (graceful grass), *Imperata cylindrica* (blady grass), *Oplismenus aemulus* (basket grass) and **Passiflora suberosa* (corky passion vine). The downstream section of this watercourse discharged onto a broad alluvial plain.

Regional ecosystem 12.3.3

This vegetation community has a VMA status of 'Endangered' and a biodiversity status of 'Endangered'.

Both of the floodplain areas were found to support a moderately intact distribution of *Eucalyptus tereticornis* and associated *Corymbia tessellaris* and/or *Eucalyptus crebra*. The

sub-canopy and low tree layers were dominated by *Eucalyptus tereticornis* and/or *Lophostemon suaveolens.* The shrub layers, where present, were comprised of juvenile upper strata species, *Acacia disparrima, Planchonia careya* (cocky apple) and *Acacia leiocalyx ssp. leiocalyx* (early-flowering black wattle). The groundcover layer in this vegetation type was highly variable due to the variation in the density of the mid-stratum and frequency and duration of inundation and grazing. Several ephemeral wetlands were identified on the largest floodplain area. These wetlands supported a predominant cover of wetland species such as *Sporobolus scabridus, Cyperus* spp., *Fuirena ciliaris. Hygrophila angustifolia (*karamat), *Fimbristylis* spp. (fringe rushes), *Marsilea crenata* (a nardoo sp.) and *Ammania multiflora*.

Regional ecosystem 12.2.2

This vegetation type was representative of an EPBC listed 'Critically Endangered' ecological community (Littoral Rainforest and coastal vine thickets of eastern Australia [TSSC, 2008a]).

This vegetation community has a VMA status of 'Of Concern' and a biodiversity status of 'Endangered'.

The balance of vegetation in this portion of the study area was represented by small to medium-sized patches of low microphyll-notophyll vine forest. Of particular note was a patch of vine forest situated on a small Holocene sand dune on the eastern side of Hamilton Point. The canopy layer of this community was dominated by *Pouteria sericea* (wild prune), *Exocarpus latifolius* (native cherry), *Acronychia laevis* (glossy acronychia) and associated *Pleiogynium timorense* (Burdekin plum), *Polyalthia nitidissima* (canary beech), *Cupaniopsis anacardioides* (tuckeroo), *Eleodendron melanocarpum* (black-fruited olive plum), *Drypetes deplanchei* (yellow tulip), *Trophis scandens* (burney vine) and *Cissus oblonga* (smooth water vine). The shrub layers were similarly composed and included other species such as *Alyxia ruscifolia* (chain fruit), *Carissa ovata* (klunkerberry), *Myrsine variabilis* (muttonwood) and *Diospyros geminata* (scaly ebony). The groundcover layer was dominated by *Ottochloa gracillima, Oplismenus aemulus* and various vine species.

This community was flanked by a similarly composed narrow distribution of vine forest that was situated on metamorphic colluviums and is therefore representative of RE 12.11.4. Two other areas of DERM mapped RE 12.2.2, including the mapped polygon at North China Bay, were either dominated by sclerophyllous woodland species or representative of fragmented generalist vine forest species on metamorphic colluvium. These areas were not analogous with the current DERM mapping or the EPBC Act listed ecological community.

General observations

No areas of active or recent cultivation were recorded within this portion of the study area.

No threatened flora species were recorded, although marginally suitable habitat for *Cycas megacarpa* was identified on the south facing slopes of Ship Hill and the headland between North China Bay and Hamilton Point in *Corymbia citriodora* open forest (RE 12.11.6). Detailed surveys failed to locate this vegetatively distinct species. A considerable number of a previously unidentified taxon of the *Cupaniopsis* genus (refer to Section 4.3.2.1]

were identified within RE 12.11.4 on Boatshed Point and three specimens within RE 12.2.2 on Hamilton Point. This species is closely related to the EPBC Act listed *Cupaniopsis shirleyana*, however its conservation status is currently unknown (pending determination of the Queensland Herbarium). The areas of vine forest (REs 12.11.4 and 12.2.2) provide potential habitat for a number of threatened flora but detailed surveys failed to locate any specimens.

The type and status of REs that were identified within the study area on Curtis Island are summarised in Table 13 below.

Table 13 Regional ecosystems present and the field-validated amount of each within the Curtis Island project area.

Regional ecosystem (RE)	VM status	Biodiversity status	EPBC status	Area of remnant vegetation (ha)	Area of high value regrowth vegetation in a restricted area (ha)	Area of high value regrowth vegetation (ha)
12.1.2	'Least Concern'	'No Concern at Present'	*n/a*	4.09	n/a	n/a
12.1.3	'Least Concern'	'No Concern at Present'	*n/a*	3.98	n/a	n/a
12.2.2	**'Of Concern'**	**'Endangered'**	**CRITICALLY ENDANGERED**	0	n/a	n/a
12.3.3	'Endangered'	**'Endangered'**	*n/a*	25.69	n/a	n/a
12.3.6	'Least Concern'	'No Concern at Present'	*n/a*	3.56	n/a	n/a
12.3.7	'Least Concern'	'No Concern at Present'	*n/a*	4.21	n/a	n/a
12.11.4	**'Of Concern'**	'**Of Concern'**	*n/a*	3.04	n/a	n/a
12.11.6	'Least Concern'	'No Concern at Present'	*n/a*	71.24	n/a	n/a
12.11.14	**'Of Concern'**	'**Of Concern'**	*n/a*	122.13	n/a	n/a
12.11.14/ 12.11.4	**'Of Concern'**	'**Of Concern'**	*n/a*	(1.73)**	n/a	n/a
12.11.14/ 12.11.6 (60/40)	**'Of Concern'** / 'Least Concern'	'**Of Concern'**/ 'No Concern at Present'	*n/a*	(0.64)**	n/a	n/a
12.11.14/ 12.11.6 (50/50)	**'Of Concern'** / 'Least Concern'	'**Of Concern'**/ 'No Concern at Present'	*n/a*	(0)**	n/a	n/a

Proportion or percentage of field-validated mixed polygon added to the corresponding RE (i.e. 50% of 1.73 ha added to RE 12.11.4 and 50% to RE 12.11.14)

Mainland tunnel entry shaft and tunnel spoil disposal area

The mainland tunnel entry shaft and tunnel spoil disposal area is mapped by DERM as supporting primarily remnant RE 12.1.2 with a mixed area of RE 11.3.29/11.3.3 (60/40) fringing the western boundary of the site (Plate 3). The RE mapping to the north and northwest of this area is highly complicated due to substantial disturbance and landform modification as well as the presence of Boat Creek. Examples of disturbance and landform modification at the site include rail lines, conveyors, ancillary infrastructure, bunds and access tracks. Remnant RE 12.1.3 is also mapped as fringing the coastline to the immediate east of the site.

Plate 3 Mainland tunnel entry shaft and tunnel spoil disposal area (Ecosure, 2010)

During field surveys in 2011, access to this site was achieved via the Fisherman's Road and foot traverse along the southern bank of Boat Creek. The impact area (proposed spoil dump, causeway and tunnel entry for the pipeline) was surveyed via binoculars due to the depth of estuarine mud and presence of foraging migratory waders.

Regional ecosystem 12.1.2

This vegetation community has a VMA status of 'Least Concern' and a biodiversity status of 'No Concern at Present'.

The greater balance of the area comprises an extensive estuarine mudflat. The leeward side of the mangrove, low closed forest to the east of the site, and the southern side of mangrove shrubland fringing Boat Creek supported small but dense fields of *Sporobolus virginicus* grassland or scattered clumps of samphire forbland with occasional stunted mangrove species. The grassland, forbland and bare mudflats are all representative of remnant RE 12.1.2.

Regional ecosystem 12.1.3

This vegetation community has a VMA status of 'Least Concern' and a biodiversity status of 'No Concern at Present'.

The mangrove, low closed forest to the east of the site was found to support a dense cover of *Rhizophora stylosa* and occasional *Avicennia marina ssp. australasica* (RE 12.1.3). Areas of mangrove dieback were occasionally encountered on the seaward side. These areas were generally less than 2000 m^2 in area.

Regional ecosystem 11.3.4

This vegetation community has a VMA status of 'Of Concern' and a biodiversity status of 'Of Concern'.

The area of DERM mapped RE 11.3.29/11.3.3 (60/40) was sampled during the July 2010 surveys. This area was found to support a relatively consistent distribution of woodland to open forest which was dominated by *Eucalyptus tereticornis* and associated *Eucalyptus crebra, Corymbia tessellaris* and *Corymbia clarksoniana* (long-fruited bloodwood). The very sparse mid-strata was similarly composed, while the shrub layers were dominated by scattered specimens of *Melaleuca nervosa*, *Lophostemon suaveolens* and/or *Acacia disparrima*. The groundcover was dominated by a dense cover of **Hyparrhenia rufa* (thatch grass) which excluded most other species including canopy recruitment. The vegetation type was found to be most representative of remnant RE 11.3.4.

General observations

These vegetation communities do not provide potential habitat for any threatened flora species that are known to occur within the immediate and broader region.

The type and status of REs that were identified within the mainland tunnel entry shaft and tunnel spoil disposal area are summarised in Table 14 below.

Table 14. Regional ecosystems present and the field-validated amount of each within the mainland tunnel entry shaft and tunnel spoil disposal project area.

Regional ecosystem (RE)	VM status	Biodiversity status	EPBC status	Area of remnant vegetation (ha)	Area of high value regrowth vegetation in a restricted area (ha)	Area of high value regrowth vegetation (ha)
12.1.2	'Least Concern'	'No Concern at Present'	*n/a*	53.6	n/a	n/a
12.1.3	'Least Concern'	'No Concern at Present'	*n/a*	0	n/a	n/a
11.3.4	**'Of Concern'**	**'Of Concern'**	*n/a*	16.1	n/a	n/a

TWAF 7

Lot 200 on CTN2173 is currently mapped by DERM as supporting non-remnant vegetation.

Access to this site was not forthcoming at the time of the February 2011 survey and was therefore surveyed via binoculars from several vantage points along Hanson Road, Chapple Street and Palm Drive. The spatial distribution of the observed woody regrowth was uncertain. However, the regrowth appeared to be of even age and possessed a median height of approximately 6 m. The species composition was difficult to determine but appeared to include *Eucalyptus tereticornis, Corymbia citriodora* and *Acacia spp.* (*A. disparrima, A. holosericea, A. leiocalyx, A. fimbriata*). The mid-stratum appeared to be degraded with **Lantana camara* present. This vegetation type is not representative of a described RE.

The site is located in a tight, twisting pocket of Auckland Creek and is flanked by a narrow strip of mangrove, low closed forest to shrubland. This community was representative of remnant RE 12.1.3.

These vegetation communities do not provide potential habitat for any threatened flora species that are known to occur within the immediate and broader region.

TWAF 8

Lot 46 on SP235946 is currently mapped by DERM as supporting remnant RE 11.3.4 and non-remnant, high value regrowth that is characteristic of an 'Of Concern' RE and non-remnant vegetation.

Regional ecosystem 11.3.4

This vegetation community has a VMA status of 'Of Concern' and a biodiversity status of 'Of Concern'.

A relatively consistent distribution of woodland to open forest was found to occur within the eastern two-thirds of the site. This woodland was dominated by *Eucalyptus tereticornis* and associated *Eucalyptus crebra, Corymbia tessellaris, Corymbia clarksoniana* and *Lophostemon suaveolens*. The mid-strata were similarly composed, while the shrub layers were dominated by *Acacia disparrima, Melaleuca nervosa*, *Lophostemon suaveolens* and/or *Planchonia careya*. Vine thicket generalists such as *Geijera salicifolia* (broad-leaved wilga), *Mallotus philippensis* (red kamala), *Pittosporum spinescens* (orange thorn) and *Bridelia leichhardtii* (small-leaved scrub ironbark) were occasionally encountered in the shrub layer. The groundcover was generally dominated by a dense cover of native grasses such as *Heteropogon contortus* (bunched speargrass), *Arundinella nepalensis* (reed grass), *Digitaria breviglumis* (a finger grass) and *Imperata cylindrica*.

Vegetation along the northern, western and southern boundaries of the site was similarly composed however generally lacked the canopy cover intercept that would satisfy the criteria for remnant status. These areas were representative of non-remnant, high value regrowth characteristic of an 'Of Concern' RE (i.e., RE 11.3.4).

A braided ephemeral drainage line was identified within the southern portion of this site. The distribution of all strata that fringed these channels was found to be markedly inconsistent but comprised of elements that could be characteristic of RE 11.3.11. This vegetation community has a VMA status of 'Endangered' and a biodiversity status of 'Endangered'. This RE would also be considered a component of the SEVT of the Brigalow Belt and Nandewar Bio-regions threatened ecological community under the EPBC Act ('Endangered').

The discussion below indicates that the vegetation associated with the drainage line is ultimately representative of remnant RE 11.3.4 with elements of RE 11.11.5 and/or 11.12.4, rather than representing degraded and/or fragmented RE 11.3.11.

Both RE 11.11.5 and 11.12.4 are 'Least Concern' under the VMA, with a biodiversity status of 'No Concern at Present'.

The canopy layer ranged from isolated emergents to a sparse cover of *Eucalyptus tereticornis* and associated *Corymbia tessellaris* and *E. crebra*. The sub-canopy was dominated by *Melaleuca quinquenervia* and associated *Casuarina cunninghamina* (river oak) with *Terminalia porphyrocarpa* (brown damson) and *Lophostemon suaveolens* occurring occasionally. The low tree layer was also dominated by *M. quinquenervia* but supported a more diverse collection of associated vine forest generalists. These included *T. porphyrocarpa, Pleiogynium timorense, Acacia fasciculifera* (scrub ironbark), *Cryptocarya triplinervis*, *Mallotus philippensis, Aidia racemosa*, *Ficus virens*(white fig), *Drypetes deplanchei* and various vines. The tall shrub layer was dominated by species commonly encountered in the low tree layer and associated *Cupaniopsis anacardioides*, *Pittosporum ferrugineum* (rusty pittosporum), *Elaeodendron melanocarpum* and *Diospyros geminata*. The low shrub layer was dominated by *Acaclypha erenorum* (soft acalypha), *Alchornea ilicifolia* (native holly), *Mallotus claoxyloides* (green kamala) and associated upper strata species. The groundcover layer was markedly degraded with dominant species including **Megathyrsus maximus var. pubiglumis* (green panic), **Melinis repens* (red natal grass), **Bidens pilosa* (cobbler's pegs), *Sida spp., *Ageratum houstonianum* (blue billygoat weed) and **Rivinia humilis*).

Fire appears to have been excluded from the area for some time. The vine forest species possessed a cover intercept ranging from 5 to 25% and were predominantly juvenile or mid-mature specimens. These factors indicate that the distribution of vine forest species is potentially a mesic shift resulting from altered land use intent, particularly the exclusion of fire. It is presumed that these generalists have established opportunistically from larger upstream communities of vine forest rather than having been reduced in number and spatial distribution through clearing, fire or grazing pressures.

In general, RE 11.3.4 does not provide potential habitat for any threatened flora species that are known to occur within the immediate and broader region. However, the ephemeral drainage line provides limited opportunity for threatened species to exist. Detailed traverses of the drainage line failed to identify any threatened flora species.

The type and status of REs that were identified within TWAF 8 are summarised in Table 15 below.

Table 15 Regional ecosystems present and the field-validated amount of each within the TWAF 8 project area.

Regional ecosystem (RE)	VM status	Biodiversity status	EPBC status	Area of remnant vegetation (ha)	Area of high value regrowth vegetation in a restricted area (ha)	Area of high value regrowth vegetation (ha)
11.3.4	**'Of Concern'**	**'Of Concern'**	*n/a*	30.3	8.03	n/a

Launch Site 1

Launch Site 1 is largely mapped by DERM as containing non-remnant vegetation.

Regional Ecosystem 12.1.2 and 12.1.3

Along the river edge there is fringing vegetation, which is mapped by DERM as 'Least Concern' RE 12.1.2 and also RE 12.1.3. Observations from a boat on the Calliope River suggested that the vegetation was consistent with saltpan vegetation (RE 12.1.2) and mangrove shrublands (RE 12.1.3).

These sites were not ground truthed and so the areas in Table 16 refer to the DERM mapped extent.

Table 16 Regional ecosystems present and the field-validated amount of each within the Launch Site 1 project area.

Regional ecosystem (RE)	VM status	Biodiversity status	EPBC status	Area of remnant vegetation (ha)	Area of high value regrowth vegetation in a restricted area (ha)	Area of high value regrowth vegetation (ha)
12.1.2	'Least Concern'	'No Concern at Present'	*n/a*	1.7	n/a	n/a
12.1.3	'Least Concern'	'No Concern at Present'	*n/a*	1.8	n/a	n/a

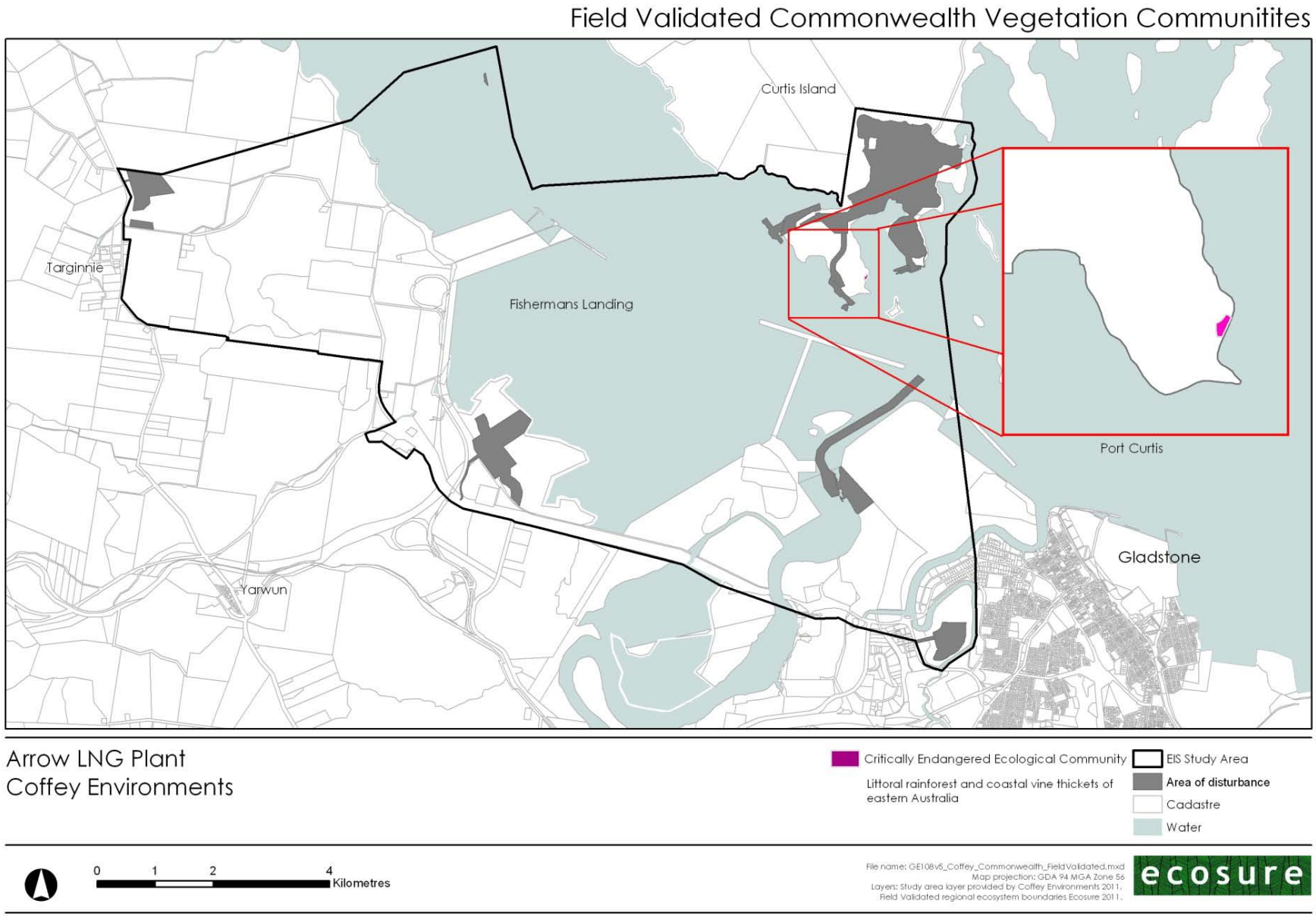


Figure 4 Commonwealth vegetation community – field validated

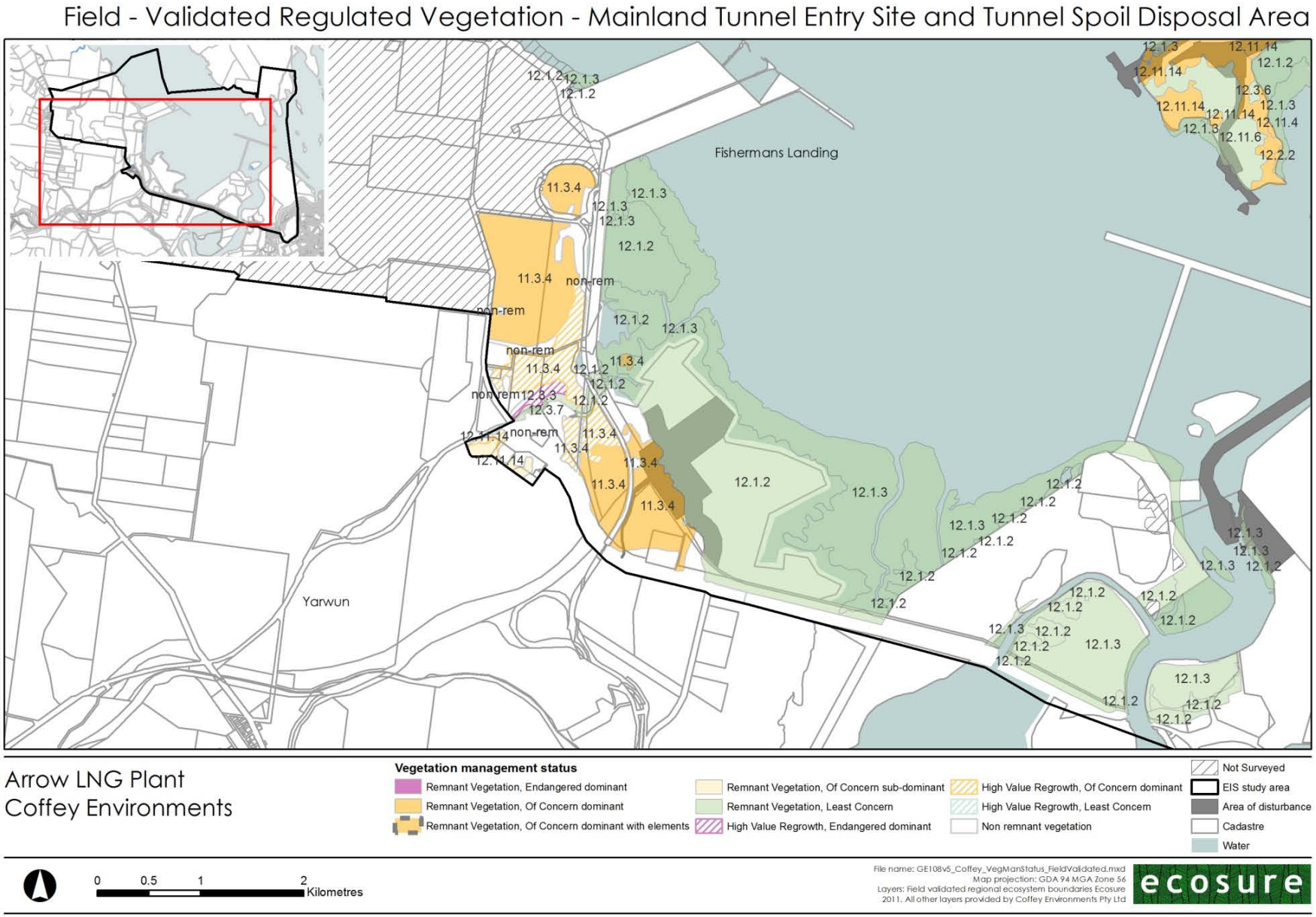


Figure 5 Queensland vegetation communities - field validated: mainland tunnel entry shaft and tunnel spoil disposal area.

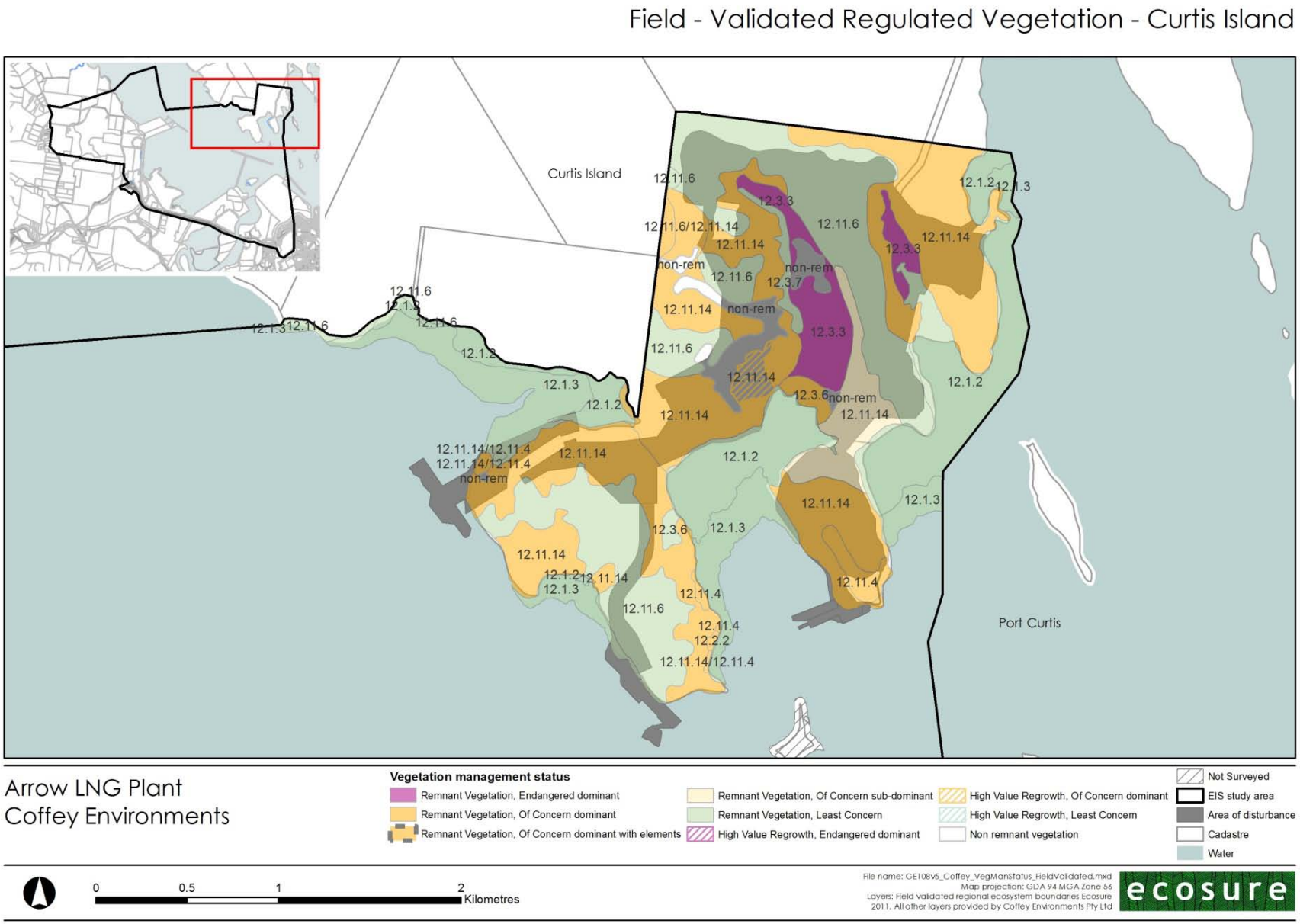


Figure 6 Queensland vegetation communities - field validated: Curtis Island.

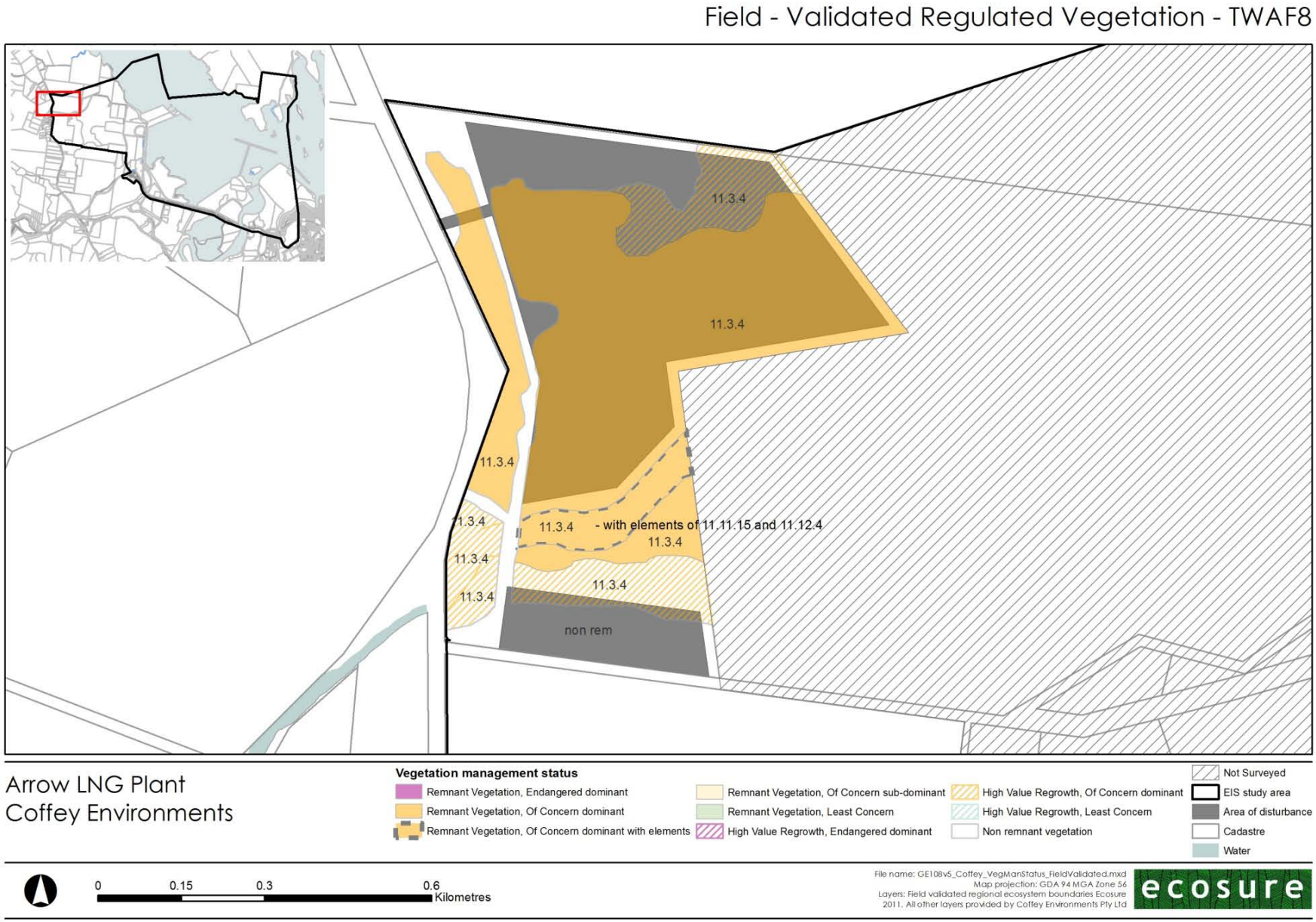


Figure 7 Queensland vegetation communities – field validated: TWAF 8

4.3 Flora Species of Conservation Significance

The literature review (as described in Section 3.3) identified 21 species which are afforded a conservation status under the EPBC Act or NC Act Regulation and which may occur within the study area. An assessment of the likelihood of these species occurring within the study area is presented in Table 17.

No threatened species were identified during targeted field searches of the study area. However, the as yet undescribed species identified on Curtis Island may be determined to have conservation significance. Given that this species may have a naturally restricted range and is closely related to the threatened flora species, *Cupaniopsis shirleyana* (wedge-leaved tuckeroo) it has been included for discussion in this section.

Table 17 Likelihood of threatened flora, identified in database searches, occurring in the study area.

FAMILY	Botanical name	Common name	NC Regulation status[1]	EPBC Act status[2]	Species information and occurrence notes	Assessment of likelihood within study area and habitat description	Source [4]
Phyllanthaceae	*Actephila sessilifolia*	Broad-leaved Actephila	NT	-	Shrub in dry rainforest and vine thickets on red, talus or granitic soils north from Yarrol (Monto district south of Gladstone) to Rollingstone and Bowling Green Bay, both near Townsville from altitude of 30-900 m (Cooper, 2004; Harden et al., 2006a; DNR, 1998).	Low (to Moderate): Suitable habitat exists but survey failed to locate this vegetatively distinct species. Records in similar habitat in close proximity to the study area (<3 km to northwest on Mt. Larcom).	HERBRECS, Wildlife Online
Apocynaceae	*Alyxia magnifolia*	Large-leaved Chain fruit	NT	-	Stiff prickly-leaved shrub reported from notophyll vine forest, complex notophyll vine forest, or vine forest with *Araucaria cunninghamii* emergents, or in rainforest with emergent eucalypts, between 30- 800 m altitude north from Blackall Range. Often on soils derived from igneous rocks but also poorer soils (Harden et al., 2006a; DNR 1999).	Low: Marginally suitable habitat exists but survey failed to locate this vegetatively distinct species.	Wildlife Online
Sapindaceae	*Atalaya calcicola*	Rock Whitewood	NT	-	Tree to 10 m in height growing in vine thickets and monsoon forests on hillsides, rocky slopes, rock outcrops and occasionally in gully heads. Occurs in several disjunct populations from Chillagoe (west of Cairns) to Nagoorin near Gladstone at altitudes between 290-500m (Harden et al., 2006a; Cooper, 2004; DNR, 1998).	Low: Marginally suitable habitat exists but altitudinal gradient not present and species appears to be restricted to a small area approximately 5 km south of the study area.	Wildlife Online
Sapindaceae	*Atalaya collina*	Yarwun Whitewood	E	E	Small spreading tree in dry rainforest. Small population known only from Yarwun near Gladstone and Ubobo near Miriam Vale (Harden et al,. 2006a; TSSC 2008b).	Low (to Moderate): Suitable habitat exists but species appears restricted to a small area approximately 5 km south of the study area.	HERBRECS Wildlife Online PMS
Sapindaceae	*Atalaya rigida*	Veiny Whitewood	NT	-	Small tree to 8 m in dry rainforest, monsoon forest, littoral rainforest and vine thickets on red clay soil or black clay loams. It has also been recorded in open forest. Occurs in disjunct populations north from Mt Glastonbury near Gympie to Cairns district from altitudes between sea level and 500m (Harden et al., 2006a; Cooper, 2004; DNR, 1998).	Low (to Moderate): Suitable habitat present and records in similar habitat in close proximity to the study area (found within SEVT approximately 6 km northwest of TWAF 8) .	Wildlife online

FAMILY	Botanical name	Common name	NC Regulation status[1]	EPBC Act status[2]	Species information and occurrence notes	Assessment of likelihood within study area and habitat description	Source [4]
Rutaceae	*Bosistoa selwyni/B.transversa*	Heart-leaved Bosistoa/ Three-leaved Bosistoa	V	V	A crooked tree up to 22 m tall with a dense dark-green crown, *Bosistoa transversa* grows in wet sclerophyll forest, dry sclerophyll forest and rainforest up to 300 m in altitude. *Bosistoa selwynii* is now considered to possibly belong to the same species as *Bosistoa transversa* (Harden et al., 2006a).	Low: Marginally suitable habitat present, but no records from the immediate region.	PMS
Orchidaceae	*Bulbophyllum globuliforme*	Miniature Moss Orchid	V	V	Epiphytic orchid on *Araucaria cunninghamii* (Stanley and Ross, 1986, 1989, 1995). Epiphytic species favouring (almost exclusively) the underside of upper branches of older *Araucaria cunninghamii* (suspected to be at least 100 years old) in primarily notophyll vine forests and Araucarian microphyll vine forests between 500-800 m altitude (Jones, 2006; DNR, 1998).	Very Low: Suitable habitat not present and no records from the immediate region.	PMS
Sapindaceae	*Cupaniopsis shirleyana*	Wedge-leaved Tuckeroo	V	V	Shrub or small tree to 10 m in height from Maryborough district north to Mt. Larcom and as a disjunct distribution in the Carina area in Brisbane. Occurs in dry rainforest and scrubby open forest on steep slopes, screeslope gullies and rocky stream channels at elevations between 60-550 m (Harden et al., 2006a; DNR, 1998).	Low (to Moderate): Suitable habitat present and records exist within the vicinity of the study area. [Note: an unidentified taxon with similar characteristics to *C.shirleyana* was recorded. Status to be confirmed by Queensland Herbarium. Refer to Section 4.3.1].	HERBRECS Wildlife Online PMS
Cycadaceae	*Cycas megacarpa*	(a) cycad	E	E	A small to medium-sized cycad with erect trunk to 3 m in height, grows on margins or occasionally in dry rainforest and in sclerophyll forest and woodland. Found north from Kilkivan to Moonlight Range, west of Rockhampton (Harden et al,. 2006a; Queensland Herbarium, 1997; DNR, 1998).	Low (to Moderate): Suitable habitat present and records exist within the vicinity of the study area.	HERBRECS PMS

FAMILY	Botanical name	Common name	NC Regulation status[1]	EPBC Act status[2]	Species information and occurrence notes	Assessment of likelihood within study area and habitat description	Source [4]
Combretaceae	*Dansiea elliptica*	Dainsea	NT	-	Occasionally deciduous small to medium-sized tree (larger in the tropics) in littoral and dry rainforest and vine thickets. In southeast Queensland this species is known from coastal notophylll vine forests and semi-evergreen vine thickets on sandy soils at altitudes between 30-150 m. Occurs from Kuranda to the Tully River, Deepwater and between Gladstone and Rockhampton in an area from Mt.Larcom to Bajool to Rundle Range (Cooper, 2004; Harden et al,. 2006a; DNR, 1998).	Low to (Moderate): Suitable habitat present and records exist within the vicinity of the study area (found within SEVT approximately 10 km southwest of the study area).	HERBRECS Wildlife Online
Celastraceae	*Denhamia parvifolia*	Small-leaved Denhamia	V	V	Shrub or small tree in dry rainforest, brigalow scrubs, vine thickets and occasionally in *Eucalyptus crebra* open forest on fertile red-brown, sandy, clay loams on hill slopes and crests of variable aspects. Occurs north from Kingaroy to the Mundubbera district at elevations ranging from 160-560 m (Harden et al., 2006a; TSSC, 2008c; DNR, 1998).	Low : Marginally suitable habitat present but no records exist within the vicinity of the study area.	Wildlife Online PMS
Acanthaceae	*Graptophyllum excelsum*	Scarlet Fushia	NT	-	Shrub to 3 m with slender axillary spines sometimes present. Usually found in soil pockets among rocks and in rock crevices on steep rough, rocky eroded hillslopes in monsoonal vine forest, vine thickets and dry rainforest from near Chillagoe to Jimna in southeast Queensland. In the Chillagoe area the species has also been recorded in grassy woodland in association with *Eucalyptus cullenii* and *Corymbia erythrophloia*. Grows in soils derived from limestone, sandstone or basic igneous rock (Cooper, 2004; Harden et al., 2006a; DNR, 1998).	Low (to Moderate): Suitable habitat present and records exist within the vicinity of the study area (<4 km to northwest on northern end of Mt. Larcom).	HERBRECS Wildlife Online PMS
Hernandiaceae	*Hernandia bivalvis*	Grease Nut	NT	-	Small tree to 20 m in dry rainforest and vine thickets from Dyander Creek near Prosperpine to Mt. Tamborine west of the Gold Coast (Cooper, 2004; Harden et al., 2006a; DNR, 1998).	Low (to Moderate): Suitable habitat present and records exist within the vicinity of the study area (<4 km to northwest on northern slopes and foothills of Mt. Larcom).	HERBRECS Wildlife Online

FAMILY	Botanical name	Common name	NC Regulation status[1]	EPBC Act status[2]	Species information and occurrence notes	Assessment of likelihood within study area and habitat description	Source [4]
Combretaceae	*Macropteranthes fitzalanii*	Northern Bonewood	NT	-	Shrub or small tree to 7 m high in dry rainforest and vine thickets north from the Gladstone area (Harden et al., 2006a; Forster, 1994).	Low (to Moderate): Suitable habitat present and records in similar habitat in close proximity to the study area (found within SEVT approximately 6 km northwest of TWAF 8).	Wildlife Online
Combretaceae	*Macropteranthes leiocaulis*	Southern Bonewood	NT	-	Shrub to medium-sized seasonally deciduous tree in vine thickets and dry rainforest north from the Binjour Plateau, northwest of Gayndah (Harden et al., 2006a; DNR, 1998; Forster, 1994).	Low (to Moderate): Suitable habitat present and records exist within the vicinity of the study area (found within SEVT approximately 6km northwest of TWAF 8).	HERBRECS Wildlife Online
Apocynaceae	*Parsonsia larcomensis*	Mt. Larcom Silkpod	V	V	Creeping to adscendent climber to 5 m long in subtropical and dry rainforest and adjacent shrublands on cliffs or rocky outcrops of acid volcanic rocks or serpentites. Known from Mt. Perry, Mt. Larcom, Mingga Mountain and Mt. Wheeler with disjunct populations on the Byfield Range and at Cape Upstart (Harden et al., 2006a; TSSC, 2008d).	Low (to Moderate): Suitable habitat exists but underlying geology and coarse topographical requirements not present. However, given that the species has highly effective wind-blown fruit, there is potential for isolated specimens to become established within the study area.	HERBRECS Wildlife Online PMS
Apocynaceae	*Parsonsia lenticellata*	Narrow-leaved Parsonsia	NT	-	Twiner of rainforest, gallery rainforest and open forest from the Daintree to Mackay area from an altitude between sea level and 450 m (Cooper 2004). [Note: This record may have originated from a misidentification of the very similar *Parsonsia paulforsteri* (Harden et al., 2006b; Cooper, 2004)].	Very Low: Suitable habitat present but well removed from known distributional range. HERBRECS record potentially mis-identification of *P.paulforsteri* which was found to occur ubiquitously within SEVT to the northwest of the study area. Samples which were identified in this area and sent to Queensland Herbarium were identified as *P. paulforsteri*.	HERBRECS

FAMILY	Botanical name	Common name	NC Regulation status[1]	EPBC Act status[2]	Species information and occurrence notes	Assessment of likelihood within study area and habitat description	Source [4]
Simaroubaceae	*Quassia bidwillii*	Quassia	V	V	Shrub, often suckering from roots, in dry rainforest, vine thickets and lowland rainforests in disjunct populations north of the Gympie district (Goomboorian to Mackay) and occasionally open forests adjacent to vine thicket communities, woodlands and fringing mangrove communities on a variety of geological substrates (Harden et al., 2006a; Logan River Branch Society for Growing Native Plants, 2008; DNR, 1998).	Low (to Moderate): Suitable habitat exists but survey failed to locate this vegetatively distinct species. Records in similar habitat in close proximity to the study area (<3 km to northwest on Mt. Larcom).	HERBRECS Wildlife Online PMS
Caesalpineaceae	*Senna aclinis*	Brush Senna	NT	-	Erect shrub growing to 3 m tall on margins of subtropical, dry and littoral rainforests and vine thickets on soils derived from mixture of basalt and metamorphic rocks. Found from north of Gloucester area (NSW) to Gladstone and west to the Taroom district with a disjunct population known from Eungella, west of Mackay (Harden et al., 2006a; DNR, 1998).	Low (to Moderate): Suitable habitat exists but survey failed to locate this vegetatively distinct species. Records in similar habitat in close proximity to the study area (<10 km to southwest on Mt. Larcom).	HERBRECS
Orchidaceae	*Taeniophyllum muelleri*	Ribbon-root Orchid	-	V[5]	Common in shrubs and trees in rainforest, sheltered areas in open forest, humid gullies and streamside vegetation. Occurs from Wilson River (near Wauchope, NSW) to Cape York Peninsula from 50-1200 m in altitude (Jones, 2006).	Low: Suitable habitat present but no records in the wider region.	PMS
Rutaceae	*Zieria actites*		V	-	Shrub to 1 m tall and found only above 600 m altitude on the peaks and upper cliff lines on Mt. Larcom. Occurs in exposed situations in open woodland and shrubland (Duretto and Forster, 2007).	Very Low: Suitable habitat, underlying geology and coarse topographical requirements not present.	HERBRECS, Wildlife Online

1 - NC Regulation status: Conservation status of each taxon under the Status taken from the Queensland Nature Conservation (Wildlife) Regulation 2006: Vulnerable (V), Near Threatened (NT), Least Concern (-), Not Listed (–).

2 - EPBC status: Conservation status of each taxon under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act): Vulnerable (V), Endangered (E), Not Listed (–).

3 - Likelihood of occurrence within the study area:

Very Low = The study area is outside the species normal range, habitat and/or underlying geology does not exist (no further impact assessment required).

Low = Database searches indicate the species could potentially occur in the study area, however previous records are likely to be historic or invalid, the study area is outside the species normal range, habitat does not exist or the species is considered locally extinct (no further impact assessment required).

Moderate = Habitat exists for the species; however it is either marginal or not particularly abundant. The species is known from the wider region and could potentially occur (further impact assessment required).

High = The species is known to occur in the local area and core habitat exists in the study area (further impact assessment required).

Recorded = The species was recorded in the study area as part of field surveys (further impact assessment required).

4 - Source: EPBC Protected Matters Search [PMS] (DEWHA, 2009d), Wildlife Online (DERM, 2009d), HERBRECS database (Queensland Herbarium, 2009)

5 - **[NOTE:** *Taeniophyllum muellerii* is erroneously listed under the EPBC Act. This species should only be listed as a 'Vulnerable' Norfolk Island Flora Species and not as 'Vulnerable' on the mainland**]**

6 - *Indigofera baileyii* was removed from the schedules of the NC Regulation (October 2010) and is no longer considered a threatened species

4.3.1 Commonwealth

No EPBC listed species were identified within the study area. The literature review (Table 17) indicates that five species listed under the EPBC Act have a low to moderate likelihood of occurring in the study area. An additional two species had a low or very low likelihood of occurrence.

Within the region, *Cycas megacarpa* (a cycad) was recorded during field surveys conducted in the northern section of the Gladstone Infrastructure Corridor in July 2010. These specimens were located on private property approximately 7.5 km northwest of TWAF 8. This species is currently listed as 'Endangered' under both the EPBC Act and NC Regulation. The species was observed in several disjunct locations in *Corymbia citriodora ssp. citriodora* and/or *Eucalyptus crebra* woodland to open forest on the east-facing slope of a moderately inclined low hill/ridge located on the western side of Mt. Larcom. The distribution of the species within these populations was highly variable. In total, 430 individuals were recorded, including one very large, mature specimen in excess of 5 m in height and possessing a diameter at breast height of 28 cm.

Although suitable habitat was recorded in several other locations within the study area, no other individual specimens or populations of *Cycas megacarpa* were encountered.

During pre-clearing vegetation assessments relating to geotechnical investigations on Curtis Island (outside of the scope of this report), specimens of an unidentified species of *Cupaniopsis,* thought to be closely related to the threatened flora species, *Cupaniopsis shirleyana,* were identified within the Arrow LNG Plant project area (Plates 4–6). The recorded specimens were therefore lodged with the Queensland Herbarium for positive identification. The lodged specimens were identified by the Queensland Herbarium as *C. shirleyana,* which is currently listed as 'Vulnerable' under both the EPBC Act and NC Regulation. These specimens were recorded within a mildly fragmented area of SEVT located on the southern extent of Boatshed Point.

This area was revisited and assessed in detail during the detailed survey (July 2010). It was determined that the previously identified specimens of *Cupaniopsis* displayed vegetative and reproductive characteristics which were not entirely characteristic of *C. shirleyana*. The same specimens were sampled when in flower and were re-submitted to the Queensland Herbarium for additional analysis by a Senior Botanist and the Director of the Queensland Herbarium. Initial assessment in August 2010 indicated that the sampled species, herein referred to as *Cupaniopsis* sp. indet. is potentially a new taxon. Further research and sampling was requested by the Queensland Herbarium to enable positive identification and establish population size and regional distribution. These surveys were conducted on September 1st to 4th 2010 and included areas of SEVT located outside the study area on Garden Island, and headlands and unnamed islands in Graham Creek.

A total of 164 specimens were recorded in fragmented SEVT (RE 12.11.4) on Boatshed Point and a further three specimens were recorded in a small patch of 'beach scrub' (RE 12.2.2). The specimens that were identified in RE 12.2.2 were recorded in a tight clump under a mature specimen of *Alectryon conatus*, which is also a member of the Sapindaceae family.

This would indicate that these specimens are likely to have been dispersed by a bird or bat from the main population on Boatshed Point.

The DERM mapped areas of SEVT RE 12.11.4 on Garden Island and an unnamed headland located to the east of Boatshed Point and fringing the southeastern boundary of the proposed Arrow LNG Plant facility were found to be either representative of *Eucalyptus crebra* woodland on metamorphic (RE 12.11.14) or fragmented vine forest of low diversity. No further specimens of *Cupaniopsis* sp. indet. were recorded at these locations. However, a small, privately owned island located to the immediate south of Boatshed Point (Witty Island) was circumnavigated by boat and assessed using binoculars. The primary vegetation type on this island was SEVT on metamorphic rocks (RE 12.11.4) and specimens of *Cupaniopsis* sp. indet. were observed.

The southern face of an unnamed island in Graham Creek supported relatively intact SEVT (RE 12.11.4) and was also found to support a considerable number of this species. The distribution and density of *Cupaniopsis* sp. indet in this habitat was highly variable and is likely to be dependent upon the structure and condition of the vine forest habitat. Preliminary assessment of the distribution and habitat quality of SEVT would suggest that several thousand specimens of this species potentially persist on the island. Further detailed survey of this island would be required to ascertain a definitive density and distribution of this species.

Outside of the study area, vegetatively similar specimens were also recorded in fragmented to intact SEVT (RE 11.11.18) in ephemeral drainage lines on moderately inclined low hills located to the west-northwest of Mt. Larcom. These areas were also re-visited and numerous plants were sampled for submission to the Queensland Herbarium. A total of 202 specimens across six populations were recorded in the vicinity of Mt. Larcom.

Figure 9 illustrates the known locations of *Cupaniopsis* sp. indet. specimens and Appendix H provides the details of each record.

Plate 4 *Cupaniopsis* (sp. indet) – flower (Hansen Botanical Assessments Pty Ltd)

Plate 5 *Cupaniopsis* (sp. indet) – fruit (Hansen Botanical Assessments Pty Ltd)

Plate 6 *Cupaniopsis* (sp. indet) - leaf variation (Hansen Botanical Assessments Pty Ltd)

4.3.2 State

As indicated in Appendix B, no threatened flora species under the NCA were recorded within the study area.

Thirteen threatened flora species were considered to have a low to moderate likelihood of occurrence despite not being positively identified during the current survey effort. These species were considered as potentially occurring on the basis of suitable habitat, geology and topography coupled with Queensland Herbarium records in the immediate vicinity of the study area. A further eight species were considered to have a very low to low likelihood of occurrence based on the presence of marginally suitable habitat and Queensland Herbarium identified records in close proximity to the study area. However, these eight species are generally recognised as being naturally restricted in their distributional range and/or requiring specific habitat qualities which were not recorded within the study area.

The balance of threatened flora species identified during the desktop review process were considered to have a low to very low likelihood of occurrence due to the lack of suitable habitat, geology, topography and/or known records within the wider region. The source of each record is provided in Table 16 above.

Numerous flora species were considered to be locally or regionally significant as they are considered to be occurring at the limit of their distributional range. The Gladstone region is a transitional zone wherein numerous tropical specialists occur at the southern limit of their range, and many sub-tropical species occur at the northern limit of their range. These species are not currently listed as being threatened under the EPBC Act or NC Regulation and include:

- *Capparis ornans, Crotalaria brevis, Durabaculum undulatum, Ehretia grahamii, Melaleuca fluviatilis* and *Rhamnella vitensis*, at the southern limit of their range.
- *Graptophyllum spinigerum* and *Rhysotoechia bifoliata*, at the northern limit of their distributional range.
- *Macrozamia miquellii*, which is endemic to the Port Curtis pastoral district.

4.4 Introduced Flora Species

4.4.1 Nationally Declared Pest Species

The review of the HERBRECS database identified three exotic flora species, recognised as WONS, likely to occur in the study area (**Cryptostegia grandiflora, *Lantana camara var. camara* and *Salvinia molesta*).

Field surveys confirmed the presence of two WONS in the study area (Table 18). **Cryptostegia grandiflora* was frequently encountered as isolated individuals or small infestations in woodland to open sclerophyllous forest on gently undulated low rises, alluvial plains and watercourses. **Lantana camara var. camara* was frequently encountered as isolated individuals or small thickets in numerous vegetation types. In some communities **Lantana camara var. camara* dominated the low shrub layer and occasionally formed an

impenetrable thicket.

External to the study area, the aquatic weed **Hymenachne aplexicaulis* (hymenachne) was observed in and adjacent to two small dams in the vicinity of Cullen Road which intersects the northwest portion of the Northern Transport Infrastructure Corridor (approximately 6.7 km northwest of TWAF 8). This represents an extension to the known range of this species. As pipeline construction and road development associated with the gas supply of several proponents (excluding Arrow) to Curtis Island is proposed throughout this area, there is considerable risk that this species could be spread throughout the Gladstone region, including to the study area.

4.4.2 State Declared Pest Species

Declared plants are those that are targeted for control under Queensland legislation (the LP Act) as they are recognised as having, or may potentially have, significant environmental, economic or social impacts. The declaration of a plant imposes a legal obligation on landholders to control or eradicate the plant (DEEDI, 2011a). There are three categories of declared plants:

- Class 1 – these plants are not well established within Queensland, however have the potential to become a significant pest. All Class 1 plants are subject to eradication within Queensland and it is an offence to introduce, keep or supply these plants without a permit.
- Class 2 – pest plants already established within Queensland that have substantial impacts. Control is required to prevent further spread into areas free of the pest. Landholders are obligated, under legislation, to prevent the spread of these plants and it is an offence to possess, sell or release these plants without a permit.
- Class 3 – these plants are common in areas of the state and control is required under legislation, only if the plant is impacting on, or may impact on, an environmentally significant area, such as a national park. It is an offence to introduce, release or supply these plants.

Species recorded during detailed surveys are summarised in Table 18. Further details on the exotic species listed can be found within the Pest Management Plan (Ecosure 2011).

Table 18 Declared pest plants recorded in the study area.

Botanical Name	Common Name	Queensland Status	Commonwealth Status	REs supporting Species
Cryptostegia grandiflora	Rubber Vine	Class 2	WONS	12.3.3, 12.11.6, 12.11.14
Lantana camara var. camara	Common Lantana	Class 3	WONS	11.3.4, 12.2.2, 12.3.3, 12.11.4,
Opuntia stricta	Common Prickly Pear	Class 2	-	12.11.14

In addition to those species identified above, other declared pest plants observed in the region (but outside of the study area) include:

- **Asparagus plumosus* (climbing asparagus fern).
- **Bryophyllum delagoense* (mother-of-millions).

- **Bryophyllum x houghtonii* (live-leaf).
- **Lantana montevidensis* (creeping lantana).
- **Hymenachne aplexicaulis* (hymenachne).
- **Macfadyena unguis-cati* (cat's claw creeper).
- **Opuntia tomentosa* (velvet prickly pear).
- **Sporobolus pyrimidalis* (giant rats tail grass).
- **Thevetia peruviana* (Captain Cook tree).

Although these species were not recorded within the surveys undertaken as part of this project, there exists a moderate to considerable risk that they may spread throughout the Gladstone region and subsequently be introduced into the study area over time. This is due to increased development occurring within the study area.

Relative Abundance of Pest Flora Species

The majority of weed species recorded during surveys were moderately to well established within their suitable habitats. Notably, the declared species of **Lantana camara, *Cryptostegia grandiflora,* and, to a lesser extent, **Opuntia stricta,* were frequently distributed throughout the study area.

Table 19 describes the relative abundance of both declared and non-declared woody, climbing and herbaceous weeds, as well as exotic grasses for each field-validated regional ecosystem.

Table 19 Relative abundance of pest flora species within field-validated regional ecosystems.

Regional ecosystem	WONS	State declared exotic flora[1]	Non- declared exotic flora (excl. grasses)[1]	Exotic pastoral grasses
11.3.4	+ - 2	1 - 2	1 - 2	1 – 6
12.1.2	Nil	Nil	+	1
12.1.3	Nil	Nil	Nil	Nil
12.2.2	1 – 2	1 -2	1 - 3	1 – 3
12.3.3	+ - 1	+ - 1	+ - 2	2
12.3.7	1 – 2	1 - 2	1 - 3	1 – 2
12.11.4	1	1	1 - 4	+
12.11.6	+	+	+ - 1	+ - 2
12.11.14	+	+	+ - 1	+ - 1
improved pasture	1 – 3	1 - 3	2 - 3	1-3
roadside	+	+	3 - 4	3 – 5

[1] The relative abundance of recorded species was assigned in correlation with the Braun-Blanquet technique, wherein:

nil = exotic flora species absent

+ = one or two individuals only

1 = provides less than 5% cover within the occupied stratum and encountered infrequently within community;

2 = provides less than 5% cover within the occupied stratum but encountered frequently within community;

3 = provides 5 to 24% cover within the occupied stratum;

4 = provides 25 to 49% cover within the occupied stratum;

5 = provides 50 to 74% cover within the occupied stratum;

6 = provides 75 to 100% cover within the occupied stratum.

4.5 Fauna

4.5.1 Overview

Field surveys recorded 162 terrestrial fauna species, consisting of 18 mammal, 15 reptile, nine frog and 120 bird species (Appendix C).

Ten species were observed which are listed as 'Migratory' under the EPBC Act. Of these migratory species, one is also listed as 'Near Threatened' under the NCA. There was also one 'Vulnerable' bird species listed under the NCA surveyed, and one mammal species which is 'Vulnerable' under both the EPBC and the NCA.

4.6 Fauna Habitat Descriptions

4.6.1 Curtis Island LNG Facility, Hamilton Point and Boatshed Point

Four broad habitats occur across the study area on Curtis Island; intertidal areas, *Eucalyptus tereticornis* woodland on alluvial flats, SEVT and mixed eucalypt open-forest to woodland.

Intertidal Areas

Low mangrove shrubland was the dominate vegetation type within the intertidal areas. These corridors of were usually separated from the surrounding open-forest/woodland by a thin strip of *Sporobolus virginicus* and *Juncus* species, usually less than 5 m wide. Structural components within the mangrove shrubland included a low, closed canopy cover, and abundant fallen woody debris, including hollow logs (Plate 7). This habitat is considered suitable for water mouse (*Xeromys myoides*).

The extensive, bare tidal mudflats are periodically inundated by tidal waters. The edges of the tidal mudflats in many areas were highly degraded by pest fauna (likely feral pigs [*Sus scrofa*]). Eroded banks were usually present along the edges of the mudflats. There were very few patches of *Sporobolus virginicus* and samphire forbland present in these areas, as a result of damage caused by feral herbivores and erosion.

Plate 7 Potential habitat for water mouse, North China Bay (Curtis Island) (Ecosure, 2010)

***Eucalyptus tereticornis* Woodland on Alluvial Flats**

This habitat type was common in low-lying areas in the vicinity of the Arrow LNG Plant site. *Eucalyptus tereticornis* was the dominant canopy species with a midstorey comprised mainly of mature Lophostemon suaveolens. The understorey was dominated by *Acacia* species, which were dense in patches. The ephemeral creeks running through the habitat were incised to varying extents, and were lined with a mix of native midstorey and understorey species, including *Livistona australis* (cabbage tree palm). The groundcover layer was a mix of exotic and native vegetation.

Mature, hollow-bearing trees, arboreal termitaria containing hollows and fallen woody material were common throughout this habitat. There was evidence of disturbance including controlled burns, weed invasion and feral herbivore damage.

Semi-Evergreen Vine Thicket

SEVT habitat was generally confined to patches and gullies on the rocky/scree slopes of the headlands and littoral zone within the Arrow LNG Plant site. There was an abundance of leaf litter and rocky groundcover. The majority of SEVT patches were relatively intact with a low, closed canopy cover. The exception was patches of SEVT subject to feral herbivore damage, weed invasion and past clearing, particularly in the ground layer.

Mixed Eucalypt Open-Forest to Woodland

Mixed eucalypt open-forest to woodland on undulating low hills dominated the Arrow LNG Plant site with species such as *Corymbia citriodora ssp. citriodora* and *Eucalyptus crebra* prominent in the canopy layer *Acacia* and *Eucalyptus* species were dominant in the understorey and were dense in small patches. The groundcover layer ranged from sparse native grass cover to a mix of dense native/exotic grass cover. Arboreal termitaria and large hollow-bearing stags were common habitat features. Hollow-bearing trees, leaf litter and in

some areas, fallen woody material including hollow logs, were also abundant. Weed invasion and controlled burns appeared to be the main cause of disturbance in this habitat.

4.6.2 Mainland Tunnel Entry Shaft and Tunnel Spoil Disposal Area

The mainland tunnel entry shaft and tunnel spoil disposal area is characterised by extensive bare tidal mudflats surrounded by low mangrove shrubland on the seaward side and along the creek fringes. Structural components within the mangrove shrubland include a low, closed canopy cover, and abundant fallen woody debris, including hollow logs. Mangrove dieback was evident in patches, particularly around the edges. The tidal mudflats are periodically inundated by tidal waters. The edges of the tidal mudflats in many areas are degraded by human activities and eroded banks were present along the edges of the mudflats in some areas. There were limited patches of *Sporobolus virginicus* and *Sarcocornia quinqueflora* (bead weed) in these areas. The lack of floral diversity may be attributed to human activities and erosion from tidal flows.

The low-lying mixed open-forest adjacent to the intertidal area consists of several mature canopy species such as *Eucalyptus tereticornis*, *Corymbia intermedia* and *Eucalyptus crebra*. This habitat type occurs in isolated remnants, separated by roads and industrial land uses. The mixed understorey is primarily comprised of *Acacia* and *Melaleuca* species. Invasion of dense exotic grasses has occurred throughout parts of this habitat type, particularly in the southern section of the alignment. In general, there was abundant arboreal termitaria, hollow-bearing trees, hollow logs and in some areas, shallow ephemeral ditches.

GHD (2010) found roosting habitat for shorebirds in the southern section of this area.

4.6.3 TWAF 7 and TWAF 8

TWAF 8 is located in the far western extent of the study area and the majority of this section is characterised by *Eucalyptus tereticornis* woodland on alluvium. High quality habitat features were identified within this area including numerous large habitat trees possessing hollows of varying sizes and arboreal termitaria with hollows. The canopy layer ranged from approximately 25-30 m high. Bird's nests were observed throughout the area, including a potential raptor nest. There was some disturbance by weed invasion in areas close to the watercourse in the central portion of TWAF 8. The rocky ephemeral watercourse was lined with mature *Eucalyptus tereticornis* and vine thicket generalists, which formed a riparian corridor with linkages to the coast and Mt. Larcom Range.

The habitat values of TWAF 7 are generally low given that the majority of the area has been previously cleared and is in the early stages of rehabilitation. The fringing intertidal area provides foraging habitat for wading birds, although this would likely be restricted to small numbers as the area is not of sufficient quality to support high numbers. There are very limited opportunities for significant species to utilise TWAF 7 due to its low ecological value and limited connectivity.

4.6.4 Launch Site 1

Targeted fauna surveys were not conducted at Launch site 1. The mangrove shrubland habitat present is potentially suitable for water mouse.

4.7 Fauna Species of Conservation Significance

The literature review identified 54 species which are afforded a conservation status under the EPBC and/or NCA and which are known to occur or possibly occur in the study area (Table 20). Of these 54, four are also classed as 'Migratory under the EPBC. In total, there are 52 'Migratory' species which may occur within the study area.

Records of significant fauna from surveys undertaken for other projects within the Arrow LNG Plant study area are illustrated in Figure 8. An assessment of the likelihood of occurrence of these species within the study area is presented in Tables 20 and 21, along with details of any record from the Arrow LNG Plant field surveys. (Appendix C). Details of threatened fauna records from field surveys are provided in Appendix I.

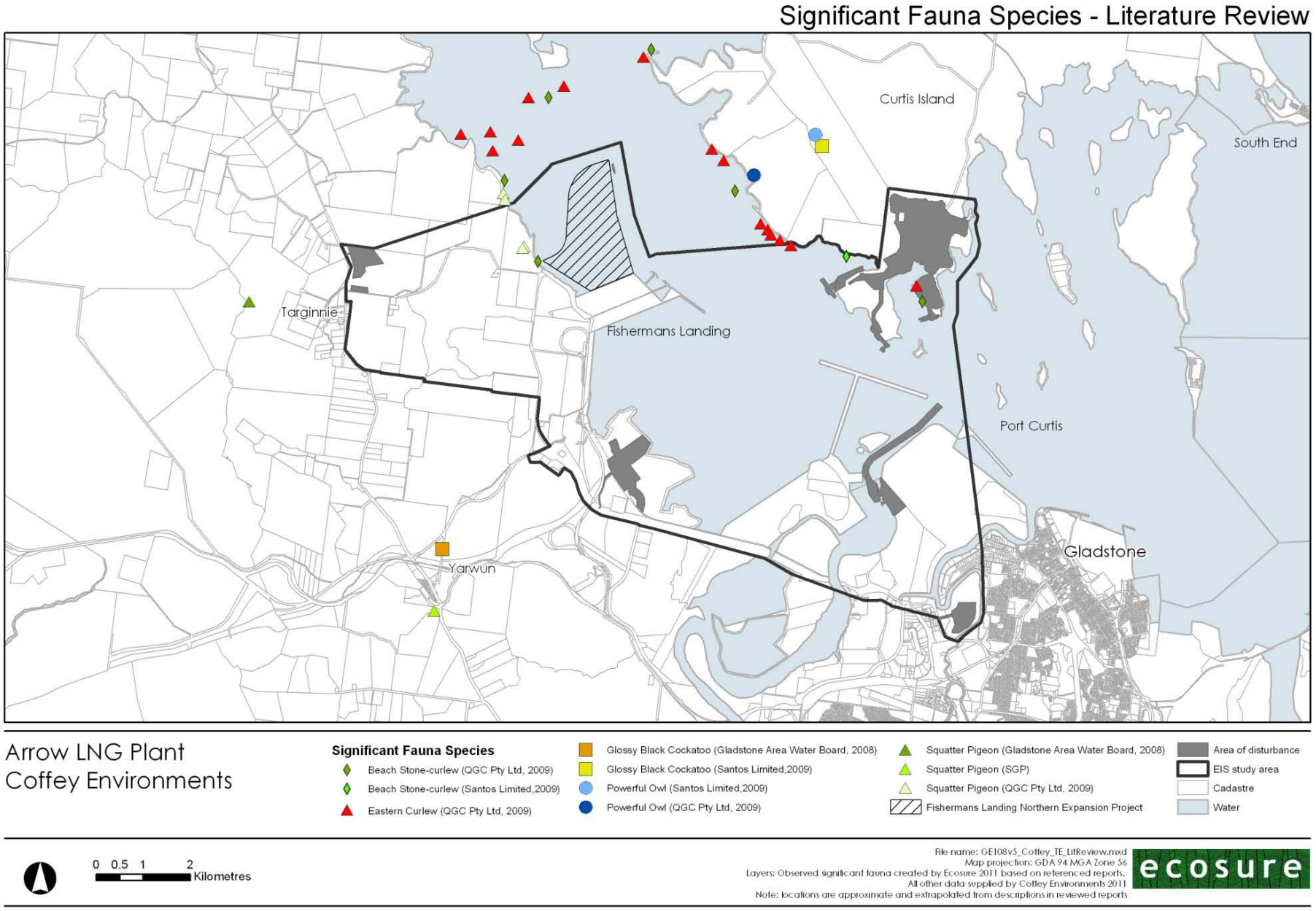


Figure 8 Significant fauna species, based on review of available literature.

Table 20 Likelihood of threatened fauna, identified in database searches, occurring in the study area.

Species		NCA Status	EPBC Status	Species Information and Occurrence Notes	Assessment of likelihood and habitat description
Common Name	**Scientific Name**				
Amphibians					
Tusked Frog	*Adelotus brevis*	V	-	Occurs from central Queensland to southern New South Wales. Found under logs and hollows/rock crevices beside streams and ponds in a range of habitats such as rainforest, wet sclerophyll forest, dry eucalypt forest, grassland and urban areas (Robinson, 1993; Meyer *et al*., 2001).	Moderate: Due to suitable streams and ponds within patches of eucalypt forest habitat occurring throughout the study area.
Birds					
Herald Petrel	*Pterodroma heraldic*	E	CE	Marine, pelagic species occurring in tropical and subtropical waters of the Pacific Ocean (DSEWPC, 2011).	Low: Due to unsuitable habitat and outside of species range.
Yellow Chat (Capricorn subspecies)	*Epthianura crocea macgregor*	E	CE	Endemic to the central Queensland Coast. Known only on Curtis Island and the adjacent mainland coast, where range is estimated to be 25 km^2. Inhabits wetlands and associated grasslands on seasonally inundated plains under marine influence. The wetlands are characterised by shallow braided channels and depressions with a variety of other habitats including dense sedge-beds, grasslands, tall Samphire and muddy areas (Houston and Melzer, 2008).	Moderate: Due to degraded intertidal habitat along the eastern section of the mainland and southern parts of Curtis Island. Known population exists to the north on Curtis Island.
Black-throated Finch (southern subspecies)	*Poephila cincta cincta*	E	E	Once distributed from the south of Cairns to just over New South Wales border, and inland (Queensland CRA/RFA Steering Committee, 1997a). There has been very few species recordings south of 23°S (Tropic of Capricorn) since the late 1970s (Garnett and Crowley, 2000). Occupies grassy woodland dominated by eucalypts, paperbarks or acacias, where there is access to seeding grasses and water (Garnett and Crowley, 2000).	Low: Appears to be out of range despite presence in QLD Wildlife Online database. Patches of suitable woodland habitat adjacent to water sources, does occur throughout the study area.
Black-breasted Button-quail	*Turnix melanogaster*	V	V	In Queensland, populations are small and isolated and confined to restricted habitat in the southeast Queensland Bioregion. Favours vine thicket rainforest as well as softwood scrubs in the Brigalow Belt, vine scrub regrowth, dry sclerophyll forest adjacent to rainforest and *Acacia* and *Austromyrtus* scrubs on sandy coastal soils (Garnett and Crowley, 2000).	Low (to Moderate): Due to patches of suitable vine thicket habitat occurring in the western half of the mainland section of the study area.

Species		NCA Status	EPBC Status	Species Information and Occurrence Notes	Assessment of likelihood and habitat description
Common Name	Scientific Name				
Squatter Pigeon (southern subspecies)	*Geophaps scripta scripta*	V	V	Occurs on the inland slopes of the Great Dividing Range, in particular around the Burdekin-Lynd divide in central Queensland as well as scattered sites throughout southeast Queensland. Inhabits grassy understorey of open eucalypt forests and woodland, usually with good access to water (DEWHA, 2008a).	High: Observed numerous times in disturbed pasture grassland and woodland within several kilometres of the mainland section of the study area (Appendix C). These habitat types are common throughout the study area.
Australian Painted Snipe	*Rostratula australis*	V	V	Scattered distribution throughout many parts of Australia where it is usually found in shallow inland wetlands, either freshwater or brackish, that are either permanently or temporarily filled (DSEWPC, 2011). Habitat includes small islands and although more common in SE Aus (Murray-Darling basin), there are records from across Queensland (Birds Australia, 2011).	Low (to Moderate): Due to patches of suitable low-lying grassland habitat (therefore conducive to water ponding) occurring in the mainland section, in particular areas north of Fishermans Landing and in the northern section of TWAF 8.
Kermadec Petrel (western subsp.)	*Pterodroma neglecta neglecta*	-	V	Pelagic species. Rare visitor to mainland. Breeds on offshore islands across the southern Pacific Ocean (Marchant and Higgins, 1990).	Low: Due to unsuitable habitat and outside of species range.
Red Goshawk	*Erythrotriorchis radiatus*	E	V	Found in eastern Queensland where it requires a very substantial home range covering between 50 and 220 square kilometres. Utilises a variety of habitat types including tall open forest, woodland, savannah with scattered trees and the edge of rainforest (Marchant and Higgins, 1993). Prefers to be near rivers and a mosaic of forest types (Pizzey and Knight, 2003).	Low (to Moderate): Due to patches of suitable open forest/woodland habitat occurring throughout the study area.
Southern Giant-Petrel	*Macronectes giganteus*	E	E	Rare visitor to mainland. Breeds on six subantarctic and Antarctic islands in Australian territory (DSEWPC, 2011).	Low: Due to unsuitable habitat.
Star Finch (southern subsp.)	*Neochmia ruficauda ruficauda*	E	E	Distributed sparsely across central Queensland. Favours mainly open grasslands and grassy woodland which is usually close to fresh water bodies (DSEWPC, 2011).	Very Low: Due to recent expert review of the status which has lead to the subspecies being assumed extinct (pers. comm. Birds Australia Southern Queensland Conference, 2011)
Little Tern	*Sterna albifrons*	E	-	Breeds along the eastern and southeastern coast of Australia. Prefers sheltered coastal habitats including undisturbed tidal estuaries, estuarine islands and harbours as well as exposed ocean beaches (Higgins and Davies, 1996).	Moderate (to High): Due to suitable estuarine habitat occurring south of Fisherman's Landing along the mainland coastline, and the coast of Curtis Island.

Species		NCA Status	EPBC Status	Species Information and Occurrence Notes	Assessment of likelihood and habitat description
Common Name	Scientific Name				
Australian Swiftlet	*Aerodramus terraereginae*	NT	-	Mainly occurs in coastal northeast Queensland, with southern range limit to Mackay. Occasionally seen as a casual visitor in coastal areas of southeast Queensland. Utilises airspace over a range of different habitats (Pizzey and Knight, 2003).	Moderate: Potentially occasional visitor to airspace over study area, although unlikely to utilise habitats within the study area.
Black-chinned Honeyeater (eastern subsp.)	*Melithreptus gularis*	NT	-	Occurs throughout eastern Australia, from the inland slopes of Great Dividing Range, extending to coastal areas between Brisbane and Rockhampton. Habitat includes dry eucalypt woodlands (Garnett and Crowley, 2000). May also be found in timbered watercourses and scrubs with limited understorey (Pizzey and Knight, 2003).	High: Due to suitable dry open-forest/woodland habitat occurring throughout the study area. Recorded 15 km north of the study area in similar habitat (GAWB, 2008).
Black-necked Stork	*Ephippiorhynchus asiaticus*	NT	-	Found along eastern Queensland, also occurs in Western Australia, Northern Territory and New South Wales. Occupies freshwater swamps, tidal mudflats, mangroves, as well as open woodlands and floodplains (Garnett and Crowley, 2000).	Moderate: Due to suitable intertidal habitat occurring along the coastline of the mainland section, and the coast of Curtis Island.
Eastern curlew	*Numenius madagascariensis*	NT	-	Migratory wader to coastal regions throughout Australia. Occurs on tidal mudflats and sandflats, often with beds of seagrass, as well as sheltered coasts (Higgins and Davies, 1996).	Recorded: Observed on tidal mudflats along the mainland coastline and on an exposed sandbar at Hamilton Point (Appendix C). Suitable intertidal habitat occurs throughout the study area along the mainland coastline, and coast of Curtis Island.
Grey Falcon	*Falco hypoleucos*	NT	-	Mainly found in areas on inland drainage systems which receive less than 500 mm of annual rainfall. Frequents timbered lowland plains, particularly *Acacia* shrublands that are crossed by tree-lined watercourses (Marchant and Higgins, 1993).	Low: Due to unsuitable habitat and study area occurring on the very eastern limit of known distribution.
Grey Goshawk	*Accipiter novaehollandiae*	NT	-	Uncommon raptor found throughout eastern Australia. Found in a variety of habitats including rainforests, dry and wet eucalypt forests, timbered watercourses and taller woodlands (Pizzey and Knight, 2003).	High: Recorded along ridge top of Ship Hill, Curtis Island (Appendix C). Potential breeding pair in this area. Suitable forested habitat occurs throughout the Curtis Island section of the project and the open-forest areas within the mainland section.

Species		NCA Status	EPBC Status	Species Information and Occurrence Notes	Assessment of likelihood and habitat description
Common Name	Scientific Name				
Lewin's Rail	*Rallus pectoralis pectoralis*	NT	-	Disjunct distribution through near-coastal environments between Kangaroo Island, South Australia, and Townsville, Queensland. Inhabits permanent to ephemeral, fresh to saline wetlands that have dense emergent or fringing vegetation. They also use artificial habitats with similar structural features (Marchant and Higgins, 1993).	Moderate: Due to scattered dams and streams with dense fringing vegetation occurring throughout the mainland section, north from the mainland tunnel entry shaft and tunnel spoil disposal area.
Radjah Shelduck	*Tadorna radjah rufitergum*	NT	-	In Queensland, scarce south of Cape York Peninsula and no longer present south of Maryborough. Occupies wetlands, estuaries as well as the littoral zone of monsoonal regions (Marchant and Higgins, 1990).	Moderate: Recorded approximately 15 km north on the mainland on a large constructed dam (GAWB, 2008).
Cotton Pygmy-goose	*Nettapus coromandelianus*	NT	-	Considered a vagrant outside Queensland. Found on freshwater lakes, swamps and large water bodies (Marchant and Higgins, 1990).	Moderate: Due to suitable wetland habitat occurring north of Fishermans landing within the mainland section of the study area. Recorded approximately 15 km north on the mainland in similar habitats (GAWB, 2008).
Sooty Oystercatcher	*Haematopus fuliginosus*	NT	-	Scattered distribution around Australian coast. Favours intertidal rocky shorelines and coral reefs, as well as other marine habitats (Marchant and Higgins, 1993).	High: This species was recorded on a small rocky island off Curtis Island, approximately 7.5 km east of study area during field surveys. Suitable habitat occurs in the vicinity of Boatshed Point and Hamilton Point.
Square-tailed Kite	*Lophoictinia isura*	NT	-	Scarce resident in southeast coastal Australia. Occurs in grasslands and open forest and woodland, particularly those with abundant populations of passerine birds (Marchant and Higgins, 1993).	Very High: Recorded adjacent to Targinie State Forest, approximately two km north of TWAF 8 (Appendix C). Suitable forested habitat occurs throughout the study area.
Beach Stone-curlew	*Esacus neglectus*	V	-	Disjunct distribution around the coast and on offshore islands in northern and eastern Australia (Marchant and Higgins, 1993). Frequents coastal habitats including undisturbed islands, reefs, sandbanks, spits or islands in estuaries and beaches with mangroves or estuaries close by (Garnett and Crowley, 2000).	Recorded: Observed on tidal mudflats on mainland coastline and at the mouth of Graham Creek, Curtis Island (Appendix C). Recorded in the study area on Curtis Island and mainland north of Fishermans Landing (QCG, 2009). Suitable intertidal habitat occurs throughout the study area along the mainland coastline, and the coast of Curtis Island.

Species		NCA Status	EPBC Status	Species Information and Occurrence Notes	Assessment of likelihood and habitat description
Common Name	**Scientific Name**				
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	V	-	Located in southeastern Australia from Eungella south to Victoria. Prefers coastal woodlands and drier forested areas where it feeds on the cones of she-oaks (Pizzey and Knight, 2003).	High: Recorded in open-forest habitat within the Curtis Island pipeline alignment below Ship Hill, Curtis Island (BG Group, 2008; URS, 2008). Also recorded in the Yarwun area to the south of the study area (GAWB, 2008).
Powerful Owl	*Ninox strenua*	V	-	Occurs along eastern Australia, mostly on the coastal side of the Great Dividing Range and adjacent inland slopes. Home ranges are approximately 1,000 ha within suitable habitat of dry and wet open sclerophyll forest and woodland, However, often found roosting in thicker vegetation, including rainforest and exotic pine plantations (Schodde and Mason 1980; Chafer 1992; Kavanagh 1997; Higgins 1999; cited in Garnett and Crowley 2000).	High: Observed roosting along a creek adjacent to Graham Creek (Appendix C) and recorded in open forest habitat below Ship Hill, Curtis Island (BG Group, 2008). Likely nesting pair on Curtis Island due to suitable foraging and nesting habitat (e.g. large, hollow-bearing trees and stags). Similar roosting, foraging and nesting habitat are present throughout the mainland section of the study area, as well as habitat for prey species.
Butterflies					
Imperial Hair Streak Butterfly	*Jalmenus eubulus*	V	-	In Queensland, it is restricted to the central and southern areas of the state. Breeds only in old-growth forest or woodland. Suitable habitat includes Brigalow and Belah communities. Larvae are known to be monophagous, feeding exclusively on the foliage of Brigalow (EPA, undated).	Low: Due to unsuitable habitat.
Mammals					
Northern Quoll	*Dasyurus hallucatus*	-	E	Distributed across eastern half of Queensland in fragmented populations with the highest densities occurring in the Mackay-Whitsunday area. Inhabits a range of open woodland and open forest types preferring rocky areas (Braithwaite and Begg, 2000; Van Dyck and Strahan, 2008).	Moderate: Due to patches of suitable vine thicket and open-forest/woodland habitat on rocky slopes occurring along the range in the western portion of the mainland section, and suitable open-forest/woodland habitat within the Curtis Island section.

Species		NCA Status	EPBC Status	Species Information and Occurrence Notes	Assessment of likelihood and habitat description
Common Name	Scientific Name				
Semon's Leaf-nosed Bat	*Hipposideros semoni*	E	E	Occurs from Cape York Peninsula to Cooktown. Unconfirmed records indicate that it may also be found further south in the Mt. Windsor Tableland area and Kroombit Tops, and as far south as St. Mary's State Forest near Maryborough. Inhabits rocky escarpment areas where roosts include rock overhangs and shallow caves (Thomson, Pavey and Reardon, 2001).	Low: Due to unsuitable habitat and well outside known range.
Eastern Long-eared Bat	*Nyctophilus timoriensis*	V	V	Largely confined to the western slopes of Great Dividing Range across southeast Australia. Inhabits a wide range of habitat types however favours Callitris forest, mixed eucalypt forest and poplar box open forest (Churchill, 2008).	Low: Due to unsuitable habitat and outside of normal range.
Water Mouse	*Xeromys myoides*	V	V	In central Queensland, known to occur within fringing mangroves in the high intertidal zone dominated by Ceriops tagal and/or Bruguiera spp. (Gynther and Janetski, 2008).	High: Due to suitable intertidal habitat occurring along the mainland coastline and the southern section of Curtis Island. Water mouse has been observed in surveys at the Australia Pacific LNG project site (Worley Parsons, 2011).
Grey-headed Flying-fox	*Pteropus poliocephalus*	-	V	Distributed along eastern coastal Australia, with Gladstone located in the vicinity of the northern limit. Found to favour rainforests, open forests, closed and open woodlands as well as Melaleuca swamps and Banksia woodlands. Also found throughout urban and agricultural areas where food trees exist (Menkhorst and Knight, 2004; Van Dyck and Strahan, 2008; DSEWPC, 2011).	High: Observed in numerous areas within several kilometres of the mainland section of the project area and in an area just south of Graham Creek on Curtis Island (Appendix C). Suitable foraging habitat occurs throughout the study area.
Large-eared Pied Bat	*Chalinolobus dwyeri*	V	V	Recorded from Blackdown Tableland in central Queensland. Commonly found in dry eucalypt forests and woodlands, as well as sandstone outcrop areas (Churchill, 2008). Known to roost in disused mine shafts, caves and overhangs (DSEWPC, 2011).	Low: Due to unsuitable roosting habitat and outside of known range.
Golden-tipped Bat	*Phoniscus papuensis*	NT	-	Spider-eating specialist found all along the east coast of Queensland. Mainly inhabits rainforest and also known from tall open forest and, dry and wet sclerophyll forest (Churchill, 2008).	High: Due to suitable tall open forest and vine thicket habitat occurring throughout the study area. Suspected call recorded from Anabat analysis in tall open-forest habitat less than 3 km from the northern boundary of the mainland section.

Species		NCA Status	EPBC Status	Species Information and Occurrence Notes	Assessment of likelihood and habitat description
Common Name	**Scientific Name**				
Little Pied Bat	*Chalinolobus picatus*	NT	-	Found in some areas along the Queensland coast. Favours riverine open forest but also occurs in dry open forest and woodland (Churchill, 2008).	Moderate: Due to suitable open-forest/woodland habitat occurring throughout the study area, providing foraging and roosting (hollow-bearing trees) resources.
Coastal Sheathtail Bat	*Taphozous australis*	V	-	Occurs along the east coast of Queensland and numerous coastal islands from about Shoalwater Bay north to Cape York. Found in open sclerophyll forest, grasslands and mangrove swamps (Churchill, 2008).	Moderate: Due to suitable coastal foraging habitat. No suitable roosting habitat occurs within the study area.
Ghost Bat	*Macroderma gigas*	V	-	Mainly northern Australia, however occurs as far south as the central Queensland coast. Inhabits a wide range of habitats including rainforest, black soil grasslands and deciduous vine forest. Prefers caves and mines for roost sites (Churchill, 2008).	Moderate: Due to suitable foraging and forested habitat. No suitable roosting habitat occurs within the study area.
Koala	*Phascolarctos cinereus* (southeast Queensland Bioregion only)	V	-	An arboreal folivore, distributed on both sides of the Great Dividing Range from about Chillagoe in north Queensland to South Australia. Prefers sclerophyll forest, woodland and urban areas where Eucalyptus food trees exist (Van Dyck and Strahan, 2008; Menkhorst and Knight, 2004).	Moderate: Due to suitable primary foraging habitat occurring throughout the study area. Recorded approximately 15 km north on the mainland in similar habitats (GAWB, 2008).
Reptiles					
Loggerhead Turtle	*Caretta caretta*	E	E	Occurs in all coastal waters, with breeding records south to southeast Queensland. Most significant site found to be Mon Repos near Bundaberg (Wilson and Swan, 2010).	Low: Due to unsuitable nesting habitat.
Leatherback Turtle	*Dermochelys coriacea*	E	E	Occurs in all coastal waters around Australia and mainly found in winter in southeast Queensland. Nesting records are uncommon between Fraser Island and Mackay (Wilson and Swan, 2010).	Low: Due to unsuitable nesting habitat.
Olive Ridley Turtle	*Lepidochelys olivacea*	E	E	Found in coastal waters of northern Cape York and Wet Tropics (Wilson and Swan, 2010).	Low: Due to unsuitable nesting habitat.

Species		NCA Status	EPBC Status	Species Information and Occurrence Notes	Assessment of likelihood and habitat description
Common Name	Scientific Name				
Brigalow Scaly-foot	*Paradelma orientalis*	V	V	Endemic, occurring mainly in the Brigalow Belt bioregion. Prefers sandstone ridges in woodlands and vine thickets, and in open forests and woodlands, in particular ironbark, cypress pine, brigalow, bull oak, spotted gum and vine scrubs where it is found under sandstone slabs, logs, coarse leaf litter and grass tussocks (Wilson and Swan, 2010).	Moderate: Due to patches of suitable vine thicket and open-forest/woodland habitat occurring throughout the study area. Recorded on Boyne Island in similar woodland habitat, approximately 12 km to the southeast (DSEWPC, 2011).
Dunmall's Snake	*Furina dunmalli*	V	V	Confined almost entirely to the southern half of the Brigalow Belt bioregion where it occurs around Expedition Range in central Queensland. Found in open forest and woodland, especially woodland growing on floodplains of deep-cracking black clay and clay loam soils (DSEWPC, 2011).	Low: Due to unsuitable woodland habitat.
Flatback Turtle	*Natator depressus*	V	V	Occurs in tropical waters of northern Australia where in Queensland, nesting site have been recorded from Bundaberg north to Torres Strait including a site on Curtis Island (DSEWPC, 2011). Often comes ashore to nest by day (Wilson and Swan, 2010).	Low: Due to unsuitable nesting habitat.
Green Turtle	*Chelonia mydas*	V	V	Found in all coastal waters across northern Australia with breeding records south to southeast including nesting records from Curtis Island (DSEWPC, 2011).	Low: Due to unsuitable nesting habitat.
Hawksbill Turtle	*Eretmochelys imbricata*	V	V	Forages in tropical tidal and sub-tidal coral and rocky reef areas with no breeding records south of Cape York (DSEWPC, 2011).	Low: Due to unsuitable nesting habitat and south of range.
Yakka Skink	*Egernia rugosa*	V	V	Endemic skink, found within the Brigalow Belt and northern southeast Queensland where it inhabits burrows within dry open forest and woodland, as well as under heaped dead timber and in deep rock crevices (Wilson and Swan, 2010).	Moderate: Due to suitable dry open forest and woodland habitat occurring throughout the study area.

Species		NCA Status	EPBC Status	Species Information and Occurrence Notes	Assessment of likelihood and habitat description
Common Name	Scientific Name				
Collared Delma	*Delma torquata*	V	V	Endemic to south-east Queensland. Distributed around central Queensland at Ulam Range (60 km south of Rockhampton) and Expedition National Park (70 km west of Taroom). Inhabits rocky sloped or ridge-top areas, often westerly-facing, in sclerophyll woodland where it is found under weathered loose rocks, flattish bedrock outcroppings, logs or mats of leaf litter, or in cracks and crevices among tussock grasses (Ryan, 2006).	Moderate: Due to patches of suitable open-forest and woodland habitat occurring on slopes throughout the study area.
Fitzroy River Turtle	*Rheodytes leukops*	V	V	Known from Fitzroy River and tributaries in Brigalow Belt. Favours fast-flowing clear water (Wilson and Swan, 2010).	Low: Due to unsuitable habitat and outside known distribution.
Ornamental Snake	*Denisonia maculata*	V	V	Endemic to the Brigalow Belt bioregion, particularly throughout the drainage system of the Fitzroy and Dawson Rivers as well as records from the Rockhampton area. Favours Brigalow woodland growing on clay and sandy soils, riverside woodland, also occurs in open-forest growing on natural levees (DSEWPC, 2011).	Low: Due to unsuitable woodland and open-forest habitat growing on alluvial soils. Recorded approximately 15 km north on the mainland (GAWB, 2008).
Common Death Adder	*Acanthopsis antarcticus*	NT	-	Previously abundant in many areas of the Brigalow Belt, however numbers have declined dramatically (Wilson and Swan, 2010). Occurs in wet and dry eucalypt forests, woodlands and coastal heaths (Wilson and Knowles, 1998).	Moderate: Due to patches of suitable habitats occurring throughout the study area.
Robust Burrowing Snake	*Antairoserpens warro*	NT	-	Burrowing elapid, found along the north-eastern coast and ranges of Queensland preferring forests and woodland (Shea et al, 1993; Wilson and Swan, 2010).	Low: Suitable open-forest and woodland habitat present but well removed from known distributional range. Wildlife Online record potentially mis-identified.
Cooloola Snake-skink	*Ophioscincus cooloolensis*	NT	-	Endemic to southeast Queensland. Known from Cooloola and Fraser Island. Also, disjunct record from Kroombit Tops, upland area nearly 300 km to northwest. Found in coastal heaths, woodlands and rainforests on white sands (Wilson and Swan, 2010).	Low: Due to unsuitable habitat occurring in the study area and out of range.
Saltwater Crocodile	*Crocodylus porosus*	V	-	Occurs along Queensland coast south to about Rockhampton. Inhabits coastal rivers, swamps, estuaries, wetlands and open sea (Wilson and Swan, 2010).	Moderate: Due to suitable estuarine habitat occurring along the mainland coastline and the southern section of Curtis Island.

Table 21 Likelihood of threatened fauna (migratory), identified in database searches, occurring in the study area.

Species		EPBC Status	Species Information and Occurrence Notes	Assessment of likelihood and habitat description
Common Name	**Scientific Name**			
Birds				
Eastern Osprey	*Pandion haliaetus*	M	Large, fishing raptor distributed along most of the Australian coastline. Preferred habitat includes islands, coasts, bays and estuaries (Pizzey and Knight, 2003).	Recorded: Observed in bay adjacent to the South End barge landing and the southern tip of Hamilton Point (Appendix C). Suitable coastal habitat occurs along mainland coastline and the southern section of Curtis Island.
Caspian Tern	*Hydroprogne caspia* (*Sterna caspia)*	M	Part-migratory, found over most of Australia. Occurs in coastal and offshore waters, mudflats, beaches and estuaries (Pizzey and Knight, 2003).	Recorded: Observed on tidal mudflat in the northern part of the mainland section (Appendix C). Suitable habitat occurs along the mainland coastline and the southern section of Curtis Island.
Australian Painted Snipe	*Rostratula australis*	M	Scattered distribution throughout many parts of Australia where it is usually found in shallow inland wetlands, either freshwater or brackish, that are either permanently or temporarily filled (DSEWPC, 2011).	Low (to Moderate): Due to patches of suitable low-lying grassland habitat occurring in the mainland section, in particular areas north of Fisherman's Landing and immediately south of TWAF 8.
Southern Giant-Petrel	*Macronectes giganteus*	M	Rare visitor to mainland. Breeds on six subantarctic and Antarctic islands in Australian territory (DSEWPC, 2011).	Low: Due to unsuitable habitat.
Little Tern	*Sterna albifrons*	M	Breeds along the eastern and southeast coast of Australia. Prefers sheltered coastal habitats including undisturbed tidal estuaries, estuarine islands and harbours as well as exposed ocean beaches (Higgins and Davies, 1996).	Moderate (to High): Due to suitable estuarine habitat occurring south of Fishermans Landing along the mainland coastline, and the southern section of Curtis Island.
Eastern curlew	*Numenius madagascariensis*	M	Migratory wader to coastal regions in the north-east of Australia. Occurs on tidal mudflats and sandflats, often with beds of seagrass, as well as sheltered coasts (Higgins and Davies, 1996).	Recorded: Observed on tidal mudflats along the mainland coastline and on an exposed sandbar at Hamilton Point (Appendix C). Suitable intertidal habitat occurs throughout the study area along the mainland coastline, and southern section of Curtis Island.
Barn Swallow	*Hirundo rustica*	M	Usually annual visitor to southeast Queensland. Widespread in northern Queensland 'winters' in southern Australia (Pizzey and Knight, 2003). Favours open country and agricultural land, particularly those areas associated with water (Pizzey and Knight, 2003).	Moderate: Due to patches of suitable disturbed grassland habitat occurring within the mainland section of the study area.

Species		EPBC Status	Species Information and Occurrence Notes	Assessment of likelihood and habitat description
Common Name	Scientific Name			
Bar-tailed Godwit	*Limosa lapponica*	M	A common migratory wader occurring across most of the Australian coastline. Found on coastal mudflats, sandbars, shores of estuaries and salt marsh (Pizzey and Knight, 2003).	High: Observed on tidal mudflat less than one km from the northern boundary of the mainland section (Appendix C). Suitable intertidal habitat occurs along the mainland coastline and coast of Curtis Island.
Black-faced Monarch	*Monarcha melanopsis*	M	Summer breeding migrant to southeast Australia preferring eucalypt woodlands, rainforests and coastal scrubs (Pizzey and Knight, 2003).	Moderate: Due to patches of suitable eucalypt woodland and vine thicket habitat occurring throughout the study area.
Black-tailed Godwit	*Limosa limosa*	M	Regular summer migrant to Australia. Found on tidal mudflats, estuaries, sand spits as well as shallow river margins (Pizzey and Knight, 2003).	Moderate: Due to patches of suitable intertidal habitat occurring along the mainland coastline and coast of Curtis Island.
Broad-billed Sandpiper	*Limicola falcinellus*	M	Uncommon summer migrant mostly to coastal Australia. Inhabits tidal mudflats, freshwater wetlands and saltmarsh (Pizzey and Knight, 2003).	Moderate: Due to patches of suitable intertidal habitat occurring along the mainland coastline and coast of Curtis Island.
Cattle Egret	*Ardea ibis*	M	Usually associated with grazing cattle where it is found in stock paddocks, pastures, wetlands and tidal mudflats (Pizzey and Knight, 2003).	High: Due to patches of suitable disturbed grassland habitat throughout the mainland section and suitable intertidal habitat occurring along the mainland coastline and coast of Curtis Island.
Common Greenshank	*Tringa nebularia*	M	Widespread migrant. Occurs across a range of inland and coastal habitats from billabongs, swamps and floodplains to mudflats and mangrove communities (Pizzey and Knight, 2003).	High: Recorded on Curtis Island (QGC, 2009) and likely around Port Curtis.
Common Sandpiper	*Actitis hypoleucos*	M	Scarce summer migrant to eastern Australia inhabiting a variety of substrates on the edges of rivers and streams from coastal areas to far inland (Pizzey and Knight, 2003).	Moderate: Due to patches of suitable intertidal habitat occurring along the mainland coastline and southern section of Curtis Island.
Cotton Pygmy-goose	*Nettapus coromandelianus*	M	Considered a vagrant outside Queensland. Found on freshwater lakes, swamps and large water bodies (Marchant and Higgins, 1990).	Moderate: Due to suitable wetland habitat occurring within the mainland section of the study area. Recorded approximately 15 km north on the mainland in similar habitats (GAWB, 2008).

Species		EPBC Status	Species Information and Occurrence Notes	Assessment of likelihood and habitat description
Common Name	**Scientific Name**			
Curlew Sandpiper	*Calidris ferruginea*	M	Widespread records along the Queensland coast south of Cairns and around Australian coast. Mainly occurs on tidal mudflats as well as swamps, lagoons and wetlands near the coast (Pizzey and Knight, 2003; DSEWPC, 2011).	Moderate: Due to patches of suitable intertidal habitat occurring along the mainland coastline and southern section of Curtis Island.
Double-banded Plover	*Charadrius bicinctus*	M	Annual winter migrant, mainly to southern Australia. Favours wide beaches, tidal mudflats, shallow saline and freshwater wetlands as well as paddocks with sparse vegetation (Pizzey and Knight, 2003).	Moderate: Due to patches of suitable intertidal habitat occurring along the mainland coastline and southern section of Curtis Island.
Eastern Reef Egret	*Egretta sacra*	M	Distributed across much of the Australian coastline. Usually frequents rocky shores, islands, beaches, tidal rivers and mangroves (Pizzey and Knight, 2003).	High: Observed on tidal mudflat approximately 7.5 km east of study area, just south of the South End township, Curtis Island. Suitable intertidal habitat occurs along the mainland coastline and southern section of Curtis Island.
Fork-tailed Swift	*Apus pacificus*	M	Aerial summer migrant. Occurs in airspace over a diverse range of habitats including rainforest and semi-arid desert (Pizzey and Knight, 2003).	High: Recorded on Curtis Island (QGC, 2009).
Great Egret	*Ardea alba*	M	Widespread throughout Queensland. Occurs in wetlands, flooded pastures, dams and tidal mudflats (Pizzey and Knight, 2003).	Recorded: Observed on tidal mudflats in the northern part of the mainland section of the study area (Appendix C). Patches of suitable low-lying disturbed grassland habitat occurs throughout the mainland section. Suitable intertidal habitat occurs along the mainland coastline and southern section of Curtis Island.
Great Knot	*Calidris tenuirostris*	M	Abundant across northern Australia. Prefers sheltered coastal mudflats of estuaries and inlets. Occasionally present on salt lakes, lagoons and saltworks ponds (Pizzey and Knight, 2003).	High: Recorded on Curtis Island (QGC, 2009) and likely around Port Curtis.
Greater Sand Plover	*Charadrius leschenaultii*	M	Regular summer migrant. Favours a variety of habitats including tidal mudflats, mangroves, and saltmarsh (Pizzey and Knight, 2003).	Moderate: Due to patches of suitable intertidal habitat occurring along the mainland coastline and southern section of Curtis Island.
Grey Plover	*Pluvialis squatarola*	M	Regular summer migrant to coastal Australia and islands where it inhabits tidal mudflats, saltmarsh and estuaries (Pizzey and Knight, 2003).	Moderate: Due to patches of suitable intertidal habitat occurring along the mainland coastline and southern section of Curtis Island.

Species		EPBC Status	Species Information and Occurrence Notes	Assessment of likelihood and habitat description
Common Name	**Scientific Name**			
Grey-tailed Tattler	*Heteroscelus brevipes*	M	Common summer migrant. Prefers coastal areas, in particular mudflats and sand beaches (Pizzey and Knight, 2003).	High: Recorded on Curtis Island (QGC, 2009).
Latham's Snipe	*Gallinago hardwickii*	M	Non-breeding migrant to southeast Australia preferring soft wet ground associated with mainly open, freshwater wetlands as well as flooded paddocks and seepage below dams (Pizzey and Knight, 2003; DSEWPC, 2011)	Moderate: Due to patches of suitable disturbed grassland habitat occurring throughout the mainland section of the study area.
Lesser Sand Plover	*Charadrius mongolus*	M	Non-breeding migrant. Widespread along Queensland coastal areas. Inhabits tidal sandflats and mudflats (Pizzey and Knight, 2003).	Recorded: Observed on tidal mudflat along the southern boundary of the mainland section (Appendix C). Suitable intertidal habitat occurs along the mainland coastline and southern section of Curtis Island.
Little Curlew	*Numenius minutus*	M	Summer migrant favouring floodplains, tidal mudflats and dry grasslands (Pizzey and Knight, 2003).	Moderate: Due to patches of suitable intertidal habitat occurring along the mainland coastline and southern section of Curtis Island.
Marsh Sandpiper	*Tringa stagnatilis*	M	Common summer migrant to mainly coastal areas of Australia preferring wetlands, tidal mudflats and mangroves (Pizzey and Knight, 2003).	Moderate: Due to patches of suitable intertidal habitat occurring along the mainland coastline and southern section of Curtis Island.
Oriental Plover	*Charadrius veredus*	M	Regular summer migrant. Found in tidal mudflats and bare claypans, as well as margins of coastal marshes (Pizzey and Knight, 2003).	Moderate: Due to patches of suitable intertidal habitat occurring along the mainland coastline and southern section of Curtis Island.
Oriental Pratincole	*Glareola maldivarum*	M	Rare, nomadic wader. Found on plains, shallow edges of open wetlands, tidal mudflats and beaches (Pizzey and Knight, 2003).	Moderate: Due to patches of suitable intertidal habitat occurring along the mainland coastline and southern section of Curtis Island.
Pacific Golden Plover	*Pluvialis fulva*	M	Common migrant, disperses mainly to coastal areas such as tidal mudflats, beaches (Pizzey and Knight, 2003).	High: Recorded on Curtis Island (QGC, 2009) and likely around Port Curtis.
Rainbow Bee-eater	*Merops ornatus*	M	Distributed across much of mainland Australia. Found mainly in open forests and woodlands, shrublands, and in numerous cleared or semi-cleared habitats, including farmland and urban areas (DSEWPC, 2011).	Recorded: Observed in numerous habitats both within, and in close proximity to the study area (Appendix C). Suitable habitat occurs throughout the study area.

Species		EPBC Status	Species Information and Occurrence Notes	Assessment of likelihood and habitat description
Common Name	**Scientific Name**			
Red Knot	*Calidris canutus*	M	Regular, widespread summer migrant. Occurs in tidal mudflats, sandflats, beaches, saltmarshes, as well as flooded pastures and ploughed lands (Pizzey and Knight, 2003).	Moderate: Due to patches of suitable intertidal habitat occurring along the mainland coastline and southern section of Curtis Island.
Red-necked Stint	*Calidris ruficollis*	M	Common migrant, widespread around Australia where it frequents a diverse range of habitats including both tidal and inland mudflats, salt marshes, beaches and temporary floodwaters (Pizzey and Knight, 2003).	High: Recorded on Curtis Island (QGC, 2009) and likely around Port Curtis.
Ruddy Turnstone	*Arenaria interpres*	M	Regular summer migrant to coastal Australia preferring tidal reefs and pools, as well as mudflats (Pizzey and Knight, 2003).	Moderate: Due to patches of suitable intertidal habitat occurring along the mainland coastline and southern section of Curtis Island.
Rufous Fantail	*Rhipidura rufifrons*	M	Breeding migrant to southeast Australia. Favours undergrowth of rainforests and wetter eucalypt forests, monsoon forests, paperbarks, coastal scrubs and mangroves (Pizzey and Knight, 2003).	Recorded: Observed in vine thicket habitat on Boatshed Point, Curtis Island (Appendix C). Also observed several kilometres to the northeast of the mainland section of the study area in similar vine thicket habitat. Suitable habitats occur throughout the study area.
Sanderling	*Calidris alba*	M	Regular summer migrant found on broad ocean beaches of firm sand, also inhabits tidal mudflats and coastal lagoons (Pizzey and Knight, 2003).	Moderate: Due to patches of suitable intertidal habitat occurring along the mainland coastline and southern section of Curtis Island.
Satin Flycatcher	*Myiagra cyanoleuca*	M	Uncommon migrant to eastern Australia. Favours densely vegetated gullies in forests and tall woodlands. Also found in coastal forests, mangroves and scattered trees in open areas (Pizzey and Knight, 2003).	High: Recorded on Curtis Island (URS, 2009).
Sharp-tailed Sandpiper	*Calidris acuminata*	M	Abundant wader in southeast Australia. Inhabits mainly fresh or salt water wetlands (Pizzey and Knight, 2003).	High: Recorded on Curtis Island (QGC, 2009) and likely around Port Curtis.
Spectacled Monarch	*Monarcha trivirgatus*	M	Occurs along coastal northeast and eastern Australia, also coastal islands. Prefers understorey of upland/lowland rainforests, thickly vegetated gullies and riparian vegetation (Pizzey and Knight, 2003).	High: Observed in vine thicket habitat, several kilometres to the north-east outside the mainland section of the study area. Suitable habitat occurs in the western half of the mainland section and on headlands in the southern section of Curtis Island.
Terek Sandpiper	*Xenus cinereus*	M	Common summer migrant found on coastal mudflats as well as sandbars, reefs and coastal swamps (Pizzey and Knight, 2003).	High: Recorded on Curtis Island (QGC, 2009) and likely around Port Curtis.

Species		EPBC Status	Species Information and Occurrence Notes	Assessment of likelihood and habitat description
Common Name	**Scientific Name**			
Whimbrel	*Numenius phaeopus*	M	Common migrant to northern parts of Australia. Prefers tidal mudflats of estuaries and lagoons associated with mangroves. Occasionally occurs on sandy beaches and salt lakes (Pizzey and Knight, 2003).	Recorded: Observed on tidal mudflat in several locations along the mainland coastline (Appendix C). Suitable intertidal habitat also occurs along the southern section of Curtis Island.
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	M	Distributed along the coastline of mainland Australia. Found in coastal habitats, particularly those in close proximity to the shoreline. Also favours wetlands and extensive areas of open water such as larger rivers, dams and the ocean (DSEWPC, 2011).	Recorded: Observed in numerous habitats both within, and in close proximity to the study area (Appendix C). Suitable habitat occurs throughout the study area.
White-throated Needletail	*Hirundapus caudacutus*	M	Widespread aerial insectivore occurring throughout east and southern Australia in summer, where it is found in most coastal areas of Queensland. Recorded over most types of habitat (DSEWPC, 2011).	High: Recorded on Curtis Island (QGC, 2009).
Wood Sandpiper	*Tringa glareola*	M	Common summer migrant. Occurs in a variety of habitats including mangroves and the margins of mudflats subject to tidal inundation (Pizzey and Knight, 2003).	Moderate: Due to patches of suitable intertidal habitat occurring along the mainland coastline and southern section of Curtis Island.
Reptiles				
Loggerhead Turtle	*Caretta caretta*	M	Occurs in all coastal waters, with breeding records south to southeast Queensland. Most significant site found to be Mon Repos near Bundaberg (Wilson and Swan, 2010).	Low: Due to unsuitable breeding habitat.
Leatherback Turtle	*Dermochelys coriacea*	M	Occurs in all coastal waters around Australia where it is mainly found in winter in southeast Queensland. Nesting records are uncommon between Fraser Island and Mackay (Wilson and Swan, 2010).	Low: Due to unsuitable breeding habitat.
Olive Ridley Turtle	*Lepidochelys olivacea*	M	Found in coastal waters of northern Cape York and Wet Tropics (Wilson and Swan, 2010).	Low: Due to unsuitable breeding habitat.
Flatback Turtle	*Natator depressus*	M	Occurs in tropical waters of northern Australia where in Queensland, nesting sites have been recorded from Bundaberg north to Torres Strait including a site on Curtis island (DSEWPC, 2011). Often comes ashore to nest by day (Wilson and Swan, 2010).	Low: Due to unsuitable breeding habitat.
Green Turtle	*Chelonia mydas*	M	Found in all coastal waters across northern Australia with breeding records south to southeast Queensland including nesting records from Curtis Island (Wilson, 2005; DSEWPC, 2011).	Low: Due to unsuitable breeding habitat.

Species		EPBC Status	Species Information and Occurrence Notes	Assessment of likelihood and habitat description
Common Name	**Scientific Name**			
Hawksbill Turtle	*Eretmochelys imbricata*	M	Forages in tropical tidal and sub-tidal coral and rocky reef areas with no breeding records south of Cape York (Wilson and Swan, 2010; DSEWPC, 2011).	Low: Due to unsuitable breeding habitat.
Saltwater Crocodile	*Crocodylus porosus*	M	Occurs along Queensland coast south to about Rockhampton. Inhabits coastal rivers, swamps, estuaries, wetlands and open sea (Wilson and Swan, 2010).	Moderate: Due to patches of suitable estuarine habitat occurring along the mainland coastline and southern section of Curtis Island.

1 - NCA status: Conservation status of each taxon under the Status taken from the Queensland Nature Conservation (Wildlife) Regulation 2006: Vulnerable (V), Near Threatened (NT), Least Concern (-), Not Listed (–).

2 - EPBC status: Conservation status of each taxon under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act): Vulnerable (V), Endangered (E), Not Listed (–).

3 - Likelihood of occurrence within the study area:

Very Low = The study area is outside the species normal range, habitat and/or underlying geology does not exist (no further impact assessment required).

Low = Database searches indicate the species could potentially occur in the study area, however previous records are likely to be historic or invalid, the study area is outside the species normal range, habitat does not exist or the species is considered locally extinct (no further impact assessment required).

Moderate = Habitat exists for the species; however it is either marginal or not particularly abundant. The species is known from the wider region and could potentially occur (further impact assessment required).

High = The species is known to occur in the local area and core habitat exists in the study area (further impact assessment required).

Recorded = The species was recorded in the study area as part of field surveys (further impact assessment required).

4.7.1 Commonwealth Threatened Species

Twenty eight species listed under the EPBC Act were identified through the review of existing information as potentially occurring within the study area (Table 20). These include ten bird, six mammal and 12 reptile species. Two Commonwealth 'Vulnerable' listed species, squatter pigeon (*Geophaps scripta scripta*) (Plate 8) and grey-headed flying-fox (*Pteropus poliocephalus*) were observed during field surveys within 5 km of the study area (Figure 9). Other surveys (referenced in Figure 8) have also found squatter pigeon within the study area. It is very likely that these species occur in the study area. The water mouse has a high likelihood of occurrence within the study area, due to the extent and intactness of fringing mangroves in the high intertidal zone and having been recorded in similar habitats on Curtis Island (Worley Parsons 2011).

Of the other 25 species potentially present in the study area, five are considered to have a moderate chance of occurring (yellow chat, northern quoll, brigalow scaly-foot yakka skink, collared delma). The remaining species have a very low, low or low to moderate likelihood of occurring.

Plate 8 Squatter pigeon, mainland area (Ecosure, 2010)

4.7.2 Commonwealth Migratory Species

A total of 52 migratory species listed under the EPBC Act were identified as potentially occurring within the study area (Table 21). Ten of these have been identified within or adjacent to the study area by other studies (including QGC 2009; GAWB 2008; URS 2009). An additional ten of these species were detected during targeted field surveys (Refer to Appendix C), (Figure 9). Thirty-four species are considered to have a moderate to high likelihood of occurring within the study area. There are eight species with a low, or low/moderate chance of being present in the study area.

White-bellied sea-eagle (*Haliaeetus leucogaster*) and rainbow bee-eater (*Merops ornatus*) were observed in several locations both in and within 5 km of the study area. These species were found in various habitats including intertidal and forested areas. A likely white-bellied sea-eagle nest was sighted on Hamilton Point. Species recorded only in intertidal areas included whimbrel (*Numenius phaeopus*), Caspian tern (*Sterna caspia*) and bar-tailed godwit (*Limosa lapponica*). Other migratory birds observed include great egret (*Ardea alba*), lesser sand plover (*Charadrius mongolus*), eastern curlew (Nu*menius madagascariensis*), rufous fantail

(*Rhipidura rufifrons*) and eastern osprey (*Pandion haliaetus*).

4.7.3 State Threatened Species

A total of 51 species listed under the NCA were identified as potentially occurring within the study area (Table 20). These include 24 bird, nine mammal, one amphibian, 16 reptile and one invertebrate species. Six species were detected during targeted field surveys (Appendix C) (Figure 9), either within the study area or within 5 km of the study area. An additional five species are considered to have a moderate/high to high likelihood of occurring in the study area. Seventeen species have a moderate likelihood.

Plate 9 Beach stone curlew, Curtis Island (Ecosure, 2010)

Beach stone-curlew (*Esacus neglectus*), listed as 'Vulnerable' (Plate 9), and eastern curlew (*Numenius madagascariensis*), listed as 'Near Threatened', were recorded in intertidal zones throughout the study area. Four additional species were detected within 5 km of the study area during surveys for the Arrow LNG Plant. All of these species were observed in areas similar to the habitats found in the study area and it very likely that they are present within the study area itself. These were powerful owl (*Ninox strenua*), ('Vulnerable'), square-tailed kite (*Lophoictinia isura*) ('Near Threatened'), grey goshawk (*Accipiter novaehollandiae*) ('Near Threatened') and squatter pigeon ('Vulnerable').

In addition, other surveys (GAWB, 2008; BG, 2008; URS, 2008) within the study area have recorded glossy black-cockatoo (*Calyptorhynchus lathami*) in the vicinity of the LNG Plant site, below Ship Hill. Squatter pigeon has also been previously recorded (Figure 8).

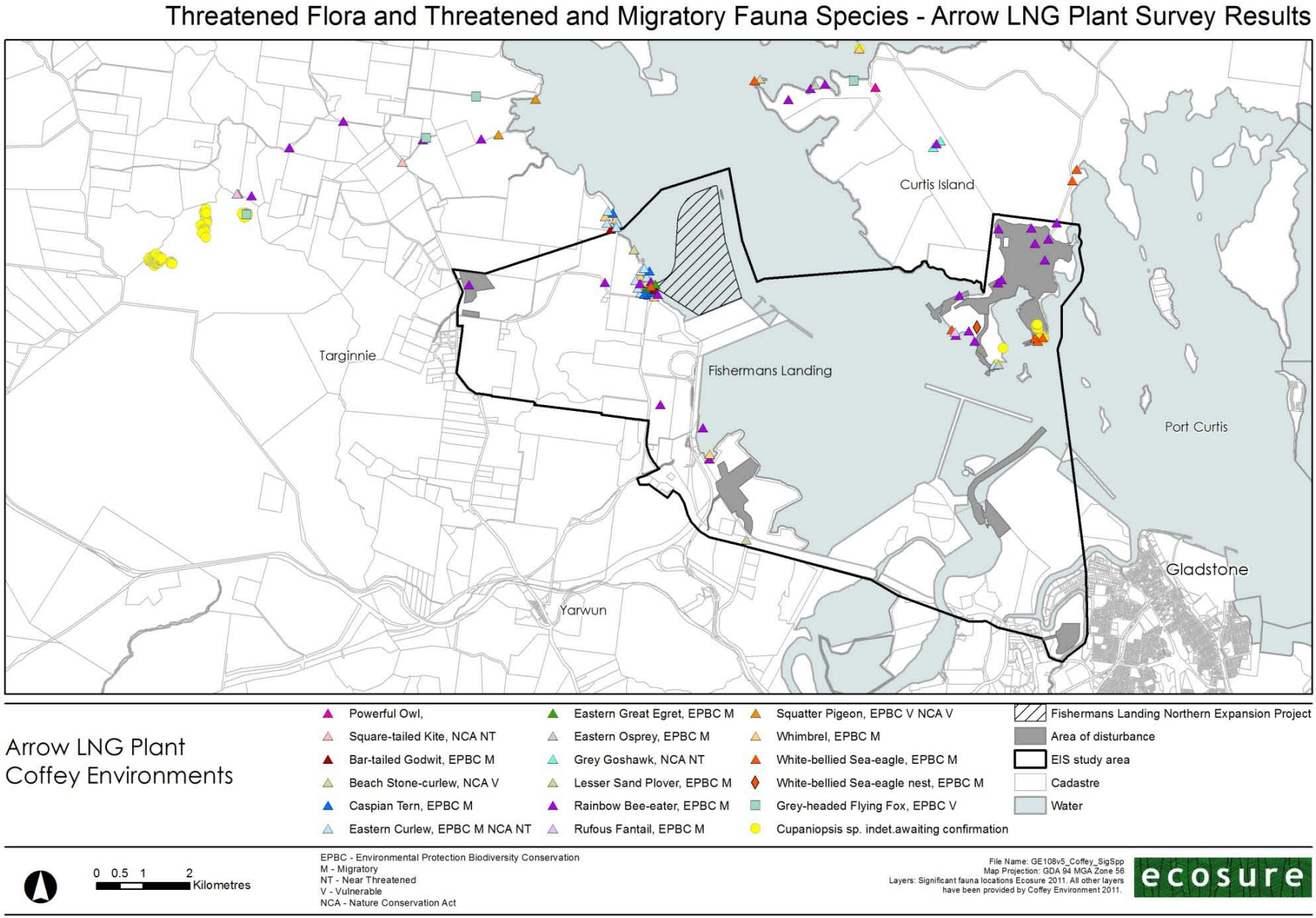


Figure 9 Field survey results - significant flora and fauna species.

4.8 Introduced Fauna Species

Targeted field surveys identified five introduced fauna species in a variety of habitats throughout the study area. The species include:

- Feral pig (*Sus scrofa*).
- Domestic horse (*Equus caballus*).
- Wild dog (*Canis familiaris*).
- Brown hare (*Lepus capensis*).
- Cane toad (*Rhinella marina*).

External to the study area, but within the region, domestic cattle (*Bos taurus*), red fox (*Vulpes vulpes*) and black rat (*Rattus rattus*) were also observed. These species are likely to occur within the study area.

Pest animal species are discussed in more detail in the Arrow LNG Plant Terrestrial Ecology Pest Management Plan (Ecosure, 2011).

4.9 Conservation Areas

Environmentally sensitive areas are illustrated at the end of the Section in Figure 10. Areas of biodiversity significance, as identified by biodiversity assessments, are shown in Figure 11.

4.9.1 Matters of National Environmental Significance (MNES)

The marine section of the study area and Curtis Island are within the boundary of the Great Barrier Reef World Heritage Area, which is included on the National Heritage register. These areas are considered to be MNES.

4.9.2 Conservation Parks and State Forests

One conservation park occurs within or adjacent to the study area. Garden Island Conservation Park is located immediately adjacent to the southeast corner of the study area, approximately 4.5 km east and 2.5 km east northeast of the proposed North China Bay and Boatshed Point jetties respectively. At its closest point, Garden Island is approximately 1.1 km to the east of the study area boundary. Calliope Forest Reserve is located approximately 2 km south of the study area on the mainland.

Curtis Island National Park and Curtis Island State Forest occur approximately 8 km northeast and 3 km north northwest of the study area respectively. Mount Stowe State Forest and Targinie State Forest are located within or adjacent to the study area.

4.9.3 Areas of Biodiversity Significance

The study area is situated at the northeastern boundary of the Brigalow Belt South and Southeast Queensland bioregions and the southeastern boundary of the Brigalow Belt North bioregion. Biodiversity Planning Assessments (BPA) for the three regions are presented in:

- Southeast Queensland North Expert Panel Reports (EPA, 2006b).
- Brigalow Belt South Expert Panel Reports (EPA, 2002b).
- Brigalow Belt South Expert Panel Reports (EPA, 2002c).

BPAs are considered a decision support tool and are used by DERM staff, other government agencies, local governments or members of the community to inform the decision making process.

The following biodiversity values have been identified within the study area:

Wildlife Corridors

The study area contains state and regionally significant wildlife corridors identified by the BPA. The state significant corridor runs along the coast from Burnett Heads to the north of Gladstone, linking vegetation tracts along the coast (EPA, 2002b). The state and regionally significant corridor borders the Calliope River within the study area (Figure 11).

Biodiversity Significance

The study area contains areas of biodiversity significance identified by the BPAs (Table 22). This includes mapped 'State Significant Biodiversity Value'. All of Curtis Island is mapped as of 'State Significant Biodiversity Value' (Figure 11).

Table 22 Areas of Biodiversity Significance as identified by Biodiversity Planning Assessments.

Location	Significance	Criteria
Areas of State Significant Biodiversity Value		
Coastal Area on Mainland	· State. · Remnant is part of a tract that is one of the largest in the bioregion (c). · Remnant contains an ecosystem in the top quartile (f). · Remnant forms part of a bioregional corridor (J). · Significant wetland.	· Wetland Vegetation Approved in CMP. · The RE is 50-75% the size of the largest example of that RE in the bioregion. · The RE is 50% -75% the size of the largest example of that RE in the subregion. · Mapped by the QLD Herbarium. · The remnant unit has a Simpson's diversity index that is >75% of the maximum value for the bioregion. · Buffer around a significant wetland.
Mainland, west of Fishermans landing	· State. · Significant Wetland (B1). · Remnant contains at least one Vulnerable or Rare species (A). · World Heritage Area (B1). · Remnant contains at least one Endangered and/or two Vulnerable or Rare species (A).	· The area within the Remnant unit has precise records or core habitat of one or more endangered taxa or two or more vulnerable or rare taxa. · <30% of 'Endangered' or 'Of Concern' RE. · High conservation value RE. · No relictual subregions at present. · Mapped by QLD Herbarium. · Simpsons index value of 0.886%. · Buffer around an Endangered RE and significant wetland. Adjacent to an Endangered RE, watercourse or important wetland.

Location	Significance	Criteria
Curtis Island	· State. · World Heritage area (B1). · Significant Wetland (B1). · Contains at least one Endangered RE and/or two Vulnerable or Rare species.	· The area within the remnant unit has precise records of core habitat for one or more endangered taxa or two or more vulnerable or rare taxa. · Endangered RE and Important wetlands. · High conservation value RE. · No relictual subregions at present. · Mapped by QLD Herbarium. · Simpsons diversity index that is >70% of the maximum value for the bioregion. · Buffer around an Endangered RE & Significant Wetland, adjacent to an Endangered RE or Wetland. · Core habitat for priority taxa. · Wildlife refugia. · Areas containing RE's with distinct variation in species composition associated with geomorphology and other environmental variables.

4.9.4 Coastal Plan Mapping

Significant Coastal Wetlands are identified in the Curtis Coast Regional Coastal Management Plan (EPA, 2003). These areas are mapped on the mainland and Curtis Coast (Figure 10).

The Curtis Coast Regional Coastal Management Plan identifies several migratory shorebird roosting sites within the study area (EPA, 2003).

4.9.5 Essential Habitat for Flora

The review of the essential habitat mapping provided by DERM identified one essential habitat area (within the study area at TWAF 8) which represents one threatened flora species, *Hernandia bivalvis* (grease nut) (Figure 10). This species was not observed during field surveys. Suitable intact SEVT, more likely to support *H. bivalvis*, was identified upslope and beyond the boundary of the TWAF 8 study area.

4.9.6 Essential Habitat for Fauna

The review of the Essential Habitat mapping provided by DERM identified several essential habitat areas for koala occurring within the project study area, including within suitable vegetation communities on Curtis Island and at the mainland tunnel entry shaft and tunnel spoil disposal area (Figure10).

Targeted searches for koala were undertaken in, and within the vicinity of, all essential habitat areas. While none were observed, it is possible they may occur within the study area. There is suitable primary foraging habitat and koala has previously been recorded approximately 15 km north on the mainland in similar habitats (GAWB, 2008).

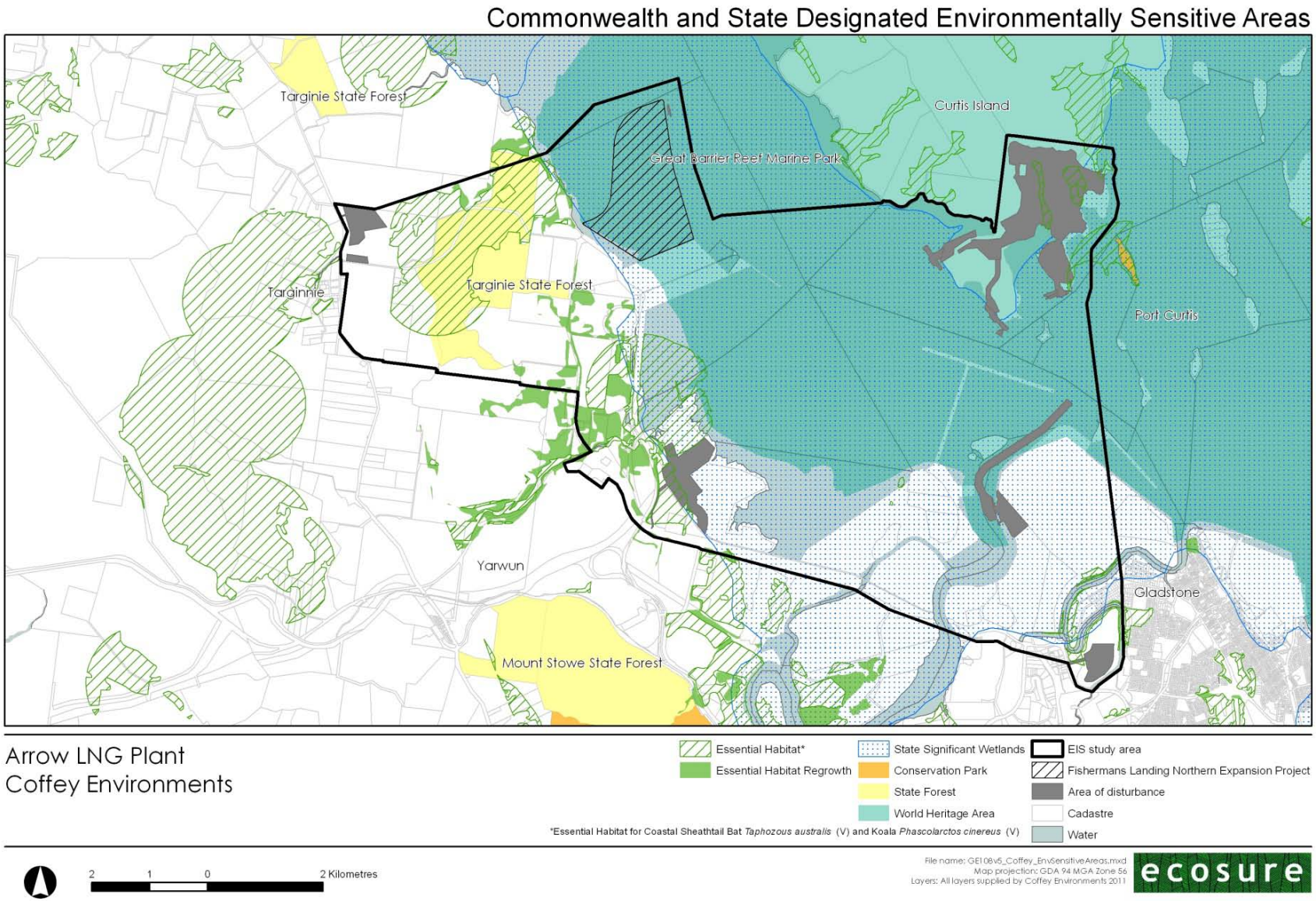


Figure 10 Areas of environmental significance, as designated by the Commonwealth and/or the State Government.

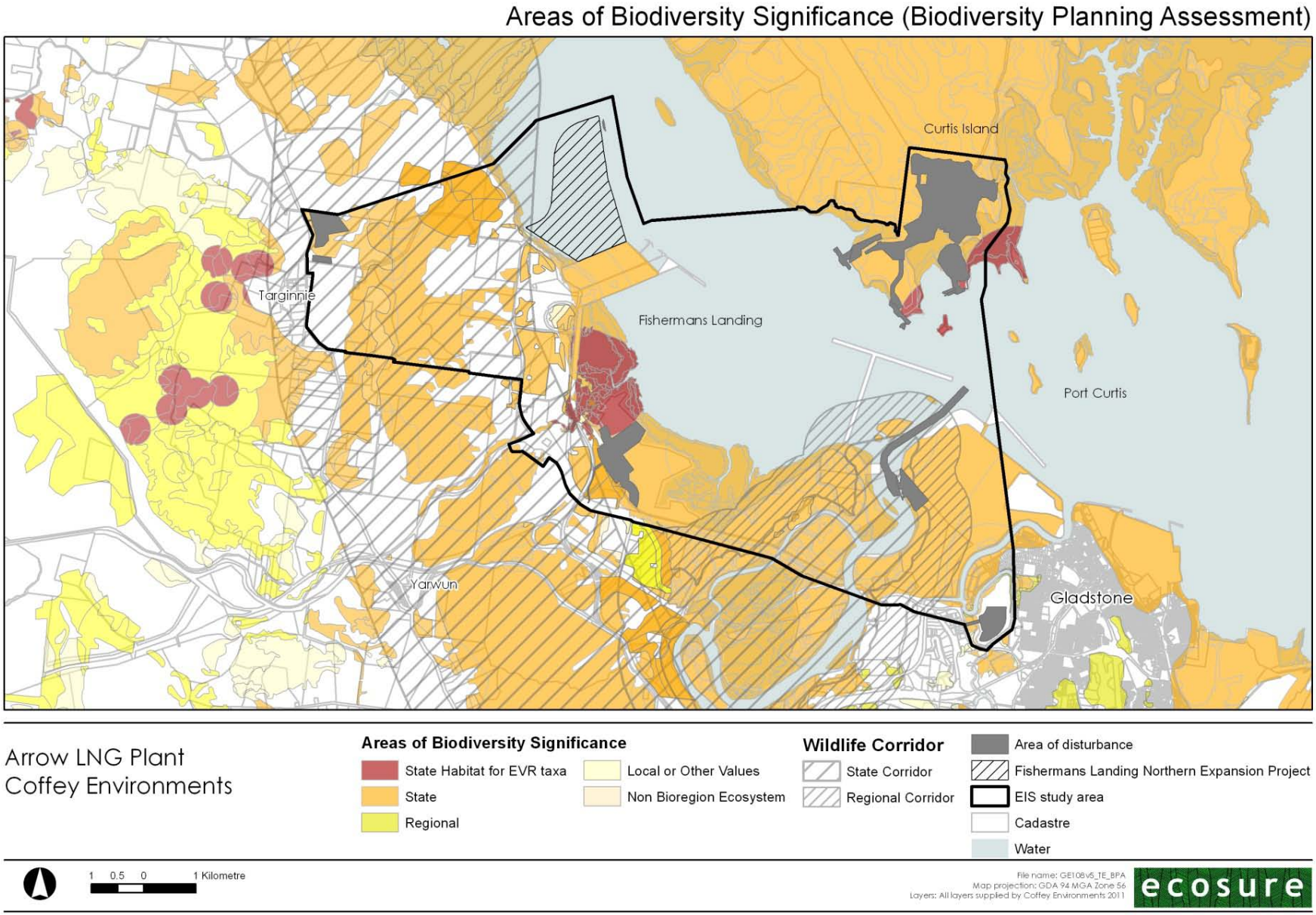


Figure 11 Areas of biodiversity significance - from Biodiversity Planning Assessments.

4.10 Sensitivity of Ecological Values

The sensitivity of existing ecological values has been determined using the method described in Section 3.7. Figure 2 details the location of these ecological values while table 23 summarises the attributes of each ecological value which led to its overall conservation status or sensitivity score. Sensitivity is illustrated in Figure 12. In Chapter 5, Table 26 presents the pre-mitigation scoring for each value (conservation status, intactness, uniqueness, degree of non-resilience to change and degree of difficulty to replace). In Chapter 7, Table 27 detailes of the final scoring for each ecologival value following an assessment of the proposed mitigation measures.

Only those ecological values which are likely to be directly affected by the project and are of high or moderate sensitivity have been included in this discussion.

Curtis Island Arrow LNG Plant

Values with high sensitivity

Value 27 and Value 31 is 'Endangered' RE 12.3.3, and this value is considered to be essential habitat for coastal sheathtail bat and koala. It potentially includes foraging habitat for grey-headed flying-fox, known in the area and at the northern limit of their range. square-tailed kite, grey goshawk, powerful owl are likely to occur due to their known presence in the area and the RE provides foraging habitat and potential breeding habitat for square-tailed kite, grey goshawk. This area is highly intact, unique, and would be difficult to replace.

Values with medium sensitivity

All the ecological values within the LNG plant construction footprint were assessed as having moderate sensitivity, apart from Values 27 and 31. The 'Migratory' rainbow bee-eater was observed throughout the LNG Plant site.

The remaining values in this area contain 'Of Concern' and 'Least Concern' vegetation communities, and the majority of them provide good quality habitat for threatened fauna species. They are each relatively resilient to change and would not be too difficult to replace.

Curtis Island saltpans and fringing mangroves

Values with high sensitivity

Value 12 is a saltpan and shorebird feeding habitat (likely to support EPBC Act listed migratory species). In addition, legislatively significant beach stone-curlew was observed. The vegetation community is of 'Least Concern' (RE 12.1.2)) although protected marine plants are present, which results in high conservation value status. They are intact, unique, not very resistant to change and difficult to replace, as regrowth mudflats are difficult to source as an offset.

Value 13 includes mangrove habitat (RE 12.1.3) which is 'Least Concern' but support marine plants and could provide habitat for the water mouse. This area is intact and has a high overall sensitivity despite having moderate resilience, being moderately easy to replace and not being very unique.

Values 12 and 13 are both recognised by the state as forming part of a state significant wetland and providing habitat for threatened species (BPA; Figure 11).

Hamilton Point

Values with very high sensitivity

Value 14 is a Commonwealth recognised critically endangered ecosystem of very high conservation value (RE 12.2.2) and is acknowledged by the state as having habitat for threatened species (BPA; Figure 11). It has high intactness, very high uniqueness, non-resilience to change, and very high difficulty in being replaced. Despite the construction footprint avoiding this area, weed incursion and other disturbances may still negatively affect the values without suitable management.

Values with high sensitivity

Values 15 and 16 are both 'Of Concern' RE 12.11.14. They are recognised by the state as threatened species habitat and provide likely habitat for a range of threatened fauna species. Within Value 15, eastern osprey and eastern curlew are known to occur. These areas are both highly intact.

Values with medium sensitivity

Value 17 is RE 12.3.6, which is 'Least Concern'. It provides potential habitat for a range of threatened species. Its conservation status is medium, and it is highly intact.

Value 18 is an 'Of Concern' RE (RE 12.11.14) and contains good quality grey-headed flying-fox foraging habitat, which are known in the area and are at the northern limit of their range. Square-tailed kite, grey goshawk and powerful owl are likely to occur due to their known presence in the area and the RE provides foraging habitat for these species. This site also provides potential koala foraging habitat. Habitat is suitable for the Brigalow scaly-foot, which is known to occur at Boyne Island, approximately 15 km to the south. Coastal sheathtail bat and black-chinned honeyeater could possibly occur, as suitable foraging habitat is present. This site therefore has high conservation value. Other factors rate as medium, giving an overall sensitivity of medium.

The remaining ecological values (19 to 22 on Hamilton Point) rate as a medium sensitivity. Value 19 is RE 12.11.6, which is 'Least Concern' and therefore has a medium conservation status. Values 20, 21 and 22 are all 'Of Concern' 12.11.4 and have a high conservation status. All four of these values provide potential habitat for a range of threatened fauna species. Each of these values is not particularly unique, and is considered relatively resilient to change.

Boatshed Point

Values with high sensitivity

Value 38 is only moderately intact RE 12.11.4 ('Of Concern') but is of high uniqueness based on the presence of the *Cupaniopsis* sp. indet. Value 38 is recognised by the state as providing

habitat for threatened species (BPA; Figure 11). This area is therefore also of high sensitivity.

Values with medium sensitivity

Values 37 and 39 are both 'Of Concern' RE's (RE 12.11.14) and provide potential habitat for threatened fauna. Each of these sites is considered to be state significant wetland. These sites therefore have high conservation significance. Values 37 and 39 are intact and therefore rate as high in terms of sensitivity.

Mainland tunnel entry shaft and tunnel spoil disposal area

Values with high sensitivity

The saltpans (Value 1 – RE 12.1.2) along the mainland coastal strip form part of a shorebird feeding and roosting area. The area is likely to support more than 15 species of migratory shorebird and is therefore considered a "significant shorebird habitat". Under international agreements (such as JAMBA, CAMBA, ROKAMBA) and the EPBC act this affords a high conservation significance rating. In addition, marine plants are present and the habitat is relatively intact despite some disturbance from illegal four wheel driving, rubbish disposal, etc. These disturbances are relatively short term and natural ecosystem function returns with each high tide. Despite the RE being categorised as 'Least Concern', the habitat is unique and would be difficult to offset with "like for like" as extensive mudflats such as this are not common in the broader region. It would therefore be difficult to replace if this was required.

The fringing mangroves (Value 2) along the mainland coastal strip are an 'Of Concern' RE (12.1.3) and could support water mouse populations (listed as 'Vulnerable' under the NCA). Small numbers and low diversity of migratory shorebirds utilise the mangroves as roosts. GHD (2010) identified roosting habitat within this area. In addition, marine plants are present and the habitat is relatively intact. The habitat is not unique and is relatively resilient and can be replaced moderately easily. The overall sensitivity is high.

Both Value 1 and Value 2 are mapped as being part of a state significant wetland and are recognised by the state as providing habitat for threatened species (BPA; Figure 11).

Value 8 is also of high sensitivity. It has a conservation status score of very high, as it is RE 12.3.3, which is 'Endangered' under the VMA. This area also provides potential habitat for a range of threatened fauna species, and is part of a state recognised wildlife corridor. This area is moderately intact, not very unique, and moderately resilient to change.

Values with medium sensitivity

Values 3 to 7 are all high conservation value 'Of Concern' RE (RE 11.3.4) and potentially support a range of listed fauna including grey-headed flying-fox, square-tailed kite, grey goshawk, powerful owl, koala, coastal sheathtail bat and black-chinned honeyeater. In addition, Values 5 and 3 are considered essential habitat for the coastal sheathtail bat and koala. They all rate as low for uniqueness, and are considered to be resilient to change. Values 3, 6 and 7 are all intact, while Value 4 and 5 are less intact.

Value 9 is 'Least Concern' RE 12.3.7. It has a medium conservation status score, is recognised by the state as being a wildlife corridor, and provides potential habitat for a range of threatened fauna species. Value 9 is moderately intact and would be moderately difficult to replace. It has low uniqueness and is relatively resilient to change.

Both Values 10 and 11 are 'Of Concern' RE 12.11.14. They both provide potential habitat for threatened fauna species including grey-headed flying-fox, square-tailed kite, grey goshawk, and powerful owl. As a result, they score 'high' for conservation status. They would both be relatively easy to replace if an offset were required, score 'low' for uniqueness and 'low' for non-resilience to change. Value 11 is more intact than Value 10.

TWAF 7

This area (Value 40) is non-remnant vegetation, and despite forming part of a regional wildlife corridor (from BPA; Figure 11), is considered unlikely to support listed fauna and is therefore of low conservation significance. It has a very low degree of uniqueness, is resilient to change and easy to replace, resulting in a low overall sensitivity.

Pre-clearing surveys should be undertaken at TWAF 7 to confirm the ecological values of the site. No targeted flora or fauna surveys have been carried out to date in this area.

TWAF 8

Values with high sensitivity

Value 41 is an 'Of Concern' RE (RE 11.3.4) and contains habitat suitable for a range of threatened fauna, such as grey-headed flying fox, koala and powerful owl. Part of this area is mapped as essential habitat for the coastal sheathtail bat and koala. It is adjacent to state forest and forms part of a state wildlife corridor (from BPA). This site therefore has a high conservation status, is intact and therefore of high sensitivity despite its ease of replacement, high resilience to change and low uniqueness score.

Values with medium sensitivity

Value 42 is High Value Regrowth of an 'Of Concern' RE (11.3.4) in a restricted area, and likely to support listed fauna, therefore is of high conservation significance. With medium intactness and low ratings for other variables, it is considered of medium sensitivity.

Value 43 is of medium conservation status owing to potential habitat for listed fauna and is High Value Regrowth of an 'Of Concern' RE (11.3.4) not in a restricted area. With medium intactness and low ratings for other variables, it is considered to be of medium sensitivity.

Pre-clearing surveys should be undertaken at TWAF 8 to confirm the ecological values of the site. No targeted flora or fauna surveys have been carried out to date in this area.

Launch Site 1

Values with medium sensitivity

Values 44 and 45 are both 'Least Concern' vegetation communities (RE 12.1.2 and RE 12.1.3). However, Value 45 may provide habitat for water mouse, and therefore is considered to be of a medium conservation status. Both sites are of moderate uniqueness and are resilient to change. Value 44 is considered to be difficult to replace (i.e. offset). As a result, both these values receive an overall sensitivity of medium.

If this launch option is utilised, pre-clearing surveys should be undertaken to confirm the ecological values of the site. No flora or fauna surveys have been carried out to date in this area and there is a possibility that suitable habitat may exist for water mouse.

Table 23 Conservation status of ecological values

Project area	Eco-logical value	Vegetation community			Threatened flora species		Threatened fauna species		Conservation areas/ other ecological features	Conservation status score
		Regional eco-system	VMA status	EPBC Act status	Known to occur	Moderate to high likelihood of occurrence	Known to occur	Moderate to high likelihood of occurrence		
Mainland Tunnel Entry Shaft	1	12.1.2	Least Concern	n/a	n/a	n/a	Squatter pigeon; beach stone-curlew; eastern curlew; rainbow bee-eater; white-bellied sea-eagle; eastern great egret.	Yellow chat, little tern, migratory shorebirds.	Shorebird feeding and roosting habitat; potentially a 'significant shorebird habitat'; marine plants; state significant wetland and threatened species habitat; essential habitat (koala and coastal sheath-tail bat)	High
	2	12.1.3	Least Concern	n/a	n/a	n/a	Squatter pigeon; beach stone-curlew; eastern curlew; rainbow bee-eater; white-bellied sea-eagle; eastern great egret.	Yellow chat, little tern, potential water mouse, migratory shorebirds.	Shorebird feeding and roosting habitat; marine plants; state significant wetland and threatened species habitat; essential habitat (koala and coastal sheath-tail bat).	High
	3	11.3.4	Of Concern	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; koala; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Essential habitat (koala and coastal sheath-tail bat)	High
	4	11.3.4	Of Concern	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; koala; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	State corridor.	High

Project area	Eco-logical value	Vegetation community			Threatened flora species		Threatened fauna species		Conservation areas/ other ecological features	Conservation status score
		Regional eco-system	VMA status	EPBC Act status	Known to occur	Moderate to high likelihood of occurrence	Known to occur	Moderate to high likelihood of occurrence		
	5	11.3.4	Of Concern	n/a	n/a	n/a	Rainbow bee-eater.	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; koala; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater, Lewin's rail.	State corridor; essential habitat (koala and coastal sheath-tail bat).	High
	6	11.3.4	Of Concern	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; koala; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater, Lewin's rail.	State corridor.	High
	7	11.3.4	Of Concern	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; koala; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater, Lewin's rail.	State corridor.	High
	8	12.3.3	Endangered	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; koala; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater, Lewin's rail.	State corridor.	Very High
	9	12.3.7	Least Concern	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	State corridor.	Medium

Project area	Eco-logical value	Vegetation community			Threatened flora species		Threatened fauna species		Conservation areas/ other ecological features	Conservation status score
		Regional eco-system	VMA status	EPBC Act status	Known to occur	Moderate to high likelihood of occurrence	Known to occur	Moderate to high likelihood of occurrence		
	10	12.11.14	Of Concern	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; koala; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	State corridor.	High
	11	12.11.14	Of Concern	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; koala; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	State corridor.	High
Curtis Island Saltpans and fringing mangroves	12	12.1.2	Least Concern	n/a	n/a	n/a	Beach stone-curlew; eastern curlew; rainbow bee-eater; white-bellied sea-eagle; eastern great egret.	Yellow chat, little tern, beach stone-curlew; likely other migratory shorebirds	Shorebird feeding habitat; marine plants; state significant wetlands; threatened species habitat; world heritage area; essential habitat (koala and coastal sheath-tail bat).	High
	13	12.1.3	Least Concern	n/a	n/a	n/a	Rainbow bee-eater.	Yellow chat, little tern, potential water mouse; additional migratory shorebirds.	Marine plants; state significant wetlands; threatened species habitat; world heritage area; essential habitat (koala and coastal sheath-tail bat).	High
Hamilton Point	14	12.2.2	Of Concern	Critically Endangered	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; world heritage area.	Very High

Project area	Eco-logical value	Vegetation community			Threatened flora species		Threatened fauna species		Conservation areas/ other ecological features	Conservation status score
		Regional eco-system	VMA status	EPBC Act status	Known to occur	Moderate to high likelihood of occurrence	Known to occur	Moderate to high likelihood of occurrence		
	15	12.11.4	Of Concern	n/a	*Cupaniopsis sp.* indet.	n/a	Eastern osprey; eastern curlew.	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; world heritage area.	High
	16	12.11.4	Of Concern	n/a	*Cupaniopsis sp.* indet.	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; world heritage area.	High
	17	12.3.6	Least Concern	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; world heritage area.	Medium
	18	12.11.14	Of Concern	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; world heritage area.	High
	19	12.11.6	Least Concern	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; world heritage area.	Medium
	20	12.11.14	Of Concern	n/a	n/a	n/a	Rainbow bee-eater; white-bellied sea-eagle; rufous fantail.	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; world heritage area.	High

Project area	Eco-logical value	Vegetation community			Threatened flora species		Threatened fauna species		Conservation areas/ other ecological features	Conservation status score
		Regional eco-system	VMA status	EPBC Act status	Known to occur	Moderate to high likelihood of occurrence	Known to occur	Moderate to high likelihood of occurrence		
	21	12.11.14	Of Concern	n/a	n/a	n/a	Rainbow bee-eater.	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; world heritage area.	High
	22	12.11.14	Of Concern	n/a	n/a	n/a	Rainbow bee-eater.	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; world heritage area.	High
LNG Plant	23	12.11.14	Of Concern	n/a	n/a	n/a	Rainbow bee-eater.	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; world heritage area.	High
	24	12.11.6	Least Concern	n/a	n/a	n/a	Rainbow bee-eater.	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; world heritage area.	Medium
	25	12.11.14	Of Concern	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; world heritage area.	High

Project area	Eco-logical value	Vegetation community			Threatened flora species		Threatened fauna species		Conservation areas/ other ecological features	Conservation status score
		Regional eco-system	VMA status	EPBC Act status	Known to occur	Moderate to high likelihood of occurrence	Known to occur	Moderate to high likelihood of occurrence		
	26	12.3.7	Least Concern	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; world heritage area.	High
	27	12.3.3	Endangered	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Essential habitat (koala and coastal sheath-tail bat); world heritage area.	Very High
	28	12.3.6	Least Concern	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; world heritage area.	Medium
	29	12.11.14	Of Concern	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; world heritage area.	High
	30	12.11.6	Least Concern	n/a	n/a	n/a	Rainbow bee-eater.	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; world heritage area.	Medium
	31	12.3.3	Endangered	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; world heritage area; essential habitat (koala and coastal sheath-tail bat).	Very High

Project area	Eco-logical value	Vegetation community			Threatened flora species		Threatened fauna species		Conservation areas/ other ecological features	Conservation status score
		Regional eco-system	VMA status	EPBC Act status	Known to occur	Moderate to high likelihood of occurrence	Known to occur	Moderate to high likelihood of occurrence		
	32	12.11.14	Of Concern	n/a	n/a	n/a	Rainbow bee-eater.	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; world heritage area; state significant wetlands.	High
	33	12.3.7	Least Concern	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; world heritage area; essential habitat (koala and coastal sheath-tail bat).	Medium
	34	12.11.14	Of Concern	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; world heritage area.	High
	35	12.11.14	Of Concern	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; world heritage area.	High
	36	12.11.6	Least Concern	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; world heritage area.	High
Boatshed Point	37	12.11.14	Of Concern	n/a	n/a	n/a	Eastern curlew.	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; state significant wetland; world heritage area.	High

Project area	Eco-logical value	Vegetation community			Threatened flora species		Threatened fauna species		Conservation areas/ other ecological features	Conservation status score
		Regional eco-system	VMA status	EPBC Act status	Known to occur	Moderate to high likelihood of occurrence	Known to occur	Moderate to high likelihood of occurrence		
	38	12.11.4	Of Concern	n/a	*Cupaniopsis sp.* indet.	n/a	Eastern curlew.	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; state significant wetland; world heritage area.	High
	39	12.11.14	Of Concern	n/a	n/a	n/a	Beach stone-curlew; eastern curlew.	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Threatened species habitat; state significant wetland; world heritage area.	High
TWAF 7	40	Non descript regrowth	n/a	n/a	n/a	n/a	n/a	Eastern curlew	Regional wildlife corridor; some essential habitat (koala and coastal sheath-tail bat).	Low
TWAF 8	41	11.3.4	Of Concern	n/a	n/a	n/a	Rainbow bee-eater.	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; koala; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater, squatter pigeon, yakka skink, Dunmail's snake	State wildlife corridor; adjacent to state forest.	High
	42	11.3.4	Of Concern	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; koala; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater, northern quoll.	State wildlife corridor.	High

Project area	Eco-logical value	Vegetation community			Threatened flora species		Threatened fauna species		Conservation areas/ other ecological features	Conservation status score
		Regional eco-system	VMA status	EPBC Act status	Known to occur	Moderate to high likelihood of occurrence	Known to occur	Moderate to high likelihood of occurrence		
	43	11.3.4	Of Concern	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; koala; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater, squatter pigeon, yakka skink, Dunmail's snake	State wildlife corridor.	Medium
Launch Site 1	44	12.1.2	Least Concern	n/a	n/a	n/a	n/a	Yellow chat, migratory shorebirds.	State wildlife corridor; state significant wetland.	Low
	45	12.1.3	Least Concern	n/a	n/a	n/a	n/a	Potential water mouse; migratory shorebirds.	State wildlife corridor; state significant wetland.	Medium
Mainland Tunnel Entry Shaft	46	Non-remnant	n/a	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; koala; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	State wildlife corridor	Very low
LNG Plant	47	Non-remnant	n/a	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Includes areas that are characteristic of RE 12.11.6, 12.11.14 and 12.3.3 and may be able to be rehabilitated as such	Low
	48	Non-remnant	n/a	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater.	Includes areas that are characteristic of RE 12.11.6, 12.11.14 and 12.3.3 and may be able to be rehabilitated as such	Low

Project area	Eco-logical value	Vegetation community			Threatened flora species		Threatened fauna species		Conservation areas/ other ecological features	Conservation status score
		Regional eco-system	VMA status	EPBC Act status	Known to occur	Moderate to high likelihood of occurrence	Known to occur	Moderate to high likelihood of occurrence		
TWAF8	49	Non-remnant	n/a	n/a	n/a	n/a	n/a	Grey-headed flying-fox; square-tailed kite; grey goshawk; powerful owl; koala; Brigalow scaly-foot; coastal sheath-tail bat; black-chinned honeyeater, squatter pigeon, yakka skink, Dunmail's snake.	State wildlife corridor	Very low

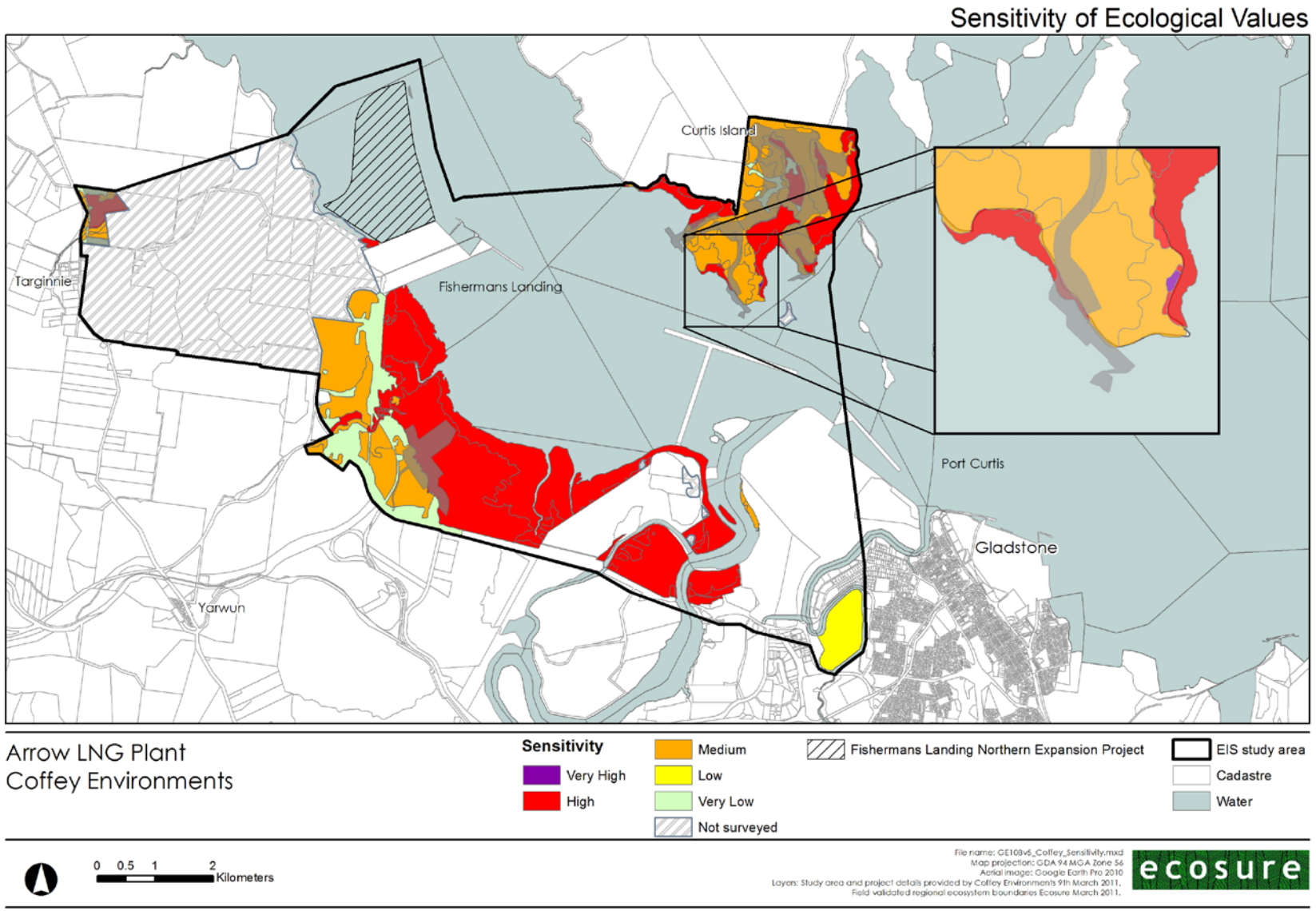


Figure 12 Sensitivity of ecological values.

5 Issues and Potential Impacts

5.1 Overview of Potential Impacts

The potential impacts to terrestrial flora and fauna consist predominantly of direct impacts, such as the loss and fragmentation of habitat, associated with the construction of the proposed TWAF, pipeline, marine jetties and LNG plant. Some impacts are likely to continue throughout the operational phase of the project, such as from noise and artificial light, and the potential for introduction of pest flora and fauna species. Key impacts resulting from project activities are summarised in Table 24. The specific locations where each impact is expected to occur are detailed in Table 26.

The construction and operation of the project will potentially result in a range of direct and indirect impacts to those existing ecological values outlined in Section 4. Discussion of potential impacts on ecological values is provided in Section 5.2. Section 5.3 assesses the significance of the impacts identified in Section 5.2. Recommendations to minimise impacts generated from general impacts of construction and operation of the project on flora and fauna is provided in Section 6.

Table 24 Likely impacts from project activities.

Impacts	Related project activities	Description
Vegetation clearing and disturbance	· Vegetation clearing for access and construction purposes.	· Clearing may be either permanent or temporary.
Habitat fragmentation and impacts on wildlife corridors	· Vegetation clearing for access and construction purposes.	· Clearing may be either permanent or temporary.
Introduced flora and fauna	· Vehicle movements. · Construction camps. · Vegetation clearing for access and construction purposes.	· Vehicles (including ships) and people may be vectors for pest flora. · The presence of people increases the amount of waste food, which may attract pest fauna. · Vegetation clearing may open up the canopy, increasing establishment/ growing conditions for pest flora.
Hydrology and pollution	· Earthworks. · Spoil stockpiles. · Redirection/alteration of watercourse. · Construction of hardstanding areas.	· Earthworks and spoil stockpiling potentially cause ASS issues, sediment mobilisation (airborne and waterborne). · Hardstanding areas may channel stormwater runoff and decrease soil absorption.
Direct disturbance of fauna	· Construction and operational lighting. · Construction and operational noise. · Vehicle movements.	· Lighting and noise can have a more indirect effect. · Vehicle movements may cause direct mortality.

Impacts	Related project activities	Description
Altered fire regimes	· Vegetation clearing for access and construction purposes. · Clearing for fire buffers. · Construction camps.	· Clearing may decrease the likelihood of burns. · Increased pest flora (i.e. grasses) may increase the fuel load. · Accidental ignition more likely with more people/activity.
Trenchfall	· Stringing and laying pipeline.	· May provide a temporary barrier to fauna movement. · Fauna entrapment may occur, which could lead to mortality due to predation, dehydration, or drowning.

5.1.1 Vegetation Clearing and Disturbance

Loss of native vegetation is one of the greatest threats to Australia's biodiversity (Department of Environment and Heritage, 2006b). The project will remove approximately 25.7 ha of 'Endangered' RE, 173.7 ha of 'Of Concern' RE and 8.1 ha of high value regrowth vegetation listed under the VMA (Table 25). Vegetation to be cleared for the project represents less than 0.2% of the total amount of each vegetation community current within Queensland. Within the context of the Gladstone local government area, clearing for this project represents less than 1% of the current extent of each vegetation community. The exception to this is RE 12.11.14, of which 3.54% of the local areas extent is proposed to be cleared by this project. These amounts are not considered to be significant.

Table 25 Regulated vegetation to be cleared.

Field-validated Regional Ecosystem (RE)	Total present within the study area		Area to be cleared^		Percentage of the area to be cleared in the context of the study area (%)	Total present within the Gladstone region (ha)	Percentage of the area to be cleared in the context of the Gladstone region (%)	Total present within QLD (ha)	Percentage of the area to be cleared in the context of the state (%)
	Remnant vegetation (ha)	High value regrowth vegetation (ha)	Remnant vegetation (ha)	High value regrowth vegetation (ha)					
11.3.4	285.11	57.49	46.4	8.03	15.89	6,017.00	0.90	186,656.0	0.0
11.11.15	17.69	1.02	0	0	0.00	39,794.00	0.00	531,315.0	0.0
11.11.18	2.27	1.44	0	0	0.00	2,051.00	0.00	4,519.0	0.0
12.1.2	521.77		59.39		11.38	15,657.0	0.38	28,532.0	0.2
12.1.3	552.17		5.78		1.05	17,646.0	0.03	50,481.0	0.0
12.2.2	0.42		0		0.00	2,552.0	0.00	2,683.0	0.0
12.3.3	32.48		25.69		79.09	20,638.0	0.12	42,963.0	0.1
12.3.6	5.23		3.56		68.12	3,868.0	0.09	14,032.0	0.0
12.3.7	9.07		4.21		46.40	8,908.0	0.05	53,259.0	0.0
12.11.4	7.54		3.91		51.78	2,995.0	0.13	3,081.0	0.1
12.11.6	142.89		71.50		50.04	93,264.0	0.08	241,676.0	0.0
12.11.14	244.63	4.64	123.38		49.50	3,495.0	3.53	30,127.0	0.4

In many instances the removal of vegetation will be permanent, particularly where hardstand areas are erected. Where vegetation is permitted to regenerate, either naturally or through revegetation, it may still be actively managed to enable vehicle access or to limit impacts to the underground pipeline.

The removal and disturbance of vegetation results in several direct and indirect environmental impacts:

- Direct impacts associated with the clearing of vegetation, including the loss of individuals of flora and fauna species of conservation significance.
- The loss of a range of habitat functions for native fauna including shelter, breeding areas and foraging resources, which can result in reduced fauna abundance and diversity.
- The loss of hollow bearing trees which are required by a wide range of fauna species for shelter and breeding, such as arboreal mammals, microbats, owls, parrots and ducks.
- Unearthing and/or damaging fauna during earthworks and clearing, such as ground dwelling species (snakes, burrowing animals) and arboreal species during vegetation clearing (such as possums and koala).
- The removal of other habitat elements from vegetation communities, such as fallen timber, leaf litter and scattered rocks. Many native fauna species rely on such habitat and disturbance will likely result in reduced fauna abundance and diversity.
- The loss of mangrove vegetation which supports several species of threatened fauna. In particular, increased fragmentation of the coastal mangrove corridor would likely cause negative impacts to the water mouse and several species of migratory and non-migratory shorebirds (including eastern curlew and beach stone-curlew).
- Erosion and sediment mobilisation, both as dust and within watercourses.

5.1.2 Habitat Fragmentation and Impacts on Wildlife Corridors

This project will disturb wildlife movement corridors and cause habitat fragmentation. Habitat fragmentation describes the changing landscape arising from partial or complete clearing of vegetation, which results in many smaller, disconnected patches of vegetation. Isolation of flora and fauna populations caused by fragmentation results in:

- Increased vulnerability to local extinction as a result of stochastic events and decreased genetic diversity in the long-term.
- Changes in species composition as a result of the local extinction of some species from a community. Fauna species with large home ranges, such as grey goshawk and powerful owl, may be unable to persist in small patches.
- Increased edge effects such as increased predation, competition and weed invasion.
- Barriers to movement, including roads, infrastructure, and to a lesser degree, trenches during pipeline stringing.

These activities will have an impact on shorebirds at both the mainland tunnel entry shaft area and on Curtis Island. Mammals and reptiles within TWAF 8 and Curtis Island are also likely to be effected by habitat fragmentation and interruptions to wildlife corridors.

5.1.3 Introduced Flora and Fauna

The review of existing information and the results of the field surveys provided records for a range of introduced flora and fauna species which occur within the study area. The majority of these species are considered widespread in the Gladstone region. However, the construction and operation of the project has the potential to allow introduced species of flora and fauna to colonise areas where they do not currently inhabit. This may include the introduction of new species (such as via ship at the MOFs/jetties) or the expansion of existing species from elsewhere in the region.

Habitat fragmentation, changes in predator/prey relationships and increased artificial food sources around human populations can encourage pest fauna to establish. Clearing of vegetation removes vegetation competition, disturbs soil and allows light into areas usually shaded, favouring colonising species, such as weeds. Vehicles and people also can become vectors for weed seed transmission by transporting seed material in foot or tyre treads.

Pest fauna (from Ecosure, 2011) may have significant environmental and economic impacts in addition to the potential threat they may pose for human and animal health. These may include:

- Reduction of ecological values as a result of predation, competition, habitat degradation and the introduction of disease
- Reduced productivity of primary production areas and predation of livestock
- Costs associated with control.

Impacts associated with the introduction and spread of introduces flora species may include (from Ecosure, 2011):

- Reduced ecological values of natural areas.
- Displacement of native flora and fauna, in particular those species of legislative significance.
- Reduced productivity of primary production areas.
- Impacts upon the health of livestock and humans.

Within the study area, an area near Fishermans Landing) is included in the Yarwun Fire Ant Restricted Area (DPIF, 2008). Fire ants are a notifiable pest species in Queensland and strict regulations apply to construction activities within a Fire Ant Restricted Area. Earthworks associated with the proposed project could potentially influence the spread of fire ants in the region, if not managed in accordance with regulatory guidelines.

For further information refer to the Arrow LNG Plant Terrestrial Ecology Pest Management Plan (Ecosure, 2011).

5.1.4 Hydrology and Pollution

Altered hydrology may result from vegetation removal, reshaping landforms, altering and/or creating drainage channels, and increasing areas of hardstanding which potentially reduces infiltration and increases flow velocity. Mangrove and saltpan vegetation acts as a filter for

sediment and nutrients. The removal of some of this buffer around Hamilton Point and around the mainland tunnel entry shaft and tunnel spoil disposal area may increase sedimentation, alter flow paths and vary water depth for existing vegetation which in turn can lead to changes in vegetation community type over time. It may also disturb natural dispersion by limiting transfer of water borne seeds.

Pollution such as from petroleum based solvents used during construction and operation and associated with vehicles, plant and equipment could degrade flora and fauna habitats. Disturbance of acid sulfate soils and potential release of leachates could also affect flora and fauna. This is most likely in low lying areas around the mangroves and salt pans of Hamilton Point and the mainland tunnel entry shaft and tunnel spoil disposal area. Whilst relatively resilient, disruption of acid sulfate soils, leaching, compaction and alteration of the natural hydrological cycle is difficult to reverse or ameliorate and could affect the habitat values.

5.1.5 Direct Disturbance of Fauna

People, plant, lighting, noise and vibration during construction and operation may affect fauna. This is particularly the case for species of conservation significance such as shorebirds within areas of RE 12.1.2 and RE 12.1.3 on both Curtis Island and at the mainland tunnel entry shaft and tunnel spoil disposal area. Negative impacts include rendering roosting, breeding and foraging habitat untenable, and increasing the chance of road kill. Artificial lighting can attract insects which encourage insectivores including some frog and reptile species and a few bird species such as bush stone-curlew. This benefits those species able to take advantage of the additional food supply, along with their predators. It can lead to a change in the species assemblage as such species may out compete other less adaptable species. Some frog and bird species mating and nesting behaviours are known to be altered by the presence of artificial light (Baker and Richardson, 2006; Longcore and Rich, 2007).

Altered Fire Regimes

Australian flora and fauna has adapted to cope with and indeed in some cases, rely on certain fire regimes (Gill et.al., 1999). It is likely that current fire regimes within the study area are quite different from pre-European settlement due to grazing, land clearing and changes in vegetation structure. The project will result in the removal of vegetation and creation of fire protection buffers around infrastructure which will likely exacerbate the change in fire regime. In areas where fire frequency is greater, mid strata vegetation can be expected to lose complexity in favour of a grass and herb ground cover. EcoLogical (2011) provide further discussion on fire regimes.

5.1.6 Trenchfall

The pipeline on both the mainland and Curtis Island will be located underground and an open trench will be used during stringing and laying of the pipe. The open trench has the potential to form a short-term barrier to movement for some species of small, ground-dwelling fauna. Additionally, there is potential for entrapment and mortality of fauna in the open trench, as well as in any open excavations.

5.1.7 Decommissioning

As items of the plant are no longer required they will be decommissioned on an as needs basis. A decommissioning plan will be prepared for the facility at the end of its operational life.

Decommissioning will be carried out in accordance with this plan. The plan will comply with the regulatory requirements in force at the time of decommissioning. The site will be stabilised to ensure that it does not pose any risk to public safety or the environment. The preparation of the decommissioning plan will be undertaken in consultation with the appropriate stakeholders.

5.2 Magnitude of Impacts on Ecological Values

The magnitude of impacts on ecological values (Figure 2) is discussed below. Each value has been considered in terms of the geographic extent, duration and severity of likely impacts. Table 26 in Section 5.3 details the magnitude 'score' for each ecological value and assesses the magnitude of impact against the sensitivity of each value. Table 26 also assesses which impacts (from Table 24) are likely to occur on which ecological value.

Impacts are likely to differ based on the peak loading of staff working within the project area. In 2014 and then from 2018 onwards, the workforce is expected to be less than 1000 people. Staff loading peaks from 2015 to 2017, with greater than 3000 planned to be working within the project area. The greatest impacts are likely to occur within the first four years of construction. Once operations commence, the workforce is anticipated to be less than 500. It is likely that impacts which will be lessened or negated during operation include hydrology and pollution, direct disturbance of fauna, and trenchfall. Vegetation clearing, habitat fragmentation, introduced flora and fauna and altered fire regimes are expected to continue having an impact throughout both construction and operation.

Curtis Island Arrow LNG Plant

Ecological values 23 to 36 and (RE 12.11.14, 12.11.6, 12.11.14, 12.3.7, 12.3.3, 12.3.6) are within the area to be almost completely cleared for the LNG Plant, haul roads and other infrastructure. All of the impacts listed in Section 5.1 could potentially occur within this area.

The impact on terrestrial ecology outside the site is possible from light, noise, pollution and sediment runoff, but with appropriate environmental controls in place the impact is likely to be contained to the site only and therefore was assessed as having low geographical impact.

The impact of the LNG plant may be considered to be permanent, therefore the duration of impact was deemed to be high. As the majority of these values will be removed and replaced with the operating plant, the severity is considered high. The overall rating for magnitude of impacts in this area was considered high.

Hamilton Point

The northern flank of Hamilton Point will be cleared for road and pipeline access. On the southern tip a MOF may be constructed with a road access through the mid section of the headland.

Values 14 (RE 12.2.2), 15 (RE 12.11.4) and 16 (RE 12.11.4) are areas of high or very high sensitivity, due to their conservation significance and low resilience. Although roads and other infrastructure avoid these areas, they will be particularly vulnerable to pests and weeds that may be introduced through edge effects and activities which could encourage pests to proliferate. The area would also be at risk from people trampling vegetation through walking or off-road vehicular traffic. Increased fire frequency from arson or for example, discarding cigarettes, could also affect the vegetation structure of these ecosystems. Because these impacts can be effectively managed with standard environmental controls, the severity of impact was considered low. Impacts will be confined to the site and are therefore considered of low geographical impact. Impacts will be long lasting (high duration), resulting in an overall magnitude rating of medium.

Value 17 (RE 12.3.6) is similarly unaffected by direct clearing and operational activities, and because of its resilience was assessed as likely to have negligible impact from the project.

Value 18 (RE 12.11.14), will be affected by permanent vegetation loss for construction of the haul road, potentially leading to all impacts outlined in section 5.1. These impacts should be contained to the site, but will be severe and long lasting, resulting in high magnitude of impact.

The eastern haul road option, if selected would result in vegetation loss to about half of Value 19 (RE 12.11.6). Likewise, Value 20 (RE 12.11.4) may have one haul road option pass through it but this will not result in complete loss of vegetation from this community. These values were therefore assessed as only incurring moderate severity as at least half the vegetation will be retained. Duration and geographic extent are as assessed for Value 18 and therefore the overall magnitude of impact is medium.

Values 21(RE 12.11.14) and 22 (RE 12.11.14) could be affected by haul roads and laydown areas resulting in a large portion of the vegetation being removed. There are two options for the MOF, at either Hamilton Point or Boatshed Point. If the Hamilton Point option is adopted Values 21 and 22 will have a high magnitude of impact, despite the low geographic impact as it will be isolated to the site. This is based on the high severity from substantial habitat loss and high duration as the loss will be permanent.

Curtis Island Saltpans and Fringing Mangroves

Values 12 (RE 12.1.2) and 13 (RE 12.1.3) will be affected by minor to moderate removal and reclamation of intertidal areas along the northern section of Hamilton Point for road and pipeline access. This is restricted to a small proportion of the overall saltpan and mangrove areas within the study area and therefore is of low geographical impact and only moderate severity as much of these values will be retained. Where the impact occurs it will be of high duration, resulting in an overall magnitude of impact of medium.

Boatshed Point

Boatshed Point is the site for the main construction camp and the basecase option for a MOF and personnel jetty. If constructed here the MOF will not be built at Hamilton Point. Despite the retention of a *Cupaniopsis* Reserve on Boatshed Point, the majority of vegetation and habitat will be removed; a geographical impact confined to the island (low) but severity and duration

will be high resulting in an overall high magnitude of impact on Values 37 (RE 12.11.13), 38 (RE 12.11.4) and 39 (RE 12.11.14). Impacts will be greatest over the two year period where the construction camp is expected to support a peak workforce (approximately 2000 beds are to be provided at Boatshed Point).

Mainland tunnel entry shaft and tunnel spoil disposal area

The saltpan area south of Boat Creek (Value 1 – RE 12.1.2) will support part of the pipeline and the tunnel shaft and will be the site for deposition of the tunnel spoil. As a result, there will be high severity of impact due to the removal of vegetation and fragmentation of the saltpan, potentially disturbing shorebird utilisation of the area and altering the natural hydrological cycle. In addition, acid sulfate soils (addressed by Coffey Environments 2011d) disruption, leaching and compaction could affect vegetation health and habitat quality. The impact will be restricted to the saltpan itself and therefore has a low geographical impact. The relative permanency of the structures results in a high duration of impact and these impacts are all difficult to reverse or ameliorate. The overall magnitude of impact is therefore high.

The severity of the impacts on the fringing mangroves (Value 2 – RE 12.1.3) will be low as the pipeline will tunnel under them. Short term turbidity may have a minor impact. This impact will be restricted to the site (low geographic consequence) but could be for a long duration (high) resulting in an overall medium magnitude of impact.

The pipeline and construction road access to the saltpans will be through Value 3 (RE 11.3.4). The permanent removal of this vegetation constitutes high severity and high duration resulting in an overall high magnitude rating despite the impacts being restricted to the site (low geographic impact).

Values 4 to 11 (RE's 11.3.3, 11.3.4, 12.3.7, 12.11.14) near the launch area were assessed as having negligible magnitude of impact as the proponent does not propose works in these areas.

TWAF 7

It is proposed that the construction of TWAF 7 (Value 40 – non-remnant vegetation) will involve removal of vegetation of most of the site (high severity). Impacts will be restricted to the site (low geographic impact) but will be relatively permanent or difficult to reverse (high duration). Overall magnitude of impact will be high.

TWAF 8

TWAF 8 includes three distinct areas of RE 11.3.4 (Values 41, 42 and 43) and some non remnant patches. Value 41 will be almost completely cleared for workers accommodation, access roads and lay down areas resulting in a high severity, high duration due to the long term impact but should only affect the site itself (low geographic impact). The overall magnitude of impact is therefore high.

Value 42 is a small ephemeral creek that will be avoided in direct construction activities but could be affected through fragmentation, edge effects and weed and pest incursion as a

result of clearing in adjacent areas. The severity is therefore medium and duration high, with geographic impact low resulting in a magnitude of medium.

Value 43 will be cleared in the north but remain intact in the south of the site, resulting in a medium severity. High duration and confined geographic impact (low) result in magnitude of impact being medium.

Launch Site 1

Values 44 and 45 (RE 12.1.2 and RE 12.1.3) will both be partially cleared if this launch site option is taken. The impacts are expected to have a high duration but low geographic extent. The impacts are therefore of a medium magnitude.

5.3 Pre-mitigation Assessment of Significance

Appendix I illustrates where each ecological value referred to below is located. Of the 4 values assessed, six were determined to be of high significance, 26 moderate, three minor and ten insignificant. The highly significant impact areas are:

- The saltpans of the mainland tunnel entry shaft and tunnel spoil disposal area (Value 1; RE 12.1.2).
- RE 12.2.2 (Value 14) on Hamilton Point which could be affected by the project without careful management of weeds and other threats, despite falling outside the construction/clearing footprint.
- The endangered RE 12.3.3 (Values 27 and 31) at the Curtis Island LNG facility that are expected to be entirely cleared prior to construction.
- The area of *Cupaniopsis* sp. indet. (Value 38) on Boatshed Point. While a majority of this area is planned to be retained, the impacts on this significance species are still expected to be high.
- RE 11.3.4 (Value 41) in TWAF 8.

For the results of the significance assessment, refer to Table 26 and Figure 13.

Table 26 Results of the pre-mitigation assessment of significance, along with the expected location of likely impacts.

Project area	Ecological value	Regional ecosystem	Likely impacts	Sensitivity						Magnitude				Significance
				Conservation status	Intactness	Uniqueness	Degree of non-resilience to change	Degree of difficulty in replacing	Sensitivity	Geographical extent	Duration	Severity	Magnitude	Pre mitigation
Mainland Tunnel Entry Shaft	1	12.1.2	VC, HF, IFF, H&P, DD	High	High	High	High	High	High	Low	High	High	High	High
	2	12.1.3	IFF, H&P, DD, T	High	High	Low	Medium	Medium	High	Low	High	Low	Medium	Moderate
	3	11.3.4	VC, HF, IFF, H&P, AF, T	High	Medium	Low	Low	Low	Medium	Low	High	High	High	Moderate
	4	11.3.4	IFF	High	High	Low	Low	Low	Medium	Negligible	Negligible	Negligible	Negligible	Negligible
	5	11.3.4	IFF	High	High	Low	Low	Low	Medium	Negligible	Negligible	Negligible	Negligible	Negligible
	6	11.3.4	IFF	High	Medium	Low	Low	Low	Medium	Negligible	Negligible	Negligible	Negligible	Negligible
	7	11.3.4	IFF	High	Medium	Low	Low	Low	Medium	Negligible	Negligible	Negligible	Negligible	Negligible
	8	12.3.3	IFF	Very High	Medium	Low	Medium	Medium	High	Negligible	Negligible	Negligible	Negligible	Minor
	9	12.3.7	IFF	Medium	Medium	Low	Low	Medium	Medium	Negligible	Negligible	Negligible	Negligible	Negligible
	10	12.11.14	IFF	High	Medium	Low	Low	Low	Medium	Negligible	Negligible	Negligible	Negligible	Negligible
	11	12.11.14	IFF	High	High	Low	Low	Low	Medium	Negligible	Negligible	Negligible	Negligible	Negligible
Curtis Island Saltpans and fringing mangroves	12	12.1.2	VC, HF, IFF, H&P, DD	High	High	High	High	High	High	Low	High	Medium	Medium	Moderate

Project area	Ecological value	Regional ecosystem	Likely impacts	Sensitivity						Magnitude				Significance
				Conservation status	Intactness	Uniqueness	Degree of non-resilience to change	Degree of difficulty in replacing	Sensitivity	Geographical extent	Duration	Severity	Magnitude	Pre mitigation
	13	12.1.3	VC, HF, IFF, H&P, D	High	High	Low	Medium	Medium	High	Low	High	Medium	Medium	Moderate
Hamilton Point	14	12.2.2	IFF	Very High	High	Very High	High	Very High	Very High	Low	High	Low	Medium	High
	15	12.11.4	VC, IFF	High	Low	Medium	High	High	High	Negligible	Negligible	Negligible	Negligible	Minor
	16	12.11.4	IFF	High	High	Medium	High	High	High	Low	High	Low	Medium	Moderate
	17	12.3.6	IFF	Medium	High	Medium	Low	Low	Medium	Negligible	Negligible	Negligible	Negligible	Negligible
	18	12.11.14	VC, HF, IFF, H&P, DD	High	Medium	Medium	Medium	Medium	Medium	Low	High	High	High	Moderate
	19	12.11.6	VC, HF, IFF, H&P, DD	Medium	High	Low	Low	Low	Medium	Low	High	Medium	Medium	Moderate
	20	12.11.14	VC, HF, IFF, H&P, DD	High	Medium	Low	Low	Low	Medium	Low	High	Medium	Medium	Moderate
	21	12.11.14	VC, HF, IFF, H&P, DD	High	Medium	Low	Low	Low	Medium	Low	High	High	High	Moderate
	22	12.11.14	VC, HF, IFF, H&P, DD	High	High	Low	Low	Low	Medium	Low	High	High	High	Moderate
LNG Plant	23	12.11.14	VC, HF, IFF, H&P, DD	High	High	Low	Low	Low	Medium	Low	High	High	High	Moderate
	24	12.11.6	VC, HF, IFF, H&P, DD, AF	Medium	High	Low	Low	Low	Medium	Low	High	High	High	Moderate
	25	12.11.14	VC, HF, IFF, H&P, DD,	High	Low	Low	Low	Low	Medium	Low	High	High	High	Moderate

Project area	Ecological value	Regional ecosystem	Likely impacts	Sensitivity						Magnitude				Significance
				Conservation status	Intactness	Uniqueness	Degree of non-resilience to change	Degree of difficulty in replacing	Sensitivity	Geographical extent	Duration	Severity	Magnitude	Pre mitigation
			AF											
	26	12.3.7	VC, HF, IFF, H&P, DD, AF	High	High	Low	Low	Low	Medium	Low	High	High	High	Moderate
	27	12.3.3	VC, HF, IFF, H&P, DD, AF	Very High	High	Medium	Medium	Low	High	Low	High	High	High	High
	28	12.3.6	VC, HF, IFF, H&P, DD, AF	Medium	High	Low	Low	Low	Medium	Low	High	High	High	Moderate
	29	12.11.14	VC, HF, IFF, H&P, DD, AF	High	High	Low	Low	Low	Medium	Low	High	High	High	Moderate
	30	12.11.6	VC, HF, IFF, H&P, DD, AF	Medium	High	Low	Low	Low	Medium	Low	High	High	High	Moderate
	31	12.3.3	VC, HF, IFF, H&P, DD, AF	Very High	High	High	Medium	High	High	Low	High	High	High	High
	32	12.11.14	VC, HF, IFF, H&P, DD, AF	High	High	Low	Low	Low	Medium	Low	High	High	High	Moderate
	33	12.3.7	VC, HF, IFF, H&P, DD, AF	Medium	High	Low	Low	Low	Medium	Low	High	High	High	Moderate
	34	12.11.14	VC, HF, IFF, H&P, DD, AF	High	Medium	Low	Low	Low	Medium	Low	High	High	High	Moderate

Project area	Ecological value	Regional ecosystem	Likely impacts	Sensitivity						Magnitude				Significance
				Conservation status	Intactness	Uniqueness	Degree of non-resilience to change	Degree of difficulty in replacing	Sensitivity	Geographical extent	Duration	Severity	Magnitude	Pre mitigation
	35	12.11.14	VC, HF, IFF, H&P, DD, AF	High	Medium	Low	Low	Low	Medium	Low	High	High	High	Moderate
	36	12.11.6	VC, HF, IFF, H&P, DD, AF	High	Medium	Low	Low	Low	Medium	Low	High	High	High	Moderate
Boatshed Point	37	12.11.14	VC, HF, IFF, H&P, DD, AF	High	High	Low	Low	Low	Medium	Low	High	High	High	Moderate
	38	12.11.4	HF, IFF, H&P, DD, AF	High	Medium	High	Medium	Medium	High	Low	High	High	High	High
	39	12.11.14	VC, HF, IFF, H&P, DD, AF	High	High	Low	Low	Low	Medium	Low	High	High	High	Moderate
TWAF 7	40	Non descript regrowth	VC, HF, IFF, H&P, AF	Low	Medium	Very Low	Very Low	Very Low	Low	Low	High	High	High	Minor
TWAF 8	41	11.3.4	VC, HF, IFF, H&P, DD, AF	High	High	Low	Low	Low	High	Low	High	High	High	High
	42	11.3.4	IFF, DD	High	Medium	Low	Low	Low	Medium	Low	High	Medium	Medium	Moderate
	43	11.3.4	VC, HF, IFF, H&P, DD, AF	Medium	Medium	Low	Low	Low	Medium	Low	High	Medium	Medium	Moderate
Launch	44	12.1.2	VC, HF, IFF, H&P,	Low	Low	Medium	Low	High	Medium	Low	High	Medium	Medium	Moderate

Project area	Ecological value	Regional ecosystem	Likely impacts	Sensitivity						Magnitude				Significance
				Conservation status	Intactness	Uniqueness	Degree of non-resilience to change	Degree of difficulty in replacing	Sensitivity	Geographical extent	Duration	Severity	Magnitude	Pre mitigation
Site 1			DD											
	45	12.1.3	VC, HF, IFF, H&P, DD	Medium	Low	Medium	Low	Medium	Medium	Low	High	Medium	Medium	Moderate
Mainland Tunnel Entry Shaft	46	Non-remnant	IFF	Very Low	Very Low	Very Low	Low	Very Low	Very Low	Negligible	Negligible	Negligible	Negligible	Negligible
LNG Plant	47	Non-remnant	VC, HF, IFF, H&P, DD	Low	Very Low	Very Low	Low	Low	Very Low	Low	High	High	High	Minor
	48	Non-remnant	IFF, H&P, DD	Low	Very Low	Very Low	Low	Low	Very Low	Negligible	Negligible	Negligible	Negligible	Negligible
TWAF8	49	Non-remnant	VC, HF, IFF, H&P, DD	Very Low	Very Low	Very Low	Low	Very Low	Very Low	Low	High	High	High	Minor

Legend:

VC = vegetation clearing and disturbance; HF = habitat fragmentation and impacts on wildlife corridors; IFF = introduced flora and fauna; H&P = hydrology and pollution; DD = direct disturbance to fauna; AF= altered fire regimes; T = trenchfall (possible).

VC, HF, IFF, H&P, DD, AF

See also Table 24.

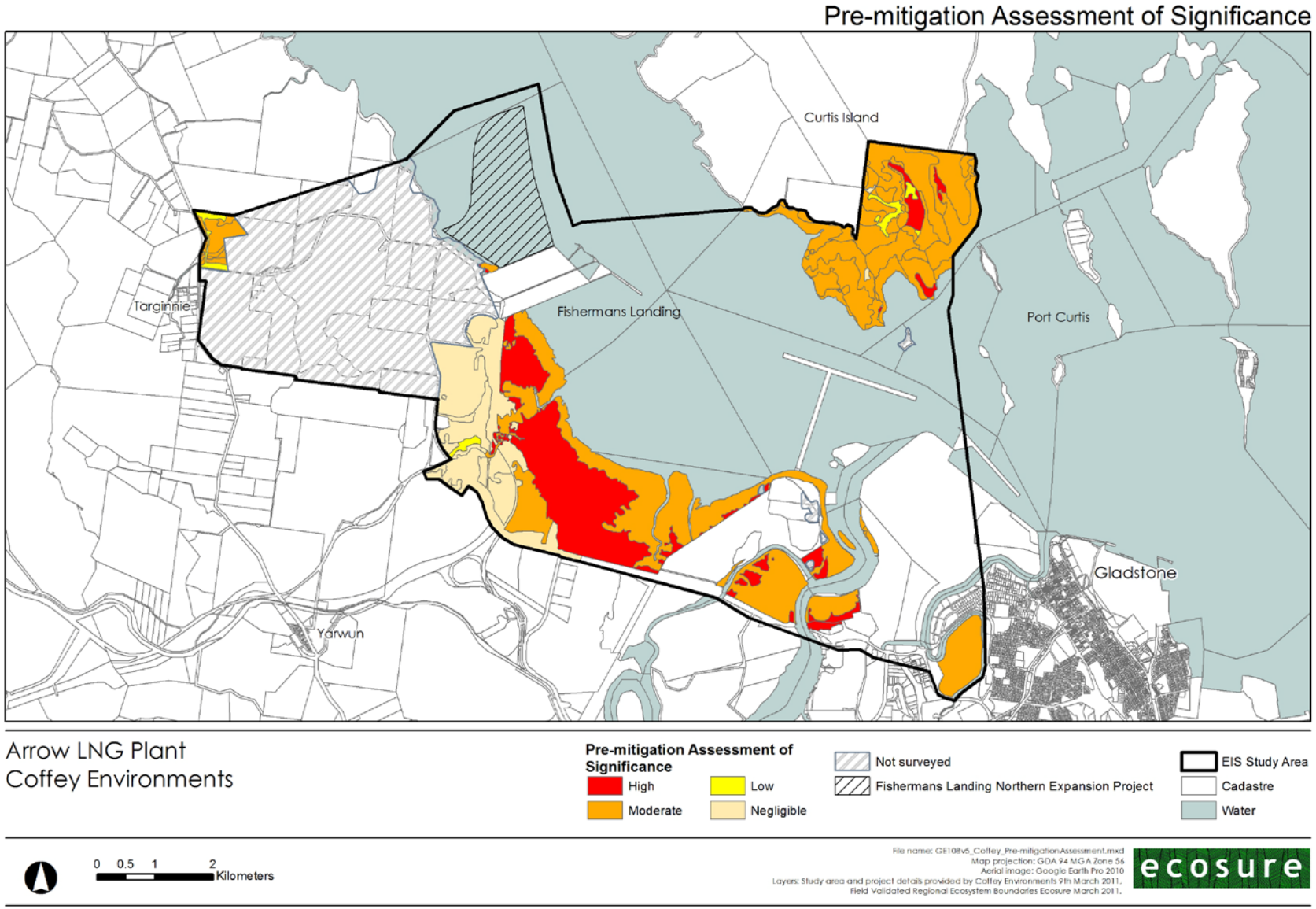


Figure 13 Pre-mitigation assessment of significance

6 Avoidance, Mitigation and Management Measures

This section describes management measures which are recommended for the mitigation of potential impacts (identified in Section 5) to flora and fauna values. Figure 2 illustrates where each ecological value referred to below is located.

In every instance, the preferred hierarchy is to first avoid the impact (i.e., through project design), then minimise the impact (i.e. through mitigation and management). Offsets should only be considered for any residual impact once it can be demonstrated that all attempts have been made to avoid and/or minimise.

It is understood that some areas which may require active management may fall outside of the project site boundaries (i.e. RE 12.2.2 on Hamilton Point). Where this is the case and where practical, any management should be undertaken in consultation with the landowner.

6.1 Designing out Potential Impacts

Consideration was given to minimising impact during the project design phase. As a principle, development within 20 m of the high water mark will be minimised to preserve intertidal and coastal vegetation communities and habitat. A *Cupaniopsis* Reserve has been proposed in order to protect the SEVT vegetation community and *Cupaniopsis* sp. indet. population on Boatshed Point. Development will be avoided where possible within 20 m of the SEVT.

Additional design aspects which have enabled avoidance of certain impacts could include:

- Acid sulfate soils will be managed at the mainland tunnel entry shaft and tunnel spoil disposal area. A comprehensive ASS Management Plan will be developed.
- On Boatshed Point, earthworks will be minimised and opportunities maximised to assimilate the development with the terrain and landform of the headland.
- A viable protection buffer is proposed on the eastern side of Boatshed Point to minimise disturbance on RE 12.1.2 and RE 12.1.3.
- Project activities will where possible avoid the watercourse and minimise disturbance to 'Of Concern' RE. 11.3.4 at TWAF 8 on the basis of preliminary survey findings.

6.2 General Recommendations

Recommendations provided in this section seek to minimise impacts of the project on terrestrial flora and fauna. The recommendations are common to a range of construction and operation activities and should be adopted in all environmental management plans for the project. Avoidance, mitigation and management measures below are in response to those impacts identified in Chapter 5.

Several broad recommendations for flora and fauna related impacts should be implemented, including:

- Areas of significant ecological values that will be retained are to be marked, and access into these areas should be avoided/restricted as much as possible during construction (i.e. no go zones).
- All personnel to attend induction prior to entering the project sites. This should include being made aware of the ecological values present (such as through the provision of a map) and the requirements of the vegetation management plan. This will include being made aware of no go zones.
- All terrestrial ecology related issues should be directed to the project environmental manager.
- A vegetation management plan should be prepared prior to any works on site.

Recommendations are considered industry best practice and have been prepared in consultation with the *Code of Environmental Practice for Onshore Pipelines* (Eco Consulting, 2009).

6.2.1 Vegetation Clearing and Disturbance

Vegetation clearing is inevitable during this project. Disturbance to vegetation and fauna habitat is to be minimised through the adoption of the following recommendations:

Planning

- A vegetation management plan, which details the permit requirements, clearing methods, areas to be cleared and management of vegetation removal is prepared for the project.
- Vegetation clearing is to be minimised to the greatest extent possible, particularly in areas where ecological values are considered to be of high or very high sensitivity (see Figure 12).
- Clearing of native vegetation is undertaken only after all other options are exhausted. Other options include retention of vegetation, selective clearing and trimming of vegetation.
- No vegetation removal shall occur until the applicable permits and approvals are obtained. All vegetation removal will be in strict accordance with approval conditions.
- Prior to initiation of works in ecologically sensitive areas, access tracks are to be clearly demarcated to prevent the establishment of secondary tracks. Existing access tracks are to be used where practicable. The location and design of access tracks should avoid sites of high ecological value or areas of significant weed invasion.
- Where access tracks transect sites of high ecological value or areas of significant weed invasion, site specific environmental management procedures will be investigated and adopted.
- Where possible all construction equipment and infrastructure (such as lay-down areas and construction camps) should be located in areas of existing disturbance. Turn-around areas and working areas should also be located in areas of existing disturbance.
- Areas for vegetation clearing will be clearly demarcated prior to any works in the project area.
- Where clearing cannot be avoided, offsets required under Commonwealth and/or

state legislation should be considered as a last resort. An offset proposal and management plan should be prepared with consideration of Section 7.2 of this report.

Vegetation Clearing

- Mature hollow-bearing trees are to be identified and clearly flagged. Where possible, they should be retained.
- Where hollow bearing trees are removed, where practical, hollows should be salvaged and installed in trees or on the ground in adjacent habitat.
- Trees for retention are to be clearly marked to avoid accidental clearing. The root zone should be adequately protected.
- Selective clearing to maintain connectivity between patches is preferred (such as maintaining connectivity between tree crowns where possible to reduce edge effects associated with increased light penetration).
- Disturbance of ground cover (native vegetation cover, leaf litter, hollow logs) is to be minimised where possible.
- Cleared vegetation and excavated topsoil should be stockpiled on site, so as to minimise impacts to adjacent areas of habitat.
- Stockpiles and equipment laydown areas should avoid the drip line of those trees which will be retained so as to minimise detrimental impact on the root system (this is the area directly located under the outer circumference of the tree branches).
- Regular monitoring of surrounding vegetation for signs of decline in plant vigour and/or dieback, which might occur as a result of changed hydrology or root disturbance from construction activity.

Rehabilitation

- A project Rehabilitation Plan is to be prepared. The Plan should include all disturbed areas and the restoration and maintenance of highly and very highly sensitive areas (see Section 4.10) to maintain and improve ecological values.
- Vegetation removed should be mulched and where possible reused in rehabilitation activities.
- Stockpiled topsoil should be stored away from areas of weed infestation.
- Time between clearing and rehabilitation should be kept to a minimum.
- Rehabilitation should use only local provenance seed and where possible include appropriately sampled threatened species impacted by the project. Collection of seed and vegetative material from any threatened plants shall be conducted in compliance with the *Guidelines for the translocation of threatened plants in Australia – Second Edition* (Vallee *et al.,* 2004) and Queensland Herbarium licenses.
- Monitoring of rehabilitation is conducted regularly by a suitably qualified person.

6.2.2 Habitat Fragmentation and Impacts on Wildlife Corridors

Suggested recommendations to limit impacts on wildlife corridors and habitat include:

- Exclusion fences designed to restrict access to people will be constructed in areas of high habitat value. This should include the area on Boatshed Point with *Cupaniopsis sp*. indet. It should also include fencing along any haul route option which passes in the vicinity of the 'Critically Endangered' RE 12.2.2 on Hamilton Point.
- Fauna proof fencing should be erected in areas of very high and high ecological sensitivity (see Figure 12) to keep fauna out of intensive work areas.
- Mature trees, hollow bearing trees and stags should be retained where possible. If practical, tree limbs containing hollows should be relocated to surrounding undisturbed areas as compensatory habitat.
- Wildlife nest boxes and other habitat enhancements should be considered for their suitability as a mitigation action within any species management plans or fauna management procedures. Any nesting boxes should be tailored for the target species (i.e. see Franks and Franks, 2006) and must have an associated management and monitoring plan developed and implemented.

6.2.3 Introduced Flora and Fauna

The project has the potential to provide for dispersal and establishment of introduced flora and fauna species in areas where they currently do not occur, as well as expansion of pre-existing infestations. Ecosure (2011) provides more specific detail on pest management. Impacts of introduced flora and fauna are to be managed through the adoption of recommendations, which include:

- A weed management plan will be prepared and implemented prior to initiation of construction activities.
- Appropriate weed control strategies are to be developed in accordance with local and regional management guidelines and/or best practice advice prescribed in DERM's pest control factsheet series.
- Implementation of appropriate wash-down procedures prior to and following access to the project area.
- Appropriate waste control measures are to be adopted to minimise new external seed sources for exotic flora.
- Routine monitoring of the project area to identify new or expanding outbreaks of weed infestation.
- Dogs or other companion animals of construction staff and contractors (excluding assistance animals) should be banned from the project area.
- Management of fire ants in accordance with Ecosure (2011).

6.2.4 Hydrology and Pollution

- Regular maintenance and auditing of all plant and equipment will be conducted to check for any leaks or spills (potential or actual).
- Refuelling and lubrication of vehicles and plant equipment will not be undertaken within 50m of a watercourse or waterbody in order to avoid accidental discharge of pollutants.
- Establish appropriate speed limits to reduce risk of potential loss of control into adjacent vegetation as well as the minimisation of dust.

- Adequate erosion and sedimentation measures are to be installed prior to the commencement of any clearing activity, routinely checked during construction operations and following significant rainfall events and removed following successful establishment of rehabilitation ground surface.

6.2.5 Direct Disturbance of Fauna

- Fauna will not be fed, handled or otherwise intimidated. There will be no hunting or trapping unless required for pest management.
- All clearing will be undertaken in the presence of a suitably qualified wildlife spotter-catcher. Spotter-catching will be under the appropriate permits and approvals.
- All handling and management of fauna will be undertaken in compliance with permits issued by Queensland DERM and authorised animal ethics committees.
- Fauna relocation protocols will be developed for fauna displaced or otherwise encountered during construction and operation.
- Impacts of light disturbance during construction and operation will be adequately managed. Lighting will utilise design sympathetic to fauna requirements.
- Disturbance from noise is to be minimised through the use of well maintained plant and equipment which issues the lowest noise output yet serves its intended purpose. Mufflers and baffles to be used where appropriate.
- 'Night caps' should be used over open pipe string ends to minimise fauna entrapment.
- Pipes should be strung with gaps for wildlife access. These should coincide with any known fauna movement areas.

6.2.6 Altered Fire Regimes

- A fire management plan will be developed to ensure infrastructure is adequately protected.
- This plan will all consider to the extent possible, minimising the impacts on native flora and fauna.

6.2.7 -Trenchfall

Following vegetation clearing and grading activities, pipe materials will be delivered to site in preparation for 'stringing', welded, and wrapped in a protective coating. Concurrently (in most cases), a linear trench will be excavated to a depth of up to 1.5 m. Impacts to flora and fauna during this phase of operations are to be minimised through the adoption of the following recommendations:

Planning

- While there are no plans to trench watercourses, if this is to occur, it should be done at the time of year likely to have minimal rainfall events to minimise potential erosion and sedimentation events/breaches. The months of June to August are the driest months in the Capricornia Coast region.

Open excavation

- Fauna proof fencing, erected in areas of ecological significance subject to intensive

work, should minimise the risk of fauna entrapment.

Trenching

- Monitoring of exposure and correct handling/storage of acid sulfate soils shall be implemented as per the ASS Management Plan.
- The amount of time the trench is open is to be minimised as far as practicable, including progressive trenching.
- The trench will be checked at the start of each day by a suitably qualified and authorised wildlife spotter-catcher to remove trapped fauna.
- If any portion of trench is to be left open unchecked for greater than 12 hours, earthern ramps or trench plugs (with a slope less than 45°) should be installed. These should occur at intervals of 1 km or less to assist trapped fauna to leave the trench.
- Protection and refuge areas for wildlife trapped in the trench to be provided at regular intervals (every 250 m). These should include sawdust filled hessian bags to provide wet weather shelter and reduce heat stress.
- Prior to backfilling, the trench should be inspected for fauna.

6.3 Specific Recommendations

Specific measures are provided below to target high and moderately significant impacts on ecological values identified in Table 24 Where offsets are discussed, see Section 7.1 for further information.

6.3.1 Curtis Island LNG Facility, Hamilton Point, Boatshed Point

Within the LNG Plant site, vegetation clearing is inevitable. As avoidance and mitigation are not practical, offsets may be required under Commonwealth and/or state legislation to partially compensate for the loss of ecological values. This is particularly pertinent for the two areas of 'Endangered' (VMA) remnant vegetation (RE 12.3.3; Values 27 and 31).

Within the saltpans and fringing mangroves (RE's 12.1.2 and 12.1.3; values 12 and 13) disturbance should be kept to a minimum. Shorebird populations should be monitored (see Section 9).

With consideration to operational requirements the lighting around the perimeter of the LNG Facility should be designed to minimise impacts on roosting shorebirds. Lowest possible luminescent globes should be used in sensitive areas, particularly around intertidal areas.

On Boatshed Point, the construction camp and associated infrastructure will result in permanent loss of most vegetation. Offsets should be provided where the project footprint cannot be minimised. The Cupaniopsis Reserve (Value 38) on Boatshed Point and RE 12.2.2 (Value 14) on Hamilton Point will both need to be specifically considered in the Rehabilitation Plan and must be subject to active management, carried out by suitably qualified bush regenerators. Management activities will need to take into account any requirements of state or federal government once the *Cupaniopsis* sp. indet. receives formal classification. The

recovery plan for SEVT should be considered when developing detailed management actions for Value 14 (DEWHA, 2009e).

Exclusion fences designed to restrict access should be erected, at a minimum, on the boundary of the project area with the Curtis Island Environmental Management Precinct, surrounding the Cupaniopsis Reserve, and along the stretch of any roadway which passes within 100 m of RE 12.2.2 on Hamilton Point (Value 14).

6.3.2 Mainland Tunnel Entry Shaft and Tunnel Spoil Disposal Area

Lighting during construction positioned along the causeway at mainland tunnel entry shaft and tunnel spoil disposal area should be designed to minimise impacts on roosting shorebirds. With consideration to operational requirements the lowest possible luminescent globes should be used in sensitive areas, particularly around intertidal areas.

Where possible, project activity will be kept a minimum of 165-255 m from shorebird foraging and roosting habitat (from DEWHA, 2009b), such as at mainland tunnel entry shaft and tunnel spoil disposal area.

The spoil area would preferably be outside of RE 12.1.2 to minimise the impact on shorebirds. If this is not possible, the footprint of the spoil area should be minimised and managed to avoid sediment and ASS mobilisation onto the surrounding vegetation communities.

Access to the saltpans and fringing mangroves (RE 12.1.2 and 12.1.3) outside the footprint of the mainland tunnel entry shaft and tunnel spoil disposal area should be prohibited.

Offsets may be required to address unavoidable impacts on marine plants in RE12.1.2 and 'Of Concern' vegetation in RE 11.3.4.

6.3.3 TWAF 8

Pre-clearing surveys should cover this area (see Section 9.1).

The waterway in the area of high value regrowth 'Of Concern' in a regulated area (RE 11.3.4; Value 42) should be avoided. A buffer to the watercourse should be established and any bridge and culvert designs should enable natural flow and passage of fish and aquatic invertebrates.

Project design should seek to avoid direct disturbance to areas of RE 11.3.4 ('Of Concern') remnant vegetation and high value regrowth (Values 41 and 43). Where avoidance is not possible, offsets may need to be considered. See Section 7.1 for more clarification on offset requirements.

Where impacts are not permanent, rehabilitation should seek to restore the site to pre-clearing vegetation type (i.e., pre-European settlement).

6.3.4 TWAF 7

Pre-clearing surveys should cover this area (see Section 9.1).

Standard environmental controls and implementation of general recommendations outlined above should be sufficient at this site due to the lack of significant ecological value identified at the site.

As with TWAF 8, where impacts are not permanent, rehabilitation should seek to restore the site to pre-clearing vegetation type (i.e., pre-European settlement).

6.3.5 Launch Site 1

Standard environmental controls should be sufficient at this site unless it is found to support significant species such as water mouse. Pre-clearing surveys should cover this area (see Section 9.1).

7 Residual Impacts

Residual impacts are impacts which continue to affect ecological values following the successful implementation of mitigation measures. The assessment of residual impacts assumes that *all* recommendations for the mitigation of impacts on detailed in Section 6 of this report are implemented successfully.

The general management measures described in Section 6 are recommended for the mitigation of the potential impacts detailed in Section 5. Additional mitigation is required only in those instances where these general measures do not adequately reduce the significance of the impact.

With successful implementation of the recommended mitigation strategies, the magnitude of impact will be reduced in most cases, in many cases reducing the overall significance rating of the impact of the project on terrestrial flora and fauna. Of the 49 ecological values assessed, 21 have either a negligible or low significance once mitigation is applied. Twenty five will have a moderate residual impact. Table 27 below describes the significance of impact pre and post-mitigation. Figure 2 shows the location of each ecological value.

Due to the high sensitivity of many of the ecological values, coupled with the long term duration of many expected impacts, there are three values where the significance has remained high. These include Value 1, Value 27 and Value 31. Those values with high residual significance, as well as those of note (where pre-mitigation significance was high but has now been reduced) are discussed below.

Curtis Island

Two ecological values will have a high residual impact in this area, Value 27 and 31. These are both an 'Endangered' RE (12.3.3) and will be permanently cleared as part of the project. It is likely that suitable offsets will need to be found to partially compensate for the loss of these values.

Value 38 has been downgraded from a high pre-mitigation significance to a moderate residual impact. This assumes that there will be minimal clearing of *Cupaniopsis* sp. indet. and that this species will be adequately protected within the proposed *Cupaniopsis* reserve.

Mainland tunnel entry shaft and tunnel spoil disposal area

Value 1 (RE 12.1.1) at the mainland tunnel entry shaft and tunnel spoil disposal area remains of high significance following mitigation. This is because impacts to the saltpans and shorebird habitat will be permanent and are considered difficult to offset like for like.

TWAF 8

Value 41 (RE 11.3.4) has been downgraded from a high pre-mitigation significance to a moderate post-mitigation significance. This assumes that disturbance is minimised and that a suitable offset can be found for the 'Of Concern' remnant vegetation present.

Table 27 Residual significance, following the application of mitigation measures

Project Area	Ecological Value	Regional Ecosystem	Likely Impacts	Sensitivity	Pre Mitigation		Mitigation	Revised Magnitude				Residual Significance
					Magnitude	Significance		Geographical extent	Duration	Severity	Magnitude	
Mainland Tunnel Entry Shaft	1	12.1.2	VC, HF, IFF, H&P, DD, T	High	High	High	Monitor shorebird populations before, during and after construction to ensure shorebird behaviours are essentially unaffected. Reconsider location of spoil and minimise overall footprint. Like for like offset very difficult.	Low	High	High	High	High
	2	12.1.3	VC, HF, IFF, H&P, DD, T	High	Medium	Moderate	Avoidance.	Low	Low	Low	Low	Moderate
	3	11.3.4	VC, HF, IFF, H&P, AF, T	Medium	High	Moderate	Minimise footprint. Offset remainder.	Low	Medium	Medium	Medium	Moderate
	4	11.3.4	IFF	Medium	Negligible	Negligible	Avoidance.	Negligible	Negligible	Negligible	Negligible	Negligible
	5	11.3.4	IFF	Medium	Negligible	Negligible	Avoidance.	Negligible	Negligible	Negligible	Negligible	Negligible
	6	11.3.4	IFF	Medium	Negligible	Negligible	Mitigation unnecessary.	Negligible	Negligible	Negligible	Negligible	Negligible
	7	11.3.4	IFF	Medium	Negligible	Negligible	Mitigation unnecessary.	Negligible	Negligible	Negligible	Negligible	Negligible
	8	12.3.3	IFF	High	Negligible	Low	Standard environmental controls.	Negligible	Negligible	Negligible	Negligible	Minor

Project Area	Ecological Value	Regional Ecosystem	Likely Impacts	Sensitivity	Pre Mitigation		Mitigation	Revised Magnitude				Residual Significance
					Magnitude	Significance		Geographical extent	Duration	Severity	Magnitude	
	9	12.3.7	IFF	Medium	Negligible	Negligible	Mitigation unnecessary.	Negligible	Negligible	Negligible	Negligible	Negligible
	10	12.11.14	IFF	Medium	Negligible	Negligible	Mitigation unnecessary.	Negligible	Negligible	Negligible	Negligible	Negligible
	11	12.11.14	IFF	Medium	Negligible	Negligible	Mitigation unnecessary.	Negligible	Negligible	Negligible	Negligible	Negligible
Curtis Island Saltpans and fringing mangroves	12	12.1.2	VC, HF, IFF, H&P, DD	High	Medium	Moderate	Monitor shorebird populations before and during construction to ensure shorebird behaviours are essentially unaffected.	Low	High	Medium	Medium	Moderate
	13	12.1.3	VC, HF, IFF, H&P, D	High	Medium	Moderate	Minimise footprint.	Low	Medium	Medium	Medium	Moderate
Hamilton Point	14	12.2.2	IFF	Very High	Medium	High	Even though these areas can be avoided, they will need to be actively managed to maintain values.	Low	Medium	Low	Low	Moderate
	15	12.11.4	VC, IFF	High	Negligible	Low	Standard environmental controls.	Negligible	Negligible	Negligible	Negligible	Minor
	16	12.11.4	IFF	High	Medium	Moderate	Even though these areas can be avoided, they will need to be actively managed to maintain values.	Low	Medium	Low	Low	Minor

Project Area	Ecological Value	Regional Ecosystem	Likely Impacts	Sensitivity	Pre Mitigation		Mitigation	Revised Magnitude				Residual Significance
					Magnitude	Significance		Geographical extent	Duration	Severity	Magnitude	
	17	12.3.6	IFF	Medium	Negligible	Negligible	Standard environmental controls.	Negligible	Negligible	Negligible	Negligible	Negligible
	18	12.11.14	VC, HF, IFF, H&P, DD	Medium	High	Moderate	Minimise footprint. Offset remainder.	Low	Medium	Medium	Medium	Moderate
	19	12.11.6	VC, HF, IFF, H&P, DD	Medium	Medium	Moderate	Minimise footprint. Offset remainder.	Low	Medium	Low	Low	Minor
	20	12.11.14	VC, HF, IFF, H&P, DD	Medium	Medium	Moderate	Minimise footprint. Offset remainder.	Low	Medium	Low	low	Minor
	21	12.11.14	VC, HF, IFF, H&P, DD	Medium	High	Moderate	Offset and minimise footprint.	Low	Medium	Medium	Medium	Moderate
	22	12.11.14	VC, HF, IFF, H&P, DD	Medium	High	Moderate	Offset and minimise footprint.	Low	Medium	Medium	Medium	Moderate
LNG Plant	23	12.11.14	VC, HF, IFF, H&P, DD	Medium	High	Moderate	Offset and minimise footprint.	Low	Medium	Medium	Medium	Moderate
	24	12.11.6	VC, HF, IFF, H&P, DD, AF	Medium	High	Moderate	Offset and minimise footprint.	Low	Medium	Medium	Medium	Moderate
	25	12.11.14	VC, HF, IFF, H&P, DD, AF	Medium	High	Moderate	Offset and minimise footprint.	Low	Medium	Medium	Medium	Moderate
	26	12.3.7	VC, HF, IFF,	Medium	High	Moderate	Offset and minimise footprint.	Low	Medium	Medium	Medium	Moderate

Project Area	Ecological Value	Regional Ecosystem	Likely Impacts	Sensitivity	Pre Mitigation		Mitigation	Revised Magnitude				Residual Significance
					Magnitude	Significance		Geographical extent	Duration	Severity	Magnitude	
			H&P, DD, AF									
	27	12.3.3	VC, HF, IFF, H&P, DD, AF	High	High	High	Offset.	Low	High	Medium	High	High
	28	12.3.6	VC, HF, IFF, H&P, DD, AF	Medium	High	Moderate	Offset and minimise footprint.	Low	Medium	Medium	Medium	Moderate
	29	12.11.14	VC, HF, IFF, H&P, DD, AF	Medium	High	Moderate	Offset and minimise footprint.	Low	Medium	Medium	Medium	Moderate
	30	12.11.6	VC, HF, IFF, H&P, DD, AF	Medium	High	Moderate	Offset and minimise footprint.	Low	Medium	Medium	Medium	Moderate
	31	12.3.3	VC, HF, IFF, H&P, DD, AF	High	High	High	Offset.	Low	High	Medium	High	High
	32	12.11.14	VC, HF, IFF, H&P, DD, AF	Medium	High	Moderate	Offset and minimise footprint.	Low	Medium	Medium	Medium	Moderate
	33	12.3.7	VC, HF, IFF, H&P, DD, AF	Medium	High	Moderate	Offset and minimise footprint.	Low	Medium	Medium	Medium	Moderate
	34	12.11.14	VC, HF, IFF, H&P, DD, AF	Medium	High	Moderate	Offset and minimise footprint.	Low	Medium	Medium	Medium	Moderate
	35	12.11.14	VC, HF, IFF, H&P, DD, AF	Medium	High	Moderate	Standard environmental controls.	Low	Medium	Medium	Medium	Moderate
	36	12.11.6	VC, HF, IFF, H&P, DD, AF	Medium	High	Moderate	Offset and minimise footprint.	Low	Medium	Medium	Medium	Moderate

Project Area	Ecological Value	Regional Ecosystem	Likely Impacts	Sensitivity	Pre Mitigation		Mitigation	Revised Magnitude				Residual Significance
					Magnitude	Significance		Geographical extent	Duration	Severity	Magnitude	
Boatshed Point	37	12.11.14	VC, HF, IFF, H&P, DD, AF	Medium	High	Moderate	Offset and minimise footprint.	Low	Medium	Medium	Medium	Moderate
	38	12.11.4	HF, IFF, H&P, DD, AF	High	High	High	Retain as much as possible. Fence off Cupaniopsis area and actively manage. Offset remainder.	Low	Medium	Medium	Medium	Moderate
	39	12.11.14	VC, HF, IFF, H&P, DD, AF	Medium	High	Moderate	Offset and minimise footprint.	Low	Medium	Medium	Medium	Moderate
TWAF 7	40	Non descript regrowth	VC, HF, IFF, H&P, AF	Low	High	Moderate	Offset and minimise footprint.	Low	Medium	Medium	Medium	Minor
TWAF 8	41	11.3.4	VC, HF, IFF, H&P, DD, AF	High	High	High	Standard environmental controls, including rehabilitation. Offset remnant vegetation and seek to minimise footprint.	Low	Medium	Medium	Medium	Moderate
	42	11.3.4	IFF, DD	Medium	Medium	Moderate	Avoidance, buffer to watercourse, bridge designed not to inhibit flow, weed management,	Low	Medium	Low	Low	Minor
	43	11.3.4	VC, HF, IFF, H&P, DD, AF	Medium	Medium	Moderate	Standard environmental controls, including rehabilitation. Offset remnant vegetation and	Low	Medium	Medium	Medium	Moderate

Project Area	Ecological Value	Regional Ecosystem	Likely Impacts	Sensitivity	Pre Mitigation		Mitigation	Revised Magnitude				Residual Significance
					Magnitude	Significance		Geographical extent	Duration	Severity	Magnitude	
							seek to minimise footprint.					
Launch Site 1	44	12.1.2	VC, HF, IFF, H&P, DD	Medium	Medium	Moderate	Standard environmental controls, including rehabilitation. Seek to minimise footprint.	Low	Medium	Low	Low	Minor
	45	12.1.3	VC, HF, IFF, H&P, DD	Medium	Medium	Moderate	Standard environmental controls, including rehabilitation. Seek to minimise footprint.	Low	Medium	Low	Low	Minor
Mainland Tunnel Entry Shaft	46	non-rem	IFF	Very Low	Negligible	Negligible	Standard Environmental controls	Negligible	Negligible	Negligible	Negligible	Negligible
LNG Plant	47	non-rem	VC, HF, IFF, H&P, DD	Very Low	High	Minor	Offset and minimise footprint	Low	Medium	Medium	Medium	Minor
	48	non-rem	IFF, H&P, DD	Very Low	Negligible	Negligible	Standard Environmental controls	Negligible	Negligible	Negligible	Negligible	Negligible
TWAF8	49	non-rem	VC, HF, IFF, H&P, DD	Very Low	High	Minor	Offset and minimise footprint	Low	Medium	Medium	Medium	Minor

Legend:

VC = vegetation clearing and disturbance; HF = habitat fragmentation and impacts on wildlife corridors; IFF = introduced flora and fauna; H&P = hydrology and pollution; DD = direct disturbance to fauna; AF= altered fire regimes; T = trenchfall (possible).
See also Table 24.

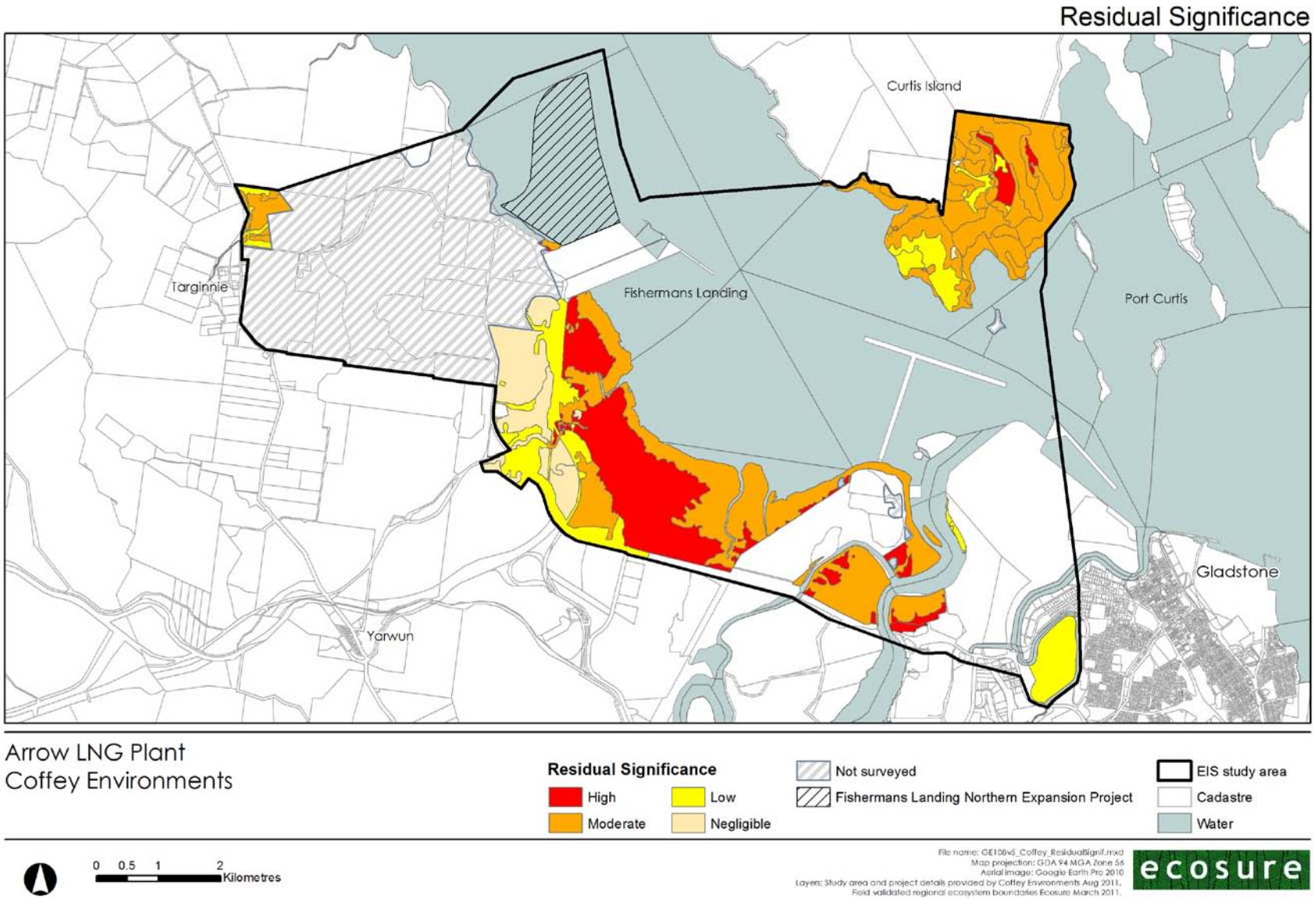


Figure 14 Post-mitigation assessment of significance

7.1 Environmental Offsets

Table 28 describes those terrestrial ecological values which are likely to require an offset and the likely difficulty of finding a suitable offset receiving site.

Table 28 Likely offset requirements for those ecological values with a high residual impact.

Value	Regional Ecosystem (RE)	Status (VMA)	Total present within the study area (ha)	Area to be cleared (ha)	Likely offset policy trigger	Degree of difficulty in replacing
Regional ecosystem	11.3.4	Of Concern	285.11	46.4	Policy for Vegetation Management Offsets	Low
Regional ecosystem	12.11.14	Of Concern	244.63	123.38	Policy for Vegetation Management Offsets	Low/medium
Regional ecosystem	12.11.4	Of Concern	7.54	3.91	Policy for Vegetation Management Offsets	Medium/high
Regional ecosystem	12.3.3	Endangered	32.48	25.69	Policy for Vegetation Management Offsets	Medium/high
High value regrowth	11.3.4	Of Concern	57.49	8.03	Regrowth Vegetation Code	Low
Essential Habitat	n/a	n/a	864.71	46.4	Policy for Vegetation Management Offsets	Low
Cupaniopsis sp. indet	n/a	Status pending	n/a	n/a	Biodiversity Offsets Policy (QLD) and/or EPBC Act	High

While offsets are generally considered to partially negate an impact, there is a degree of risk associated with offsets. Offsets may not necessarily be 'like for like' which means that impacts to specific vegetation communities might not be directly compensated for. While offsets assist in balancing the overall ecological impact, they cannot guarantee that the residual impact on particular ecological values will be reduced.

At both the federal and state level, environmental offsets are applied where impacts on ecological values cannot be avoided or adequately mitigated. The **Draft Policy Statement: Use of environmental offsets under the *Environment Protection and Biodiversity Conservation Act 1999*** (Department of the Environment and Water Resources, 2007) guides the form an offset should take for impacts on matters related to the EPBC Act. For matters related to state (Qld) legislation, offsets are governed by specific-issue offset policies.

Where an offset is triggered by both the Commonwealth and the state, the Federal and Queensland governments will work together to coordinate the offset requirements (EPA, 2008b).

7.1.1 Commonwealth Government Offset Requirements

Environmental offsets may not be applicable to all projects assessed under the EPBC Act. The scale and intensity of the impacts are considered on a case-by-case basis, in addition to the potential for conservation outcomes through offsets.

Where offsets are required, the objective is to maintain or enhance the health, diversity and productivity of the environment as it relates to matters protected by the EPBC Act (i.e. matters of national environmental significance and the environment more broadly for actions involving the Commonwealth) (see Section 4.9.1).

Offsets may be either direct, indirect, or a package consisting of both. Direct offsets may encompass securing in perpetuity existing habitat, restoring and securing degraded habitat, or re-establishing habitat. Indirect offsets might include contributing to research, implementing recovery plan actions, removing threatening processes or contributing to trust funds for consolidated purchase and restoration of strategic habitat. The draft policy prefers direct offsets, as they are more likely to deliver conservation outcomes.

There are eight policy principles which need to be demonstrated for any proposed offset under the EPBC Act (from Department of the Environment and Water Resources, 2007):

1. Environmental offsets should be targeted to the matter protected by the EPBC Act that is being impacted.

2. A flexible approach should be taken to the design and use of environmental offsets to achieve long-term and certain conservation outcomes which are cost effective for proponents.

3. Environmental offsets should deliver a real conservation outcome.

4. Environmental offsets should be developed as a package of actions - which may include both direct and indirect offsets.

5. Environmental offsets should, as a minimum, be commensurate with the magnitude of the impacts of the development and ideally deliver outcomes that are 'like for like'.

6. Environmental offsets should be located within the same general area as the development activity.

7. Environmental offsets should be delivered in a timely manner and be long lasting.

8. Environmental offsets should be enforceable, monitored and audited.

The Department of the Environment and Water Resources (2007) provides greater guidance on each of these policy principles.

7.1.2 Queensland State Government Offset Requirements

The **Queensland Government Environmental Offsets Policy** (EPA, 2008b) is the framework for all offset policies in the state. This is based on seven policy principles:

1. Offsets will not replace or undermine existing environmental standards or regulatory requirements, or be used to allow development in areas otherwise prohibited through legislation or policy.

2. Environmental impacts must first be avoided, then minimised, before considering the use of offsets for any remaining impact.

3. Offsets must achieve an equivalent or better environmental outcome.

4. Offsets must provide environmental values as similar as possible to those being lost.

5. Offset provision should minimise the time-lag between the impact and delivery of the offset.

6. Offsets must provide additional protection to environmental values at risk, or additional management actions to improve environmental values.

7. Offsets must be legally secured for the duration of the offset requirement.

For significant projects, the Coordinator-General may require offsets for impacts to ecological values not currently covered by a specific-issue offsets policy. In this case, the principles and guidelines of the Policy (EPA, 2008b) will be adhered to when setting offset conditions.

In addition, the *Environmental Protection and Other Acts Amendment Act 2011* came into force in April. This act amends the EP Act, the NCA and the SPA. It makes it clear that an administering authority can impose an environmental offset condition onto resource companies undertaking mining and petroleum activities.

Queensland specific-issue offset policies do not require offsets for impacts to ecological values that have already been captured under other specific-issue offset policies.

Specific-issue offset policies and the potential offset requirements of the Arrow LNG Plant are discussed below.

Policy for Vegetation Management Offsets

Under the VMA, DERM (2009b) may require a direct offset for impacts to connectivity, watercourses, wetlands, essential habitat, assessable vegetation associated with a wetland and remnant vegetation which is an 'Endangered' or 'Of Concern' regional ecosystem (DERM 2009e) Part S). There are a number of restrictions about what can be used as an offset receiving site. Unsuitable sites include mapped remnant vegetation (unless the area has a valid clearing approval and would otherwise be cleared) and regrowth vegetation in a restricted area (essential regrowth habitat, stream protection zones, within wetland protection areas, on slopes greater than 12%) under the regrowth vegetation code.

An offset receiving site must be in the same broad vegetation group as the impact site as well as meeting specific criteria, which are detailed in DERM (2009b).

The offset replacement ratio is negotiated with DERM but may be in the order of 5:1 of the impact area. The offset agreement remains in effect and the proponent is required to manage the offset receiving site until it:

- Has achieved remnant status; and
- Is a regional ecosystem; and where applicable,
- Includes at least three essential habitat factors for the protected wildlife that must include any essential habitat factors that are stated as mandatory for the protected wildlife in the essential habitat database; OR
- Is in an area in which the protected wildlife, at any stage of its life cycle, is located.

Whilst not a specific-issue offset policy, the Regrowth Vegetation Code (DERM, 2009a) may require the identification and/or acquisition of 'exchange areas' prior to approving the clearance of regulated regrowth and regrowth watercourse vegetation. The replacement ratio must be a minimum of 2:1 (i.e. twice the size of the area impacted). Section 4 of DERM (2009b) provides guidance on best management practice for exchange areas.

The Policy for Vegetation Management Offsets is expected to be revised in late 2011.

Draft Biodiversity Offsets Policy

DERM is likely to require an offset under the NCA to address impacts to biodiversity values where a state government agency is the assessment manager or a concurrence agency (EPA, 2008a). For significant projects under Part 4 of the SDPWO Act, the Coordinator-General (in consultation with DERM), may require an appropriate offset which could consist of:

- An offset package which delivers the environmental outcomes sought for each biodiversity value impacted, with minimal time lag between the impact and achievement of the desired outcome. The offset amount will be up to five times the size of the impacted area. The offset may be direct (acquiring and restoring land) and/or indirect (removing threats, implementing aspects of a Recovery Plan or similar); or
- A financial contribution, based on the cost of acquiring and restoring suitable land, with a multiplier of up to five times the impacted area.

The project area contains biodiversity values that may require:

- offsets to address the viability of endangered, vulnerable, near threatened species populations and their habitat (Sections 4.2, 4.3, 4.6 and 4.7)
- offsets to address the extent of 'Endangered' and 'Of Concern' regional ecosystems, as well as other significant regional ecosystem values (remnant vegetation in subregions with <30% remnant vegetation, or areas that may be a part of a large tract or terrestrial landscape corridor).

The Draft Biodiversity Offsets Policy is expected to be finalised and released in late 2011.

Mitigation and Compensation for Works or Activities Causing Marine Fish Habitat Loss

The Fish Habitat Management Operational Policy (Dixon & Beumer, 2002) applies to all development applications under the Fisheries Act, where marine fish habitat (including marine plants and lands within declared Fish Habitat Areas) is to be permanently or temporarily lost, or otherwise modified, causing loss of fisheries resources and fish habitats.

This policy considers mitigation and compensation to offset fisheries resource losses. Mitigating or compensating actions can include:

- Best practice methodologies.
- Habitat productivity enhancement.
- Restoration or replacement of fish habitat.
- Fisheries resource research and education support.
- The payment of bonds (held towards ensuring that impacts are minimal).
- Fish habitat creation.
- Fish habitat acquisition/ exchange (relinquishment of private tenure).
- Fisheries stock enhancement.

The potential impacts associated with the Arrow LNG Plant which might require an offset under the Fisheries Act include:

- Reclamation of tidal land and spoil disposal (such as from the proposed causeway and dredged spoil placement in the mainland tunnel entry shaft and tunnel spoil disposal area).
- Removal of yabby banks, crab communities (which may occur within RE 12.1.3 and RE 12.1.2).
- Changes to water quality and hydraulics (e.g. removal of tidal influence).
- Exposure of acid sulfate soils and acid leachate in watercourses (such as may occur in the mainland tunnel entry shaft and tunnel spoil disposal area as a result of dredging activities).
- Physical changes to natural substrates which will impede marine plant colonisation (revetments) (such as from the proposed causeway out to the tunnel entry in the mainland tunnel entry shaft and tunnel spoil disposal area).
- Loss of marine plants (such as from within RE 12.1.3 and RE 12.1.2).

The marine ecology report for this project (Coffey Environments, 2011a) includes detailed information regarding the impacts of the project and potential offset requirements.

8 Cumulative Impacts

The proposed project will impact on terrestrial flora and fauna ecological values, both within and adjacent to the project area. Chapters 5 and 7 provide detail on the expected impacts. When construction and operation of the Arrow LNG Plant is considered in conjunction with similar projects being undertaken in the Gladstone region, it is apparent that there is potential for cumulative impacts on terrestrial flora and fauna. The individual impacts of these projects may not be highly significant when considered separately, however where impacts overlap, a more concentrated effect may be established.

Appendix G details the projects included in this assessment of cumulative impacts. The table below (Table 29) summarises the expected areas of impact each project will have, based on available information in their EIS's. Cumulative impacts are discussed in terms of the likely impact they will have on a particular value within the bioregion.

Baseline projects are those which have been approved. The other projects considered below are those currently being assessed or which are likely to be assessed shortly.

Table 29 Assessment of likely impacts of each project included in the cumulative impacts assessment (*= baseline project).

Projects	Impact						
	Vegetation Clearance and Disturbance	**Habitat Fragmentation and Impacts on Wildlife Corridors**	**Introduced Flora and Fauna**	**Hydrology and Pollution**	**Direct Disturbance of Fauna**	**Altered Fire Regimes**	**Trenchfall**
Australia Pacific LNG	■	■	■	■	■		
Western Basin Strategic Dredging and Disposal Project			■				
Fishermans Landing Northern Expansion Project	■	■					
Arrow Surat Pipeline Project	■	■	■	■			
Central Queensland Pipeline Project	■	■	■				
Wiggins Island Coal Terminal Project	■	■	■	■	■		
Gladstone Nickel Project	■	■	■				
Gladstone Steel Plant Project	■	■					
Moura Link-Aldoga Rail Project	■	■	■	■	■		
Gladstone-Fitzroy Pipeline Project	■	■	■	■	■		
Hummock Hill Community Project	■	■			■		
Boyne Island Aluminium Smelter Extension of Reduction Lines Project	■			■			
Queensland Curtis LNG Project*	■	■	■	■	■	■	
Gladstone LNG Project*	■	■	■	■	■		■

Projects	Impact						
	Vegetation Clearance and Disturbance	Habitat Fragmentation and Impacts on Wildlife Corridors	Introduced Flora and Fauna	Hydrology and Pollution	Direct Disturbance of Fauna	Altered Fire Regimes	Trenchfall
Yarwun Alumina Refinery Expansion Project*							

8.1 Vegetation Clearance and Disturbance

Vegetation clearing is a potential impact for the majority of projects considered. The combined clearing of regulated vegetation across all projects, where this information is readily available, is illustrated in Table 30.

Table 30 Cumulative impact of clearing regulated vegetation within the Gladstone region and within the state.

Environmental Value	Area proposed to be cleared (ha)																Total area proposed to be cleared (ha)	Current extent of RE in Gladstone local government area (ha) (Accad et al, 2008)	Current extent of RE in QLD (ha) (Accad et al, 2008)	Representation of area proposed to be cleared compared to RE extent in Gladstone local government area (%)	Representation of area proposed to be cleared compared to RE extent in QLD (%)
Regional Ecosystem (RE)	Project																				
	Arrow LNG Plant	Australia Pacific LNG	Western Basin Strategic Dredging and Disposal Project	Fishermans Landing Northern Expansion Project	Arrow Surat Pipeline Project	Central Queensland Pipeline Project#	Wiggins Island Coal Terminal Project	Gladstone Nickel Project*	Gladstone Steel Plant Project*	Moura Link-Aldoga Rail Project	Gladstone-Fitzroy Pipeline Project	Hummock Hill Community Project	Boyne Island Aluminium Smelter Extension of Reduction Lines Project	Queensland Curtis LNG Project (LNG Component)º	Gladstone LNG Project (LNG Facility plus Gas Pipeline)º	Yarwun Alumina Refinery Expansion Projectº					
11.11.15	0.0	-	-	-	-	-	-	89.7	-	33.1	1.4	-	-	-	25.1	-	149.3	39,794.0	531,315.0	0.4	0.03
11.11.18	0.0	-	-	-	-	-	-	-	-	0.8	-	-	-	-	-	-	0.8	2,051.0	4,519.0	0.0	0.02
11.3.4	46.4	-	-	-	-	-	-	190.5	190.0	58.6	0.5	-	-	-	0.9	-	486.9	6,017.0	186,656.0	8.1	0.26
12.1.2	59.39	29.5	-	0.5	-	-	-	18.6	-	-	-	-	-	3.4	9.7	-	121.09	15,657.0	28,532.0	0.8	0.42
12.1.3	5.78	-	-	1.9	-	-	-	-	-	-	-	-	-	8.0	4.8	-	20.48	17,646.0	50,481.0	0.1	0.04
12.11.14	123.4	26.4	-	-	0.0	-	8.9	-	-	-	5.3	-	-	11.8	24.2	-	199.9	3,495.0	30,127.0	5.7	0.66
12.11.6	71.5	73.1	-	-	4.0	-	47.6	48.3	-	-	5.3	-	-	119.2	114.5	-	483.4	93,264.0	241,676.0	0.5	0.20
12.11.4	3.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.0	2,995.0	3,081.0	0.1	0.10
12.2.2	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	0.4	-	0.4	2,552.0	2,683.0	0.0	0.01
12.3.3	25.7	-	-	-	1.3	-	89.1	2.3	-	-	-	4.0	-	39.6	40.5	-	202.6	20,638.0	42,963.0	1.0	0.47

Environmental Value	Area proposed to be cleared (ha)																Total area proposed to be cleared (ha)	Current extent of RE in Gladstone local government area (ha) (Accad et al, 2008)	Current extent of RE in QLD (ha) (Accad et al, 2008)	Representation of area proposed to be cleared compared to RE extent in Gladstone local government area (%)	Representation of area proposed to be cleared compared to RE extent in QLD (%)
Regional Ecosystem (RE)	Project																				
	Arrow LNG Plant	Australia Pacific LNG	Western Basin Strategic Dredging and Disposal Project	Fishermans Landing Northern Expansion Project	Arrow Surat Pipeline Project	Central Queensland Pipeline Project#	Wiggins Island Coal Terminal Project	Gladstone Nickel Project*	Gladstone Steel Plant Project*	Moura Link-Aldoga Rail Project	Gladstone-Fitzroy Pipeline Project	Hummock Hill Community Project	Boyne Island Aluminium Smelter Extension of Reduction Lines Project	Queensland Curtis LNG Project (LNG Component)º	Gladstone LNG Project (LNG Facility plus Gas Pipeline)º	Yarwun Alumina Refinery Expansion Projectº					
12.3.6	3.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,868.0	14,032.0	0.0	0.00
12.3.7	4.2	1.3	-	-	0.1	-	-	1.2	-	-	-	-	-	0.3	-	-	7.1	8,908.0	53,259.0	0.1	0.01
Brigalow community	-	-	-	-	-	17	-	-	-	-	-	-	-	-	-	-	17.0	-	-	-	-
Bluegrass community	-	-	-	-	-	7.0	-	-	-	-	-	-	-	-	-	-	7.0	-	-	-	-
Endangered RE's	-	-	-	-	-	23	-	-	-	-	-	-	-	-	-	-	23.0	-	-	-	-
Of concern RE's	-	-	-	-	-	46	-	-	-	-	-	-	-	-	-	-	46.0	-	-	-	-
Least concern RE's	-	-	-	-	-	140	-	-	-	-	-	-	-	-	-	-	140.0	-	-	-	-

^ denotes that it is possibly that particular RE

* denotes areas of RE's within project area, not areas that will be cleared

ºdenotes baseline project

# denotes that the areas of the EPBC endangered communities overlap with the RE areas

NB Where heterogeneous polygon exists in the literature and the percentage mix was not given (i.e. 12.11.14/12.11.4), the dominant RE area was chosen (in this case - 12.11.14)

- indicates that this information was not readily available at the time of report compilation, and does not necessarily guarantee that these projects will not result in the clearing of these vegetation types

From the available data, it appears that RE 11.3.4 ('Of Concern' under the VMA) will be the most significant loss of a vegetation type, representing 8% of this vegetation community within Gladstone region. RE 12.11.14 ('Of Concern') will be reduced by almost 6% within the region. The decreased spatial distribution, creation of fresh edges and/or linear fragmentation that may result from these projects is likely to result in a decrease in the natural integrity of these REs. Over time and in conjunction with future projects, this may reduce the ability of these vegetation types to persist within the local government area. As a result, the impacts discussed below are likely to be more apparent within these vegetation types. Vegetation communities such as RE 11.3.4 are relatively underrepresented in reserves, and remnants are generally degraded from grazing, understorey and canopy thinning, canopy dieback and weed invasion (Queensland Herbarium, 2011). The cumulative impact of the project in conjunction with similar projects within the region may be to increase the local significance of RE 11.3.4 and RE 12.11.14 as they become less abundant.

Tables 31 and 32 provide a comparison of the remaining remnant RE 11.3.4 and RE 12.11.14 in relation to the estimated pre-clear distributions of these REs. These tables also break down the distribution of these REs in relation to tenure, in order to illustrate the extent to which these REs are held in reservation.

Table 31 Remaining area of remnant RE 11.3.4 within the Brigalow Belt bioregions and relevant sub-regions (from DERM, 2011c).

RE 11.3.4	Land tenure	Remnant pre-clear	Remnant 2006b	Percentage remnant remaining
Marlborough Downs (BBS 14)	Freehold	116,557	26,470	22.71%
	Leasehold	4,992	2,460	49.28%
	National Park	429	376	87.65%
	Other	6,701	1,761	26.28%
	State Forest	733	627	85.54%
	ALL	**129,412**	**31,694**	**24.49%**
Mount Morgan Ranges (BBS 18)	Freehold	112,556	10,014	8.90%
	Leasehold	7,401	2,301	31.09%
	National Park	454	438	96.48%
	Other	10,724	2,586	24.11%
	State Forest	642	442	68.85%
	Timber Reserve	261	69	26.44%
	ALL	**132,038**	**15,850**	**12.00%**
Brigalow Belt[1]	ALL	**691,576**	**184,355**	**26.66%**

[1] includes outlying populations in the Nandewar Northern Complex sub-region in the New England Tableland bioregion and the Broken River sub-region in the Einasleigh Uplands bioregion

Table 32 Remaining area of remnant RE 12.11.14 within the South-east Queensland and relevant sub-region

RE 12.11.14	Land Tenure	Remnant Pre-Clear	Remnant 2006b	Percentage Remnant Remaining
Burnett-Curtis Hills (SEQ10)	Freehold	10,284	2,385	23.19%
	Leasehold	546	334	61.17%
	National Park	245	230	93.88%
	Other	778	219	28.15%
	State Forest	1,453	1,411	97.11%
	ALL	**13,306**	**4,579**	**34.41%**
South-east Queensland[1]	ALL	**118,213**	**30,060**	**25.43%**

[1] includes outlying populations in the Mount Morgan Ranges sub-region and the Banana-Auburn Ranges sub-region in the Brigalow Belt bioregion

Table 33 outlines the area of remnant RE 11.3.4 and RE 112.11.14 that will be potentially impacted by the proposed projects, including both the Arrow LNG Plant project and those in the surrounding region. This represents 0.26% and 0.67% of these REs in their respective bioregions. The impacts of the Arrow LNG Plant project on RE 11.3.4 and RE 12.11.14 amounts to 0.03% and 0.41% of these vegetation communities within the bioregion.

Table 33 Cumulative and project specific impact on REs 11.3.4 and 12.11.14

Regional Ecosystem		**11.3.4**	**12.11.14**
Remaining remnant vegetation (2006)	Sub-region (BBS14)	31,694	n/a
	Sub-region (BBS18)	15,850	n/a
	Sub-region (SEQ10)	n/a	4,579
	BIOREGION	184,355	30,060
Remnant vegetation proposed to be cleared, both within and in the vicinity of the study area (2010)	Area (Ha)	487	200
	% of Sub-region (BBS14)	1.54	-
	% of Sub-region (BBS18)	3.07	-
	% of Sub-region (SEQ10)	-	4.37
	% of BIOREGION	**0.26**	**0.67**
Remnant vegetation proposed to be cleared in the Arrow LNG Plant project study area (2010)	Area (Ha)	46	123
	% of Sub-region (BBS14)	0.15	-
	% of Sub-region (BBS18)	0.29	-
	% of Sub-region (SEQ10)	-	2.69
	% of BIOREGION	**0.03**	**0.41**

- indicates that this information was not readily available at the time of report compilation, and does not necessarily guarantee that these projects will not result in the clearing of these vegetation types

In the context of each RE extent across the state, the vegetation clearing described in Table 30 can however be considered to be of low significance (i.e., <1%) of the total extent of each RE in Queensland).

However, such clearance of vegetation, including native remnant vegetation, may result in

increased significance of several impacts:

- Reduction of existing habitat patches, which includes the loss of habitat functions for native fauna including shelter, breeding areas and foraging resources. This may result in reduced fauna abundance and diversity in the Gladstone region.
- The aggregated loss of hollow bearing trees which are required by a wide range of terrestrial fauna species shelter and breeding, including arboreal mammals, microbats, owls, parrots and ducks. This could result in impacts on several threatened species, including powerful owl, glossy black-cockatoo and several species of listed microbat.
- The cumulative loss of mangrove habitat which supports several species of threatened fauna. In particular, increased fragmentation of the coastal mangrove corridor would likely increase impacts to the water mouse and several species of migratory and non-migratory shorebird (including eastern curlew and beach stone-curlew).
- Establishment and expansion of exotic flora species, including declared pest species. This may result in reduced flora and fauna abundance and diversity in the Gladstone region.
- Dominance of bulky exotic pastoral grasses (e.g. green panic {*Panicum maximum* var. *trichoglume*}) which can significantly enhance fuel loads. Coupled with an increased risk of inappropriate fire regimes this may result in loss of diversity and/or serious damage to fire sensitive communities (e.g. vine thickets).

8.2 Habitat Fragmentation and Impacts on Wildlife Corridors

Curtis Island is a refuge for highly mobile species e.g., birds and flying-foxes. The relatively intact forests provide foraging and breeding habitat for many species. If there is a loss of habitat through fire or stochastic events on the mainland, it provides a refuge, not only for displaced species but migratory species as well. Curtis Island Environmental Management Precinct will be the primary refuge for wildlife from the Curtis Island Industry Precinct as well as providing a refuge for mobile species whose mainland habitat may be disturbed. This is likely to cause increased competition for resources and may result in changes to species assemblages.

Multiple projects will inevitably operate under independently developed management plans and prescribed best practice methodologies. As such, a consistent application of mitigation and rehabilitation measures may be deficient and in some instances counter-productive.

Of those projects considered as part of this assessment, the majority identified habitat fragmentation and corridor disturbance as potential impacts on terrestrial flora and fauna. If all of these projects proceed, the cumulative effect on fauna habitat and movement corridors is likely to be amplified, resulting in increased significance of impacts such as:

- The isolation of fauna populations and resultant increase in the probability of local extinction.
- Reduced biodiversity of remnant habitat areas as a result of increased competition and narrowing of habitat.
- Reduced capacity of fauna to disperse. This may expose a species to greater risk of predation and/or to increased competition. It may also reduce gene flow and other

crucial ecosystem functions.

The Queensland Curtis LNG Project (BG Group, 2010) identified that Curtis Island forms part of the home range for a pair of powerful owls and is likely to support their roost. They have determined that, due to the cumulative impacts of LNG projects on Curtis Island this pair will no longer be able to remain on Curtis Island. However, it is hoped that the Curtis Island Environmental Management Precinct would provide alternative habitat for this pair, where the greatest impacts are likely to be related to noise and lighting.

Significant impacts are likely for the 'Endangered' vegetation (RE 12.3.3) located within the Curtis Island Infrastructure Precinct. The cumulative effect of multiple projects in this area will be to reduce the capacity of genetic transfer and evolutionary development of this vegetation type.

8.3 Introduced Flora and Fauna

A large proportion of the projects considered in this assessment identified pest flora and fauna as a potential impact. The concurrent or progressive implementation of these projects is likely to increase the opportunity for pest incursions, in addition to increasing the significance of impacts associated with pest species, such as:

- Changes to ecosystem structure and function.
- Reduction in biodiversity.
- Reduced productivity of agricultural land.

The overall cumulative impact associated with introduced flora and fauna may be considered to be moderate to low, particularly with the introduction of collaborative pest management (as recommended in Section 8.8 below).

8.4 Hydrology and Pollution

The cumulative effect of all projects assessed is likely to include increased sedimentation, pollutant release and alterations to natural hydrological process which may have a flow on impact on terrestrial ecology. With best practice management, this cumulative impact may be considered to be low to moderate.

8.5 Direct Disturbance of Fauna

There will be increased light and noise pollution. It is likely that the greatest impact will be on shorebirds and waders which utilise areas of RE 12.1.2 and RE 12.1.3, both on the mainland and on Curtis Island. Impacts will include decreased habitat for foraging, roosting and breeding within the bioregion. This may subsequently impact on species during their migration, as they may have to travel further to find suitable habitat. It is possible that migratory species may then become fatigued and perish.

Connell Hatch (2006) note that the majority of migratory species which utilise the area do so on an annual cycle, and that any disruption which occurs over two or more annual cycles will

likely result in that species never returning to the area.

The cumulative effect of increased traffic, particularly at Hamilton Point, where the Gladstone LNG project haul road is located, will be a greater likelihood of road kill. This will be of the most concern to mammal species.

Overall, the cumulative impact of the above may be considered to be moderate to low.

8.6 Altered Fire Regimes

The number of LNG projects on Curtis Island increases the risk of accidental bushfires ignition. The risk of this is mitigated by the implementation of contemporary bushfire protection design across all new developments (Eco Logical, 2011). Eco Logical (2011) provide further commentary on the cumulative impacts associated with fire.

8.7 Trenchfall

There may be short term impacts to fauna movements and the potential for entrapment and, possibly, mortality. However, trenches across all projects are expected to be closed as soon as reasonably practical and the implementation of additional management measures across all projects (such as regular trench inspections and placement of ramps to enable fauna to escape) means that the cumulative impacts of trenchfall on fauna can be considered to be low.

8.8 Additional Mitigation and Management Measures Required as a Result of Cumulative Impacts

Individually, mitigation employed by each of the projects should manage the risk of significant impacts occurring. In some instances, there may be additional measures required when the cumulative impacts of all projects in the region are considered.

To maximise effectiveness, pest management should be undertaken collaboratively. This includes timing feral animal eradication programs in tandem. Pest flora management should also consider the various programs implemented by other projects. This is particularly the case along watercourses, where upstream seed sources can negate efforts downstream.

The relative importance of the Curtis Island Environmental Management Precinct and undeveloped sections of Hamilton Point is magnified by their role as refuge for fauna from the Industry Precinct. Pest flora and fauna management is vital in these areas, as is monitoring to judge the success of retaining ecological diversity on Curtis Island. It is recommended that Arrow should focus management actions along the boundaries between the project area and these remaining intact vegetation communities.

9 Inspections and Monitoring

There are a number of monitoring programs which relate to terrestrial ecology that are recommended to be developed and implemented either pre, during or post construction. Monitoring should be reviewed, with the regime responsive to results (i.e., increasing or decreasing frequency). The monitoring program is expected to decrease in frequency and scope during operation phase. Each of these monitoring programs should be reported on at a frequency consistent with the timing of monitoring events. Monitoring programs should include, but are not limited to, those listed below.

It is understood that some areas which may require monitoring may fall outside of the site boundaries (i.e. RE 12.2.2 on Hamilton Point). Where this is the case and where practical, any monitoring should be undertaken in consultation with the landowner.

9.1 Further investigation

Further investigation and surveys should particularly focus on the three project areas which were not subject to targeted flora and fauna surveys.

TWAF 8

Flora and fauna surveys conducted during this terrestrial assessment were not targeted for threatened species, but instead looked at habitat and vegetation community type. Surveys should include bird surveys, nocturnal spotlight surveys, diurnal herp searches, harp/cage trapping, and koala surveys to determine the likely presence of significant species. Appropriate mitigation and additional monitoring measures should be put in place if threatened species are confirmed within the area.

TWAF 7

While fauna habitat values and vegetation community type have been assessed, surveys should verify the potential for any threatened species to occur.

Launch site 1

Launch site 1 was not directly accessed during flora and fauna surveys conducted during this terrestrial assessment. Pre-clearing surveys should include shorebird surveys, and trapping to determine the likely presence of water mouse. Appropriate mitigation and additional monitoring measures should be put in place if required.

9.2 Environmental Management Plan Compliance

Environmental management plans will be developed for both construction and operation and will have various compliance checks that will ensure environmental risks are managed. This will include traffic management, waste management, spill response, noise and dust control, fire control, water quality and erosion control.

9.3 Vegetation Management During Clearing

A Vegetation Management Plan will be produced by a suitably qualified and experienced ecologist that includes a number of monitoring responses during clearing and construction. There should be a checklist for monthly (at a minimum) weed inspections to identify any new outbreaks (of existing or new pest flora species). Trees left in situ in the vicinity of project works should be checked for signs of dieback or damage.

9.4 Vegetation Restoration

There are areas of particular significance which should have specific monitoring programs:

1. *Cupaniopsis* Reserve on Boatshed Point.

2. RE 12.2.2 vegetation community on Hamilton Point.

While the intention is that neither of these areas will be directly impacted on by the project, there is opportunity for indirect negative effects. A monitoring program undertaken by a suitably qualified and experienced ecologist should provide early indication of any degradation in these areas and initiate a response plan. Such a program should incorporate photo monitoring and detailed bio-condition quadrats/plots, as prescribed in Eyre *et al.* (2011) and should occur prior to clearing and construction and then annually during construction and for the life of the operational plant. In accordance with the ToR, two assessment sites per regional ecosystem type should be sufficient.

Monitoring may not be required at RE 12.2.2 if an alternative haul road option is taken. Monitoring requirements may change dependent upon the outcomes of *Cupaniopsis sp*. indet. identification.

More frequent weed inspection will be required at both sites as per Pest Flora and Fauna Management Plan (Ecosure 2011)

In addition, the boundary between the Arrow LNG Plant site and the Curtis Island Environmental Management Precinct should be frequently monitored and managed to ensure that litter, mobilised sediment and pest flora species do not encroach from the project area into the Environmental Management Precinct. This may form part of a monthly checklist in the construction and operational EMP. Following the first year of operations, monitoring frequency may be reduced to seasonal, provided there are no non-conformances.

All areas that have been restored post construction should also be monitored to ensure success. Monitoring should include photo monitoring and detailed bio-condition quadrats/plots (Eyre *et al.,* 2011) and occur annually for the duration of vegetation maintenance works.

9.5 Trenchfall and Fauna Response to Clearing

For the sections of trenching required for installation of the gas pipeline both on the mainland and on Curtis Island, daily inspections (morning and night) of trenches will be required. Because the pipe is laid in sections, only short sections of the trench should be open at any one time as

the trench is filled as the pipe is laid (see Section 6.2.7). Spotter-catchers engaged to monitor fauna during trenching will be required to submit reports on fauna collected and rehabilitated.

9.6 Shorebirds

Curtis Island and the mainland tunnel entry shaft and tunnel spoil disposal area provide potential roosting and foraging habitat for migratory shorebirds. A monitoring program for migratory shorebirds will be developed including initial pre-clearing and construction population estimates for high and low tide periods, and at a minimum, twice annual replicated surveys during the summer and once during the winter. Monitoring should establish baseline populations then assessment of the impact of the project over time, with an aim to provide corrective actions for any impacts noted. If significant roosts and feeding areas are likely to be disturbed during construction intensive monitoring should occur during peak risk periods.

9.7 Water Mouse

Water mouse habitat is available around mainland tunnel entry shaft and tunnel spoil disposal area and on Curtis Island. A water mouse was trapped on Curtis Island as part of the Australia Pacific LNG pre-clearance surveys (Worley Parsons, 2011). A trapping program will be established to determine the presence or absence of this species, and if present, how the project affects their population, with an aim to provide corrective actions for any impacts noted. Following two days of habitat surveys, a four day, three night trapping effort will be required. Each area of contiguous habitat (two on Curtis Island and one on the mainland) will require a minimum of 360 trap nights. Requirements for further monitoring will be determined after this initial study.

9.8 Nest Boxes

Nest boxes can become inhabited by non desirable species such as bees and pest birds (e.g., common myna). For any nest boxes installed, an annual monitoring program will be initiated requiring the use of techniques such as cameras on poles. Monitoring should occur twice a year, including once in the breeding season. If presence of the target species is not detected within three years, then the boxes should be relocated. Monitoring can cease within two years if the target species is observed using the box.

Nest boxes should be checked every six months for a period of five years. Damaged boxes should be repaired or replaced during this time.

Actions will be taken to remove non-desirable species and then to deter repeat utilisation. This may include modification of aperture size or repositioning the nest box.

9.9 White-bellied Sea-eagle Nesting

The likely white-bellied sea-eagle nest identified on Hamilton Point will only be removed if construction of MOF 2 is opted for. If this option is taken, the nest should be monitored for activity during the next breeding season and if active, a management plan will be formulated to ensure clearing activities avoid the breeding season. If this area is to be avoided by

construction activities, breeding season surveys should occur annually to confirm nest utilisation. If construction and/or operational activities are found to be likely to have resulted in the abandonment of the nest, suitable white-bellied sea-eagle nesting habitat should be included in the offsets plan.

9.10 Pest Flora and Fauna Monitoring

As part of the EMP, a monitoring program will be established. Ecosure (2011) provides greater guidance on monitoring considerations.

10 Conclusion

This assessment has been based on a thorough background review including previous survey from within the study area, a detailed literature review and database searches. Field work was undertaken to target those threatened species likely to be impacted by the project. The existing environment within the study area was found to contain a number of ecological values with high sensitivity due to their conservation status, condition, low resilience to change and difficulty to offset.

Pre-clearing surveys should specifically include TWAF 8, TWAF 7 and launch site 1, as these sites were not subject to targeted flora and fauna surveys.

Following implementation of mitigation measures, the most significant impacts which the Arrow LNG Plant is likely to have on terrestrial flora and fauna will occur:

- In the saltpans and shorebird habitat (RE 12.1.2) at mainland tunnel entry shaft and tunnel spoil disposal area.
- On Boatshed Point, within the SEVT community which contains a potential new taxon, *Cupaniopsis* sp. indet. and is 'Of Concern' under the VMA.
- On Curtis Island at the LNG Plant site, within two separate areas of RE 12.3.3 (considered to be 'Endangered' under the VMA) which will be completely cleared as a result of the project.

Impacts across the project area are likely to be exacerbated by the cumulative effects of numerous similar projects within the area. However, consideration of these impacts in the context of the Gladstone region suggests that these impacts will be relatively insignificant, particularly when compared to the remaining extent of these vegetation communities (i.e., RE 12.1.2 and 12.3.3) across this broader area and within Queensland.

The population of *Cupaniopsis* sp. indet. has been acknowledged for its potential significance and project design is aiming to minimise impact on this species through the creation of a Cupaniopsis reserve.

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Appendix A Terms of Reference Cross-reference Table

Cross-reference with the Co-ordinator General's Terms of Reference: Arrow LNG Plant			
Technical Study: Terrestrial Ecology		Technical Specialist: Ecosure Pty Ltd	
No.	**Terms of Reference Requirement**	**Technical Study Name**	**Technical Specialist Report Section Reference**
3.2.3.1	In particular, the EIS should indicate if the land affected by the proposal is, or is likely, to become part of the protected area estate, or is subject to any treaty. The following should be identified and mapped: · National parks. · Marine parks (state and Commonwealth). · Conservation parks. · Nature refuges (conservation agreements). · Declared fish habitat areas. · Wilderness areas. · Areas of state significance (scenic coastal landscapes). · Areas of state significance (natural resources). · Coastal wetlands. · Aquatic reserves. · Heritage/historic areas or items. · National estates. · World heritage listings and sites covered by international treaties or agreements (e.g., Ramsar, Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA), Republic of Korea-Australia Migratory Bird Agreement ROKAMBA)). · Areas of cultural significance. · Scientific reserves. MNES under the Commonwealth's EPBC Act should be described in Section 8 and mapped where possible.	Terrestrial Ecology Impact Assessment	Section 4.9 – Conservation Areas
3.2.3.2	Describe fragmentation of sites, increase of fire risk and impacts on residential and industrial uses.	Addressed by Eco Logical Australia Pty Ltd within the separate Bushfire Report	Addressed by Eco Logical Australia Pty Ltd within the separate Bushfire Report
3.2.6.1	The methods to be used for the project, including backfilling, covering, re-contouring, topsoil handling and revegetation, should be described. Consideration should be given to the use of threatened plant species during any landscaping and revegetation.	Terrestrial Ecology Impact Assessment	Section 6.2.1 Vegetation Clearing and Disturbance

Cross-reference with the Co-ordinator General's Terms of Reference: Arrow LNG Plant			
Technical Study: Terrestrial Ecology		Technical Specialist: Ecosure Pty Ltd	
No.	**Terms of Reference Requirement**	**Technical Study Name**	**Technical Specialist Report Section Reference**
3.3	Describe the existing environmental values for nature conservation that may be affected by the project in terms of: · Integrity of ecological processes, including habitats of least concern (common), near threatened, rare, vulnerable and endangered species and ecological communities. · Conservation of resources. · Biological diversity, including habitats of rare and threatened species. · Integrity of landscapes and places including wilderness and similar natural places. · Aquatic, terrestrial and marine ecosystems.	Terrestrial Ecology Impact Assessment	Chapter 4 – Existing Environment
3.3	Survey effort should be sufficient to identify, or adequately extrapolate, the floral and faunal values over the range of seasons, particularly during and following a wet season. The survey should account for the ephemeral nature of watercourses traversing the proposal area, and seasonal variation in fauna populations. The section should also outline the proposed strategies to avoid, or minimise and mitigate impacts on the identified values within the project's footprint. Key flora and fauna indicators should be identified for future ongoing monitoring.	Terrestrial Ecology Impact Assessment	Chapter 6 – Avoidance, mitigation and Management Measures Chapter 9 – Inspections and Monitoring
3.3.1.1	Identify areas that are environmentally sensitive in proximity to the project. Environmentally sensitive areas should also include areas classified as having international, national, state, regional or local biodiversity significance, or flagged as important for their integrated biodiversity values. Consideration should be given to: · National parks. · Conservation parks. · Declared fish habitat areas. · Wilderness areas. · Aquatic reserves. · Nature refuges. · Heritage/historic areas or items relating to biodiversity. · National estates. · World heritage listings and sites covered by international treaties or agreements (e.g., Ramsar, Japan-Australia Migratory Bird Agreement, China-Australia Migratory Bird Agreement, Republic of Korea-Australia Migratory Bird Agreement). · Areas of cultural significance relating to biodiversity. · Scientific reserves.	Terrestrial Ecology Impact Assessment	Chapter 4 – Existing Environment; Section 4.9 – Conservation Areas

Cross-reference with the Co-ordinator General's Terms of Reference: Arrow LNG Plant			
Technical Study: Terrestrial Ecology		Technical Specialist: Ecosure Pty Ltd	
No.	**Terms of Reference Requirement**	**Technical Study Name**	**Technical Specialist Report Section Reference**
3.3.1.1	DERM has produced a number of Biodiversity Planning Assessments that determine the biodiversity significance of terrestrial locations including areas within the footprint of, and in proximity to, the project. These should also be utilised during identification of sensitive environmental areas and the identified used values considered.	Terrestrial Ecology Impact Assessment	Section 4.9 – Conservation Areas.
3.3.1.1	MNES identified above are to be discussed in section 8.	Terrestrial Ecology Impact Assessment	Section 4.9 – Conservation Areas.
3.3.1.1	The proximity of the project to any environmentally sensitive areas should be shown on a map of suitable scale. As well as the above characteristics, areas that would be regarded as sensitive with respect to flora and fauna have one or more of the following features: Important habitats of species listed under the Nature Conservation Act 1992 and/or the EPBC Act as 'presumed extinct', 'critically endangered', 'endangered', 'vulnerable' or 'rare'.	Terrestrial Ecology Impact Assessment	Section 4.9 – Conservation Areas.
3.3.1.1	Regional ecosystems recognised by the EPA as 'endangered' or 'of concern' or 'not of concern' but where permits are no longer granted due to being at threshold levels, and/or ecosystems listed as 'presumed extinct', 'critically endangered', 'endangered' or 'vulnerable' under the EPBC Act.	Terrestrial Ecology Impact Assessment	Section 4.2.1 Regulated Vegetation – Commonwealth and Section 4.2.3.
3.3.1.1	Ecosystems that provide important ecological functions, such as riparian vegetation, important buffer to a protected area, refuge or important habitat corridor between areas. Protected areas which have been proclaimed under the Nature Conservation Act 1992 or are under consideration for proclamation.	Terrestrial Ecology Impact Assessment	Section 4.9 – Conservation Areas.
3.3.1.2	Discuss the following: · Impact of the project on species, communities and habitats of local, regional, national or international significance.	Terrestrial Ecology Impact Assessment	Chapter 5 – Issues and Potential Impacts.
3.3.1.2	Proposals to mitigate impacts (e.g., timing of works, minimise width of disturbance, proposed rehabilitation of in-stream and floodplain disturbances).	Terrestrial Ecology Impact Assessment	Chapter 6 – Avoidance, Mitigation and Management Measures.
3.3.1.2	Planned rehabilitation of vegetation communities and any relevant previous experience/experiments rehabilitating these communities.	Terrestrial Ecology Impact Assessment	Section 6.2.1 Vegetation Clearing and Disturbance Recommends Rehabilitation Plan.
3.3.1.2	Offsets relating to residual impacts with regard to the Queensland Government Environmental Offsets Policy (QGEOP) (EPA, 2008b) as well as the draft policy statement on the use of environmental offsets under the EPBC Act. The Queensland Government offsets policy provides for specific-issue offset policies, as follows: · Policy for Vegetation Management Offsets (DERM, 2009) · Mitigation and Compensation for Works or Activities Causing Marine Fish Habitat Loss (Dixon & Beumer, 2002). · Draft Policy for Biodiversity Offsets (consultation draft, EPA, 2008a). Any departure from no net loss of ecological values should be described.	Terrestrial Ecology Impact Assessment	Section 7.1 Environmental Offsets.

Cross-reference with the Co-ordinator General's Terms of Reference: Arrow LNG Plant			
Technical Study: Terrestrial Ecology		Technical Specialist: Ecosure Pty Ltd	
No.	**Terms of Reference Requirement**	**Technical Study Name**	**Technical Specialist Report Section Reference**
3.3.2.1	The terrestrial vegetation communities within the affected project areas should be described at an appropriate scale with mapping produced from aerial photographs and ground truthing, showing the following: · Location and extent of vegetation types including recognised regional ecosystem type descriptions and any areas of national, state or regional significance.	Terrestrial Ecology Impact Assessment	Chapter 4 – Existing Environment.
3.3.2.1	Location of vegetation types of conservation significance.	Terrestrial Ecology Impact Assessment	Section 4.2.3 – Field Validated Regulated Vegetation.
3.3.2.1	Vegetation map unit descriptions, including their relationship to regional ecosystems. Sensitive or important vegetation types should be highlighted and their value as habitat for fauna and conservation of specific rare floral and faunal assemblages or community types discussed.	Terrestrial Ecology Impact Assessment	Section 4.2.3 – Field Validated Regulated Vegetation.
3.3.2.1	· Current extent (bioregional and catchment) of protected vegetation types of conservation significance within protected areas (e.g., national parks, conservation parks, resource reserves, nature refuges).	Terrestrial Ecology Impact Assessment	Chapter 4 – Existing Environment.
3.3.2.1	· Any plant communities of cultural, commercial or recreational significance.	Terrestrial Ecology Impact Assessment	Section 4.3 – Flora Species of Conservation Significance.
3.3.2.1	· Distribution and abundance of significant exotic and weed species.	Terrestrial Ecology Impact Assessment	Section 4.4 – Introduced Flora Species.
3.3.2.1	The description should contain a review of published information regarding the assessment of the significance of the vegetation to conservation, recreation, scientific, educational and historical interests. The assessment should also include a description of vegetation (including re-growth and restored areas in addition to remnant vegetation) to indicate any areas of state, regional or local significance.	Terrestrial Ecology Impact Assessment	Chapter 4 – Existing Environment.
3.3.2.1	The description should also include, where relevant, MNES identified within the EPBC Act. MNES identified above should be fully discussed in section 8.	Terrestrial Ecology Impact Assessment	Section 4.9 – Conservation Areas.
3.3.2.1	For each significant natural vegetation community likely to be impacted by the project, vegetation surveys should be undertaken at an appropriate number of sites, allowing for seasonal factors, as follows: · All data should be collected in accordance with the requirements of the Queensland Herbarium CORVEG database. · Appropriate minimum site sizes should be selected, observing recognised sampling approaches and to provide an adequate sample of surveyed communities. · A list of species present at each site should be recorded · Relative abundance and community structure of plant species	Terrestrial Ecology Impact Assessment	Chapter 3 – Study Method.

Cross-reference with the Co-ordinator General's Terms of Reference: Arrow LNG Plant			
Technical Study: Terrestrial Ecology		Technical Specialist: Ecosure Pty Ltd	
No.	**Terms of Reference Requirement**	**Technical Study Name**	**Technical Specialist Report Section Reference**
	present should be recorded. · Any plant species of conservation, cultural, commercial or recreational significance should be identified. · Vegetation mapping and data should be submitted to the Queensland Herbarium to assist the updating of the CORVEG database. · Specimens of species listed as 'protected plants' under the *Nature Conservation (Wildlife) Regulation 1994,* other than common species, are to be submitted to the Queensland Herbarium for identification and entry into the HERBRECS database. The existence of rare or threatened species should be specifically addressed under sensitive areas. Any special landscape values of natural vegetation communities should be described. Existing information on plant species may be used instead of new survey work provided that the data are derived from surveys consistent with the above methodology and describe existing conditions. Methodology used for flora surveys should be specified in the appendices to the report. Any existing information should be revised and comments provided on whether the areas are degraded, cleared or affected in ways that would affect their environmental value.		
3.3.2.1	The occurrence of pest plants (weeds), particularly declared plants under the *Land Protection (Pest and Stock Route Management) Act 2002* should be shown on a map at an appropriate scale. The use of Biosecurity Queensland's Annual Pest Distribution Survey data and predictive pest maps available on the DEEDI website should be utilised in conjunction with Queensland Herbarium naturalised flora data to source the occurrence of pest plants in the project area.	Pest Management Plan (Ecosure, 2011).	Pest Management Plan (Ecosure, 2011).
3.3.2.2	Discuss all foreseen direct and indirect effects on terrestrial flora and the potential level of environmental impact identified. Action plans for protecting rare or threatened species and vegetation types identified as having high conservation value should be described and any obligations imposed by Queensland or Australian government biodiversity protection legislation or policy should be discussed. Project construction and operational activities involving clearing, salvaging or removal of vegetation should be described, and indirect impacts on vegetation not cleared should be assessed.	Terrestrial Ecology Impact Assessment	Chapter 5 – Issues and Potential Impacts.

Cross-reference with the Co-ordinator General's Terms of Reference: Arrow LNG Plant			
Technical Study: Terrestrial Ecology		Technical Specialist: Ecosure Pty Ltd	
No.	**Terms of Reference Requirement**	**Technical Study Name**	**Technical Specialist Report Section Reference**
3.3.2.2	The number of hectares of remnant vegetation proposed to be cleared (by conservation status and regional ecosystem type) for each project component should be identified. The proposed clearing should examine the effects of the proposed clearing on the long-term sustainability of these ecosystems at a regional level. This should also include the identification of potential offset areas consistent with Queensland offsets and the draft EPBC offsets policy to compensate for any loss of vegetation.	Terrestrial Ecology Impact Assessment	Chapter 5 – Issues and Potential Impacts (including Table 25, which identifies the degree of difficulty in replacing). Section 7.1 – Environmental Offsets.
3.3.2.2	With regard to the project areas, this section should include: · Significance of impacts at a local, catchment, bioregional, state, national or international level.	Terrestrial Ecology Impact Assessment	Section 5.3 – Pre-mitigation Assessment of Significance. Section 7 – Residual Impacts.
3.3.2.2	· Impact on any plants of potential or recognised environmental or economic significance. · Discussion of the ability of identified stands of vegetation to withstand any increased pressure resulting from the project and measures proposed to mitigate impacts.	Terrestrial Ecology Impact Assessment	Chapter 5 – Issues and Potential Impacts.
3.3.2.2	· Description of the methods proposed to ensure rapid rehabilitation of disturbed areas. This description should include the species chosen for revegetation which should be consistent with the surrounding vegetation associations.	Terrestrial Ecology Impact Assessment	Section 6.2.1 Vegetation Clearing and Disturbance Recommends Rehabilitation Plan.
3.3.2.2	· Details of any post construction monitoring programs and the benchmarks to be used for review of monitoring results should be included. Consideration should be given to the establishment of reference sites (at least two for each ecosystem type being rehabilitated) to provide benchmarking for rehabilitation activities	Terrestrial Ecology Impact Assessment	Chapter 9 – Inspections and Monitoring Section 6.2.1 Vegetation Clearing and Disturbance Recommends Rehabilitation Plan.

Cross-reference with the Co-ordinator General's Terms of Reference: Arrow LNG Plant			
Technical Study: Terrestrial Ecology		Technical Specialist: Ecosure Pty Ltd	
No.	**Terms of Reference Requirement**	**Technical Study Name**	**Technical Specialist Report Section Reference**
3.3.2.2	· Discussion on the potential for the introduction and/or spread of weeds or plant disease, including: · Identification of the origin of construction materials, machinery and equipment · Vehicle inspection regime, which addresses the need for vehicle and machinery wash-down and any other hygiene protocols, including the requirement that all vehicles and equipment must be cleaned before starting the job and that these wash down areas contain water/soil away from creeks and gullies. · Staff/operator education programs. · Determination of the potential for the introduction of, or facilitation of, exotic, non-indigenous and noxious plants. · Draft weed management plan in an EM Plan format. This plan should be developed and finalised in consultation with Biosecurity Officers from DEEDI land and local government environmental officers, to cover construction, rehabilitation and operation periods. · Weed management strategies are required for managing weed species already present at the project site and ensuring no new declared plants are introduced to the area. Reference should be made to the local government authority's pest management plan when determining control strategies. The strategies for managing weeds should be discussed in the main body of the EIS and provided in a working form in a Pest Management Plan as part of the overall EM plan for the project. · A biosecurity management plan for biosecurity mitigation measures where the project accesses primary production areas (plant communities of commercial significance).	Pest Management Plan (Ecosure, 2011).	Pest Management Plan (Ecosure, 2011).
3.3.2.2	The above assessment should include, where relevant, MNES identified under the EPBC Act. MNES identified above are to be discussed in section 8.	Terrestrial Ecology Impact Assessment	Chapter 5 – Issues and Potential Impacts. Section 5.3 – Pre-mitigation Assessment of Significance. Section 6.2.1 Vegetation Clearing and Disturbance. Recommends Rehabilitation Plan. Section 7 – Residual Impacts. Chapter 9 – Inspections and Monitoring.

Cross-reference with the Co-ordinator General's Terms of Reference: Arrow LNG Plant			
Technical Study: Terrestrial Ecology		Technical Specialist: Ecosure Pty Ltd	
No.	**Terms of Reference Requirement**	**Technical Study Name**	**Technical Specialist Report Section Reference**
3.3.3.1	The terrestrial and riparian fauna occurring in the areas affected by the project should be described, noting the broad distribution patterns in relation to vegetation, topography and substrate. Wildlife corridors and refuges should be identified and mapped. The description of the fauna present or likely to be present in the area should include: · Species diversity (i.e. a species list) and indicative abundance of animals, including amphibians, birds, reptiles, and mammals (including bats). · Any species that are poorly known but suspected of being rare or potentially threatened. · Habitat requirements and sensitivity to changes, including movement corridors and barriers to movement. · Existence of any rare, threatened or otherwise noteworthy species/communities in the project areas, including a discussion of the range, habitat, breeding, recruitment, feeding and movement requirements, and the current level of protection (e.g., any requirements of protected area management plans). · Use of the area by migratory and nomadic birds, in particular areas for breeding or significant congregations. · The existence of feral or exotic animals, including maps of major pest infestations. The EIS should contain results from surveys for species listed as threatened or migratory under the EPBC Act. Surveys should be conducted at the appropriate time of the year when the species is known to be present on the site, so that identification and location of these species is optimal. MNES identified here are to be discussed in section 8.	Terrestrial Ecology Impact Assessment	Chapter 4 – Existing Environment.
3.3.3.1	The methodology used for fauna surveys should be specified in the appendices to the report. The EIS should indicate how well any affected significant communities and species are represented and protected elsewhere in the region where the project occurs. Relevant site data should be provided to the DERM in a format compatible with the DERM WildNet database for listed threatened species.	Terrestrial Ecology Impact Assessment	Chapter 3 – Study Methods.
3.3.3.1	The use of Biosecurity Queensland's Annual Pest Distribution Survey data and predictive pest maps available on the DEEDI website, together with local government area pest management plans, should be utilised to source the occurrence of pest animals in the project area.	Pest Management Plan Ecosure (2011).	Pest Management Plan (Ecosure, 2011).
3.3.3.2	Discuss all foreseen direct and indirect effects on terrestrial fauna.	Terrestrial Ecology Impact Assessment	Chapter 5 – Issues and Potential Impacts.

Cross-reference with the Co-ordinator General's Terms of Reference: Arrow LNG Plant			
Technical Study: Terrestrial Ecology		Technical Specialist: Ecosure Pty Ltd	
No.	**Terms of Reference Requirement**	**Technical Study Name**	**Technical Specialist Report Section Reference**
3.3.3.2	Strategies for protecting rare or threatened species should be described and any obligations imposed by Queensland threatened species legislation or policy should be discussed. Australian government threatened species legislation should be discussed in section 8. Any recovery plans for potentially affected threatened species should be outlined, and strategies for complying with the objectives and management practices of relevant recovery plans should be described. Measures to mitigate the impact on habitat or the inhibition of normal movement, breeding or feeding patterns, and change to food chains should be described. Any provision for buffer zones and movement corridors, or special provisions for migratory or nomadic animals should be discussed.	Terrestrial Ecology Impact Assessment	Chapter 6 – Avoidance, Mitigation and Management Measures.
3.3.3.2	With regard to terrestrial and riparian fauna, the assessment of potential impacts should consider: · Impacts the project may have on terrestrial fauna, relevant wildlife habitat and other fauna conservation values, including: · Direct and indirect impacts due to loss of range/habitat, food supply, nest sites, breeding/recruiting potential or movement corridors. · Impacts on rare and threatened or otherwise noteworthy animal species.	Terrestrial Ecology Impact Assessment	Chapter 5 – Issues and Potential Impacts.
3.3.3.2	· Identification of the conservation importance of identified populations at the regional, state and national levels.	Terrestrial Ecology Impact Assessment	Chapter 4 – Existing Environment
3.3.3.2	· Cumulative effects of direct and indirect impacts.	Terrestrial Ecology Impact Assessment	Chapter 8 – Cumulative Impacts.
3.3.3.2	· Measures to minimise wildlife capture and mortality during construction and operation. Details of the methodologies that would be used to avoid injuries to livestock and native fauna as a result of the project's construction and operational works and if accidental injuries should occur, the methodologies to assess and handle the injuries.	Terrestrial Ecology Impact Assessment	Chapter 6 – Avoidance, Mitigation and Management Measures.
3.3.3.2	These would also include, where relevant, MNES identified under the EPBC Act. The MNES are to be discussed in section 8.	Terrestrial Ecology Impact Assessment	Chapter 5 – Issues and Potential Impacts.

Cross-reference with the Co-ordinator General's Terms of Reference: Arrow LNG Plant			
Technical Study: Terrestrial Ecology		Technical Specialist: Ecosure Pty Ltd	
No.	**Terms of Reference Requirement**	**Technical Study Name**	**Technical Specialist Report Section Reference**
3.3.3.2	· Methods for minimising the introduction of feral animals, and other exotic fauna such as declared pest ant species (fire ants and yellow crazy ants). · A review of control measures to prevent increases in local populations and spread of biting insect species of pest and health significance associated with construction and operational activities and disposal of construction and operational wastes. · A pest animal management plan in an EM Plan format. This plan should be developed and finalised in consultation with Biosecurity Officers from DEEDI and local government environmental officers, to cover construction, rehabilitation and operation periods. · A biosecurity management plan for biosecurity mitigation measures where the project accesses primary production areas.	Pest Management Plan (Ecosure, 2011).	Pest Management Plan (Ecosure, 2011).
3.3.4.1	The aquatic flora and fauna occurring in the areas affected by the project should be described, noting the patterns and distribution in the waterways. A description of the habitat requirements and the sensitivity of aquatic flora and fauna species to changes in flow regime, water levels and water quality in the project areas should be provided. The discussion of the fauna and flora present or likely to be present in the area should include: · Fish species, mammals, reptiles, amphibians and aquatic invertebrates occurring in the waterways within the project area, including any feral and exotic fauna species. · Aquatic (waterway) macrophytes including native and exotic/weed species · Wetlands listed by DERM as areas of national, state or regional significance, and their values and importance. · A description of terrestrial species that are ecologically associated with wetlands or waterways and are likely to be affected by the project · Aquatic habitats, substrates and stream types. · Description of mitigation measures to minimise aquatic habitat modification and associated impacts on aquatic flora and fauna. These would also include, where relevant, MNES identified under the EPBC Act. The MNES are to be discussed in section 8.	Addressed by Aquateco within the separate Aquatic Ecology Report.	Addressed by Aquateco within the separate Aquatic Ecology Report.

Cross-reference with the Co-ordinator General's Terms of Reference: Arrow LNG Plant			
Technical Study: Terrestrial Ecology		Technical Specialist: Ecosure Pty Ltd	
No.	**Terms of Reference Requirement**	**Technical Study Name**	**Technical Specialist Report Section Reference**
3.3.4.2	Discuss all foreseen direct and indirect effects on aquatic flora and fauna, including strategies for protecting rare or threatened species and any obligations, legislation or policies imposed by the Queensland and Australian governments. The discussion should include: · Measures to minimise wildlife injury and mortality during construction and operation. · Details of the methodologies that would be used to avoid injuries to native fauna as a result of the project's construction and operational works, and if accidental injuries should occur the methodologies to assess and handle injuries. · Details of measures to be used to maintain fish passage in creeks that would be affected. · Potential impacts on groundwater dependant ecosystems, with options to avoid or mitigate these impacts, and details of proposed monitoring for each identified groundwater dependant ecosystems. · Description of mitigation measures to prevent the creation of new mosquito and biting midge breeding sites, particularly during construction. · Description of the potential for and mitigation measures to prevent the introduction, transfer or facilitation of exotic, non-indigenous and noxious plants and water borne insect pests.	Addressed by Aquateco within the separate Aquatic Ecology Report.	Addressed by Aquateco within the separate Aquatic Ecology Report.
3.6.2	The following air quality issues and their mitigation should be considered: · Impacts on terrestrial flora and fauna.	Terrestrial Ecology Impact Assessment	Section 5.1.5 Direct Disturbance of Fauna. Section 6.2.5 Direct Disturbance of Fauna.
3.7.2	Potential noise impacts on terrestrial animals and avifauna, particularly migratory species should also be considered.	Terrestrial Ecology Impact Assessment	Section 5.1.5 Direct Disturbance of Fauna. Section 6.2.5 Direct Disturbance of Fauna.

Cross-reference with the Co-ordinator General's Terms of Reference: Arrow LNG Plant			
Technical Study: Terrestrial Ecology		Technical Specialist: Ecosure Pty Ltd	
No.	**Terms of Reference Requirement**	**Technical Study Name**	**Technical Specialist Report Section Reference**
7	The purpose of this section is to provide a summary of the cumulative impacts from the project which should have regard to both geographic location and environmental values. Cumulative impacts should take into consideration the effects of other known, existing or proposed project(s) where details of such projects have been provided to the proponent by the DIP or which are otherwise published to the greatest extent possible. In particular, the likelihood of cumulative impacts arising from possible shared gas transmission pipeline easements and adjoining or nearby LNG plant proposals should be addressed, where adequate information is available. With respect to Gladstone in particular, the cumulative social and economic impacts arising from large project workforces associated with proposed industrial projects being constructed in overlapping timeframes should be addressed. The requirements of any relevant state planning policies, environmental protection policies, national environmental protection measures, statutory policies, water resource planning and any other relevant plans should also be addressed. The methodology used to determine the cumulative impacts of the project should be discussed, including (to the extent possible) qualitative and quantitative criteria.	Terrestrial Ecology Impact Assessment	Section 3.8 – Assessment of Cumulative Impacts. Chapter 8 – Cumulative Impacts.
8	The controlling provisions under the EPBC Act have been determined as: · Sections 12 and 15A (World Heritage properties). · Sections 15B and 15C (National Heritage place). · Sections 18 and 18A (Listed threatened species and communities). · Sections 20 and 20A (Listed migratory species). This section should bring together assessments of impacts on Matters of National Environmental Significance (MNES) in other chapters (e.g., water resources, flora and fauna, cultural heritage, cumulative impacts) and produce a stand-alone assessment in a format suited for assessment under the EPBC Act. The project should initially be assessed in its own right followed by an assessment of the cumulative impacts related to all known proposed major industrial developments in the project component study areas with respect to each controlling provision, and relevant identified consequential actions. Predictions of the extent of threat (risk), impact and the benefits of any mitigation measures proposed, should be based on sound science and quantified where possible. All sources of information relied upon should be referenced and an estimate of the reliability of predictions provided. Any positive impacts should also be identified and	Ecosure, Coffey Environments: Marine and estuarine ecology, AECOM, Central Queensland Cultural Heritage Management P/L and Heritage Consultants Australia.	Ecosure, Coffey Environments: Marine and estuarine ecology, AECOM, Central Queensland Cultural Heritage Management P/L and Heritage Consultants Australia.

Cross-reference with the Co-ordinator General's Terms of Reference: Arrow LNG Plant			
Technical Study: Terrestrial Ecology		Technical Specialist: Ecosure Pty Ltd	
No.	**Terms of Reference Requirement**	**Technical Study Name**	**Technical Specialist Report Section Reference**
	evaluated. If environmental offsets are required, in accordance with the EPBC *Draft Environmental Offsets Policy Statement (August 2007)*, then an offset strategy should be proposed. The extent of any new field work, modelling or testing should be commensurate with risk and should be such that when used in conjunction with existing information, provides sufficient confidence in predictions that well informed decisions can be made. Obligations under and implications of any species recovery plans must be specifically addressed.		
8.1	The EIS should provide: · A description of the values of the Great Barrier Reef World Heritage Area (GBRWHA) and National Heritage places that are likely to be impacted by the project, including but not restricted to the significant regional habitat for listed threatened and migratory marine species.	Terrestrial Ecology Impact Assessment	Section 4.9 Conservation Areas.
8.1	· A description of the potential direct and indirect impacts on the values of each area, place, site or reserve, resulting from: - Modification, destruction, fragmentation, isolation or disturbance of an important, sensitive or substantial area of habitat - A substantial change in water quality (including temperature) and hydrological regime which may adversely impact on biodiversity, ecological integrity, social amenity or human health - Persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, ecological integrity, social amenity or human health may be adversely affected. · A description of the impacts on other users of the area. · A discussion of the extent to which identified impacts can be forecast or predicted and managed.	Terrestrial Ecology Impact Assessment	Chapter 5 – Issues and Potential Impacts.
8.1	· A description of any mitigation measures proposed to reduce the impact on the values and environments of each area, place, site or reserve	Terrestrial Ecology Impact Assessment	Chapter 6 – Avoidance, Mitigation and Management Measures. Section 8.3 – Additional Mitigation and Management Measures.
8.2	The EIS should provide a description of EPBC Act listed threatened species and ecological communities likely to occur in the project study area.	Terrestrial Ecology Impact Assessment	Chapter 4 – Existing Environment.

Cross-reference with the Co-ordinator General's Terms of Reference: Arrow LNG Plant			
Technical Study: Terrestrial Ecology		Technical Specialist: Ecosure Pty Ltd	
No.	**Terms of Reference Requirement**	**Technical Study Name**	**Technical Specialist Report Section Reference**
8.2	The EIS should consider and assess the impacts to identified listed threatened species and communities that may be impacted by the project. The EIS should identify which component of the project is of relevance to each species or community or if the threat of impact relates to consequential actions. Impacts may result from: · A decrease in the size of a population or a long term adverse affect on an ecological community · A reduction in the area of occupancy of the species or extent of occurrence of the ecological community · Fragmentation an existing population or ecological community · Disturbance or destruction of habitat critical to the survival of the species or ecological community · Disruption of the breeding cycle of a population · Modification, destruction, removal, isolate or reduction of the availability or quality of habitat to the extent that the species is likely to decline · Modification or destruction of abiotic (non-living) factors (such as water, nutrients, or soil) necessary for the ecological community's survival · The introduction of invasive species that are harmful to the species or ecological community becoming established · Interference with the recovery of the species or ecological community · Actions which may be inconsistent with a recovery plan. · Any positive impacts should also be identified and evaluated.	Terrestrial Ecology Impact Assessment	Chapter 5 – Issues and Potential Impacts.
8.2	A description of any mitigation measures proposed to reduce the impact on the listed threatened species and ecological communities should be discussed.	Terrestrial Ecology Impact Assessment	Chapter 6 – Avoidance, Mitigation and Management Measures. Section 8.3 – Additional Mitigation and Management Measures.
8.3	The EIS should provide a description of the EPBC Act listed migratory species, distribution, life history, habitats etc likely to occur in the project study area.	Terrestrial Ecology Impact Assessment	Chapter 4 – Existing Environment.

Cross-reference with the Co-ordinator General's Terms of Reference: Arrow LNG Plant			
Technical Study: Terrestrial Ecology		Technical Specialist: Ecosure Pty Ltd	
No.	**Terms of Reference Requirement**	**Technical Study Name**	**Technical Specialist Report Section Reference**
8.3	The EIS should consider and assess the impacts to the identified listed migratory species that may be impacted by the project. The EIS should identify which component of the project is of relevance to each species or if the threat of impact relates to consequential actions. Impacts may result from: · The destruction, isolation or modification of habitat important to a migratory species. · The introduction of invasive species in an important habitat that would be harmful to a migratory species. · The disruption of the lifecycle (breeding, feeding, migration, or resting behaviour) of an ecologically important proportion of the population of a migratory species. · Interference with the recovery of the species or ecological community. · Actions which may be inconsistent with a recovery plan. Any positive impacts should also be identified and evaluated.	Terrestrial Ecology Impact Assessment	Chapter 5 – Issues and Potential Impacts.
8.3	A description of any mitigation measures proposed to reduce the impact on migratory species should be discussed.	Terrestrial Ecology Impact Assessment	Chapter 6 – Avoidance, Mitigation and Management Measures. Section 8.3 – Additional Mitigation and Management Measures.
8.4	This section of the EIS report should be a stand-alone section and should exclusively and fully address the issues relevant to the EPBC Act controlling provisions. It should follow the following outline: Introduction, including title of EPBC Referral and numbers, and brief description of the project Description of proposed action (as it would impact on MNES). Description of the affected environment and values relevant to the controlling provisions (i.e. describe the features of the environment that are MNES protected under the EPBC Act). Assessment of impacts on MNES and mitigation measures (in accordance with available guidelines and species recovery plans). An outline of environmental management plan that sets out the framework for continuing management, mitigation and monitoring for the relevant impacts of the action and the name of the agency responsible for endorsing or approving each mitigation measure or monitoring programme. Other approvals and conditions e.g. permits for vegetation clearing, local, state planning schemes or plan or policy and a description of any approval that has been obtained from a state or Commonwealth agency or authority. Environmental record of person proposing to take the action (proponent) – details of any proceedings under a Commonwealth, state or territory law for the protection of the environment or the	Ecosure, Coffey Environments: Marine and estuarine ecology, AECOM, Central Queensland Cultural Heritage Management P/L and Heritage Consultants Australia.	Ecosure, Coffey Environments: Marine and estuarine ecology, AECOM, Central Queensland Cultural Heritage Management P/L and Heritage Consultants Australia.

Cross-reference with the Co-ordinator General's Terms of Reference: Arrow LNG Plant			
Technical Study: Terrestrial Ecology		Technical Specialist: Ecosure Pty Ltd	
No.	**Terms of Reference Requirement**	**Technical Study Name**	**Technical Specialist Report Section Reference**
	conservation and sustainable use of natural resources against the proponent and for an action for which the person has applied for a permit; if the proponent is a corporation details of the corporation. Conclusions. References and linkages to relevant sections of the EIS.		
9	This section of the EIS should detail the EM Plan developed for the project. The EM Plan should be developed from, and be consistent with, the preceding information in the EIS and meet the statutory requirements for EM Plans under S310D of the EP Act and be consistent with the EPA Guideline: Preparing an environmental management plan (EM Plan) for level 1 petroleum activities (2007) or as subsequently updated. An EM Plan should provide control actions in accordance with agreed performance criteria for specified acceptable levels of environmental harm. In addition, the EM Plan should identify: · Potential impacts on environmental values · Mitigation strategies · Relevant monitoring · Appropriate indicators and performance criteria · Reporting requirements · Appropriate corrective actions, should an undesirable impact or unforeseen level of impact occur · The recording of and response to complaints. · The aim of the EM Plan is to provide: · Commitments by the proponent to practical and achievable strategies and design standards (performance specifications) for the management of the project to ensure that environmental requirements are specified and complied with an integrated plan for comprehensive monitoring and control of impacts · Local, state and federal government authorities, stakeholders and the proponent with a common focus for approvals conditions and compliance with policies and conditions · The community with evidence that the environmental management of the project is acceptable. An EM Plan should commit to manage, enhance or protect identified environmental values. The commitments should contain the following components for performance criteria and implementation strategies: · Environmental protection objectives for enhancing or protecting each relevant value. · Indicators to be measured to demonstrate the extent to which the environmental protection objective is achieved. · Environmental protection standards (a numerical target or value	Ecosure, Coffey Environments, Coffey Geotechnics, AECOM, Central Queensland Cultural Heritage Management P/L, Heritage Consultants Australia, AEC, ACIL Tasman, Alluvium, Katestone, BMT WBM, GTA, JTA and Sonus.	Ecosure, Coffey Environments, Coffey Geotechnics, AECOM, Central Queensland Cultural Heritage Management P/L, Heritage Consultants Australia, AEC, ACIL Tasman, Alluvium, Katestone, BMT WBM, GTA, JTA and Sonus.

Cross-reference with the Co-ordinator General's Terms of Reference: Arrow LNG Plant			
Technical Study: Terrestrial Ecology		Technical Specialist: Ecosure Pty Ltd	
No.	**Terms of Reference Requirement**	**Technical Study Name**	**Technical Specialist Report Section Reference**
	for the indicator), which defines the achievement of the objective. · An action program to ensure the environmental protection commitments are achieved and implemented. This will include strategies in relation to: – Communication. – Continuous improvement. – Environmental auditing. – Monitoring. – Reporting. – Staff training. A decommissioning program for land proposed to be disturbed under each relevant aspect of the project.		
10	The EIS should make conclusions and recommendations with respect to the project based on the studies presented, the EM Plan and conformity of the project with legislative and policy requirements.	Terrestrial Ecology Impact Assessment	Chapter 10 – Conclusion.
11	All references consulted should be presented in the EIS in a recognised format.	Terrestrial Ecology Impact Assessment	References.
12.2	A cross reference table should be provided which links the requirements of each section/subsection of the TOR with the corresponding section/subsection of the EIS where those requirements have been addressed.	This Table	This Table
12.7	All specialist studies undertaken as part of the EIS should be reported as appendices to the EIS.	Ecosure, Coffey Environments, Coffey Geotechnics, AECOM, Central Queensland Cultural Heritage Management P/L, Heritage Consultants Australia, AEC, ACIL Tasman, Alluvium, Katestone, BMT WBM, GTA, JTA and Sonus.	Ecosure, Coffey Environments, Coffey Geotechnics, AECOM, Central Queensland Cultural Heritage Management P/L, Heritage Consultants Australia, AEC, ACIL Tasman, Alluvium, Katestone, BMT WBM, GTA, JTA and Sonus.

Appendix B Flora Species Observed During Field Surveys

FAMILY	Botanical name	Status	Location – regional ecosystem and assessment sites (refer to Appendix D)																			
			11.3.4				12.2.2		12.3.3		12.3.7	12.11.4		12.11.6			12.11.14			Sub-HAT Vegetation	Road Reserve
			S055	S056	S057	S058	S081	S108	S063	S078	S100	S069	S084	S085	S089	S092	S062	S070	S075		
ACANTHACEAE	*Brunoniella australis*	LC		1						2	1				1		2	2			
ACANTHACEAE	*Pseuderanthemum variable*	LC										+	+								
ACANTHACEAE	*Rostellularia adscendens*	LC															2				
ADIANTACEAE	*Adiantum aethiopicum*	LC											2-3								
ADIANTACEAE	*Adiantum hispidulum var. hispidulum*	LC											3								
ADIANTACEAE	*Cheilanthes distans*	LC																			
ADIANTACEAE	*Cheilanthes sieberi ssp. sieberi*	LC										1(t)									
AIZOACEAE	*Sesuvium portulacastrum*	LC																		3	
AMARANTHACEAE	*Achyranthes aspera*	LC						3 (e,t)											1		
AMARANTHACEAE	*Alternanthera denticulata*	LC									+(t)										
AMARANTHACEAE	*Alternanthera nana*	LC							1(t)												
AMARANTHACEAE	*Amaranthus hybridus*	*							+												
AMARANTHACEAE	*Gomphrena celosioides*	*							+ (d,t)												
AMARANTHACEAE	*Polycarpea corymbosa*	LC																			
ANACARDIACEAE	*Euroshinus falcatus ssp. angustifolius*	LC					3(t)														
ANACARDIACEAE	*Euroshinus falcatus ssp. falcatus*	LC										+(t)									
ANACARDIACEAE	*Pleiogynium timorense*	LC					3	3				2									
ANNONACEAE	*Melodorum leichhardtii*	LC										2									

FAMILY	Botanical name	Status	Location – regional ecosystem and assessment sites (refer to Appendix D)																		
			11.3.4				12.2.2		12.3.3		12.3.7	12.11.4		12.11.6			12.11.14			Sub-HAT Vegetation	Road Reserve
			S055	S056	S057	S058	S081	S108	S063	S078	S100	S069	S084	S085	S089	S092	S062	S070	S075		
ANNONACEAE	*Polyalthia nitidissima*	LC					2	1				1									
APIACEAE	*Centella asciatica*	LC							1(t)	2											
APOCYNACEAE	*Alstonia constricta*	LC																			+(t)
APOCYNACEAE	*Alyxia ruscilfolia ssp. ruscifolia*	LC					4-5	3				2									
APOCYNACEAE	*Asclepias curassavica*	*							1-2		1										
APOCYNACEAE	*Carrissa ovata*	LC					2-3	2													
APOCYNACEAE	*Cryptostegia grandiflora*	* (Class 2)							+	+				+ (t)				+			
APOCYNACEAE	*Cyanchum carnosum*	LC																		3	
APOCYNACEAE	*Gomphocarpus physocarpus*	*						1(t)	1-2					1(t)		2					
APOCYNACEAE	*Hoya australis*	LC					3														
APOCYNACEAE	*Marsdenia microlepis*	LC						1							+			2			
APOCYNACEAE	*Parsonia paulforsteri*	LC																			
APOCYNACEAE	*Parsonsia lanceolata*	LC			(+)														1(t)		
APOCYNACEAE	*Sarcostema viminale ssp. brunonianum*	LC										+(t)									
APOCYNACEAE	*Secamone elliptica*	LC					3	2													
ARALIACEAE	*Polyscias elegans*	LC											+(t)								
ARECACEAE	*Livistona decipiens*	LC							1-3(t)												
ARECACEAE	*Syagrus romanzoffiamum*	*							+												
ASTERACEAE	*Acanthospermum hispidulum*	*																			+(t)
ASTERACEAE	*Ageratum conyzoides*	*	+(t)		+(t)				+	+	+					1					

FAMILY	Botanical name	Status	Location – regional ecosystem and assessment sites (refer to Appendix D)																			
			11.3.4				12.2.2		12.3.3		12.3.7	12.11.4		12.11.6			12.11.14			Sub-HAT Vegetation	Road Reserve
			S055	S056	S057	S058	S081	S108	S063	S078	S100	S069	S084	S085	S089	S092	S062	S070	S075		
ASTERACEAE	*Ageratum houstonianum*	*																			1(t)
ASTERACEAE	*Bidens pilosa var. pilosa*	*			1(t)		1-2		1				+		1						
ASTERACEAE	*Calyptocarpus vialis*	*							3-4									+	1-3		
ASTERACEAE	*Centipedea minima*	LC						2(t)	3(d,t)												
ASTERACEAE	*Cirsium vulgare*	*																			1(t)
ASTERACEAE	*Conyza sp.*	*			+									+	+(t)						
ASTERACEAE	*Cyanthilium cinereum*	LC		+				+	3	1				1	2	2	2		2		
ASTERACEAE	*Emilia sonchifolia*	LC			1(t)			1	3	1	2			2	2	2	2		1		
ASTERACEAE	*Epaltes australe*	LC								2								+			
ASTERACEAE	*Gnaphalium pensylvanicum*	*												+(t)	+						
ASTERACEAE	*Helichrysum lanuginosum*	LC													+(t)						
ASTERACEAE	*Peripleura hispidula*	LC		2	1											1	1	2			
ASTERACEAE	*Picrus angustifolia ssp. carolorum-henricorum*	LC			+					2							+				
ASTERACEAE	*Pterocaulon redolens*	LC		1	+									1	1	1	2	1			
ASTERACEAE	*Pterocaulon serrulatum*	LC										+(e,t)									
ASTERACEAE	*Sigesbeckia orientalis*	*								+(t)				2		2-4					
ASTERACEAE	*Sonchus oleraceus*	*							+(t)												
ASTERACEAE	*Tagetes minima*	*												1-3(t)							
ASTERACEAE	*Vittadinia cuneata*	LC			+(t)																
ASTERACEAE	*Vittadinia hispidula var. setosa*	LC														+		+			

FAMILY	Botanical name	Status	Location – regional ecosystem and assessment sites (refer to Appendix D)																		
			11.3.4				12.2.2		12.3.3		12.3.7	12.11.4		12.11.6			12.11.14			Sub-HAT Vegetation	Road Reserve
			S055	S056	S057	S058	S081	S108	S063	S078	S100	S069	S084	S085	S089	S092	S062	S070	S075		
AVICENNIACEAE	*Avicennia marina ssp. australasica*	LC																		1-4	
AZOLLACEAE	*Azolla pinnata*	LC																			6(d,t)
BIGNONIACEAE	*Pandorea jasminoides*	LC					+(t)														
BIGNONIACEAE	*Pandorea pandorana*	LC					1-2														
CACTACEAE	*Opuntia stricta*	* (Class 2)															+(t)	+	1		
CAESALPINIACEAE	*Chamaecrista noname*	LC		1	1(t)				1(t)					1							
CAESALPINIACEAE	*Senna occidentalis*	*			+(t)																
CAESALPINIACEAE	*Senna surratrenis*	*																	1(t)		
CAMPANULACEAE	*Pratia concolor*	LC							+(t)												
CAPPARACEAE	*Capparis arborea*	LC					2					1									
CAPPARACEAE	*Capparis canescens*	LC																	'+(t)		
CAPPARACEAE	*Capparis mitchellii*	LC																			
CAPPARACEAE	*Capparis ornans*	LC					1(t)														
CASUARINACEAE	*Allocasuarina littoralis*	LC																4			
CASUARINACEAE	*Allocasuarina torulosa*	LC														1(t)					
CELASTRACEAE	*Denhamia pittosporoides*	LC										1									
CELASTRACEAE	*Drypetes deplanchei*	LC					4	3-4				3-4									
CELASTRACEAE	*Elaeodendron australe var. australe*	LC											'+(t)								
CELASTRACEAE	*Elaeodendron melanocarpum*	LC					4												'+(t)		
CELASTRACEAE	*Maytenus cunninghamii*	LC																	'+(t)		
CHENOPODIACEAE	*Halosarcia*	LC																		2	

FAMILY	Botanical name	Status	Location – regional ecosystem and assessment sites (refer to Appendix D)																		
			11.3.4				12.2.2		12.3.3		12.3.7	12.11.4		12.11.6			12.11.14			Sub-HAT Vegetation	Road Reserve
			S055	S056	S057	S058	S081	S108	S063	S078	S100	S069	S084	S085	S089	S092	S062	S070	S075		
	pergranulata																				
CHENOPODIACEAE	*Sarcocornia quinqueflora*	LC																		2	
CHENOPODIACEAE	*Suaeda australis*	LC																		3	
COMBRETACEAE	*Lumnitzera racemosa*	LC																		1-3	
COMBRETACEAE	*Terminalia porphrycarpa*	LC			'+(t)																
COMMELINACEAE	*Murdannia graminea*	LC								2											
CONVOLVULACEAE	*Evolvus alsinoides*	LC															2				
CONVOLVULACEAE	*Ipomoea macrantha*	LC							+	+											
CONVOLVULACEAE	*Ipomoea pleiba*	LC							2-3		1										
CONVOLVULACEAE	*Polymeria pusila*	LC													+						
CUCURBITACEAE	*Cucumis melo ssp. agrestis*	*																			
CUCURBITACEAE	*Diplocyclos palmatus*	LC						'+(t)													
CYPERACEAE	*Abilgaardia ovata*	LC								2					+			1			
CYPERACEAE	*Carex breviglumis*	LC											1								
CYPERACEAE	*Carex inversa*	LC								1											
CYPERACEAE	*Cyperus cyperoides*	LC		+(t)																	
CYPERACEAE	*Cyperus decompositus*	LC					1	4-5													
CYPERACEAE	*Cyperus difformis*	LC		1					1(d,t)												
CYPERACEAE	*Cyperus flaccidus*	LC		2	+		1								1		+				
CYPERACEAE	*Cyperus gracilis*	LC			+(t)			1		2				3							
CYPERACEAE	*Cyperus polystachyos*	LC																			1
CYPERACEAE	*Cyperus tenuispicta*	LC								1											

FAMILY	Botanical name	Status	Location – regional ecosystem and assessment sites (refer to Appendix D)																		
			11.3.4				12.2.2		12.3.3		12.3.7	12.11.4		12.11.6			12.11.14			Sub-HAT Vegetation	Road Reserve
			S055	S056	S057	S058	S081	S108	S063	S078	S100	S069	S084	S085	S089	S092	S062	S070	S075		
CYPERACEAE	*Eleocharis philippinensis*	LC							1(t)												
CYPERACEAE	*Fimbristylis aestivalvis*	LC		3	2	1															
CYPERACEAE	*Fimbristylis bisumbellata*	LC	+-2(t)	1						2											
CYPERACEAE	*Fimbristylis dichotoma*	LC																1			
CYPERACEAE	*Fimbristylis ferruginea*	LC																		1-3	
CYPERACEAE	*Fimbristylis polytrichoides*	LC																		2-4	
CYPERACEAE	*Fimbristylis sp. (n-r)*	LC								2											
CYPERACEAE	*Fuirena ciliaris*	LC								2											
CYPERACEAE	*Gahnia aspera*	LC								2	1	+							1-2		
CYPERACEAE	*Scleria mackaviensis*	LC		1-2(t)	+		1-2					+	2		2		1		1-2		
CYPERACEAE	*Scleria novae-hollandiae*	LC																	2		
EBENACEAE	*Diospyros fasciculosa*	LC										1(t)									
EBENACEAE	*Diospyros geminata*	LC					2	3					1								
ELAEOCARPACEAE	*Elaeocarpus obovatus*	LC										1(t)									
EUPHORBIACEAE	*Alchornea ilicifolia*	LC																	1(t)		
EUPHORBIACEAE	*Breynia oblongifolia*	LC			+(t)			1			2				1			1(t)	+		
EUPHORBIACEAE	*Chamaesyce hirsuta*	*		1(t)				1	1					1			1				
EUPHORBIACEAE	*Chamaesyce hyssopifolia*	LC						2(t)													
EUPHORBIACEAE	*Euphorbia tannensis*	LC																1			
EUPHORBIACEAE	*Excocaria agallocha var. agallocha*	LC																		3	

FAMILY	Botanical name	Status	Location – regional ecosystem and assessment sites (refer to Appendix D)																			
			11.3.4				12.2.2		12.3.3		12.3.7	12.11.4		12.11.6			12.11.14			Sub-HAT Vegetation	Road Reserve
			S055	S056	S057	S058	S081	S108	S063	S078	S100	S069	S084	S085	S089	S092	S062	S070	S075		
EUPHORBIACEAE	*Glochidion ferdinandi*	LC																'+(t)			
EUPHORBIACEAE	*Glochidion lobocarpum*	LC											'+(t)								
EUPHORBIACEAE	*Mallotus claoxyioides*	LC																			
EUPHORBIACEAE	*Mallotus philippensis*	LC						+(t)			2(d/l)		5-6								
FABACEAE	*Aeschynomene indica*	*							+(t)												
FABACEAE	*Cajanus reticulatus*	LC									2										
FABACEAE	*Crotalaria brevis*	LC			+(t)											+					
FABACEAE	*Crotalaria medicaginea*	LC														+					
FABACEAE	*Crotalaria montana*	LC		2	1						2			1	1	1	1	2			
FABACEAE	*Crotalaria pallida*	*												2(t)							
FABACEAE	*Desmodium gangeticum*	LC		1					1												
FABACEAE	*Desmodium rhytidophyllum*	LC		2						1	2			2	2	2-3	2	2	2		
FABACEAE	*Desmodium triflorum*	LC															+				
FABACEAE	*Desmodium varians*	LC														'+(t)					
FABACEAE	*Erythrina vespertilio*	LC	2								2										
FABACEAE	*Flemingia parviflora*	LC		2	1(t)					+	1				1-2(t)	1-2	1(t)				
FABACEAE	*Glycine tabacina*	LC		2	2			1		1	2			2-3	2	2	+	2	2		
FABACEAE	*Glycine tomentalla*	LC								+											
FABACEAE	*Hardenbernia violacea*	LC													'+(t)						
FABACEAE	*Indigofera hirsuta*	LC			+(t)			2		+(t)				3		4					
FABACEAE	*Macroptilium*	*																			'+(t)

FAMILY	Botanical name	Status	Location – regional ecosystem and assessment sites (refer to Appendix D)																			
			11.3.4				12.2.2		12.3.3		12.3.7	12.11.4		12.11.6			12.11.14			Sub-HAT Vegetation	Road Reserve
			S055	S056	S057	S058	S081	S108	S063	S078	S100	S069	S084	S085	S089	S092	S062	S070	S075		
	atropurpureum																				
FABACEAE	*Macroptilium lathyroides*	*																			'+(t)
FABACEAE	*Pyncospora lutescens*	LC															1(t)				
FABACEAE	*Stylostanthes scabra*	*			1				+												
FABACEAE	*Tephrosia juncea*	LC														2			1-2(t)		
FABACEAE	*Tephrosia purpurea var. sericea*	LC												2		+(t)		+(n-r)			
FABACEAE	*Uraria lagopodioides*	LC		1(t)																	
FABACEAE	*Zornia muriculata*	LC																			'+(t)
GENTIANACEAE	*Schenkia austrlais*	LC																		1(e)	
HALORAGACEAE	*Haloragis stricta*	LC															+				
HEMEROCALLIDACEAE	*Dianella brevipedunculata*	LC			+(t)							+									
HEMEROCALLIDACEAE	*Dianella caerulea*	LC														+			2		
HEMEROCALLIDACEAE	*Dianella longifolia*	LC		1(t)									+								
HEMEROCALLIDACEAE	*Dianella revoluta*	LC												+							
HEMEROCALLIDACEAE	*Dianella sp. (n-r)*	LC		+					+(n-r)												
JUNCACEAE	*Juncus continuus*	LC								1											
LAMIACEAE	*Anisomeles malabarica*	LC										'+(t)									
LAMIACEAE	*Leonotis nepetifolia*	*																			'+(t)
LAMIACEAE	*Spartothamnella juncea*	LC										'+(t)									
LAURACEAE	*Cassytha filiformis*	LC											'+(t)								
LAURACEAE	*Cryptocarya triplinervis var. pubens*	LC										4									

FAMILY	Botanical name	Status	Location – regional ecosystem and assessment sites (refer to Appendix D)																			
			11.3.4				12.2.2		12.3.3		12.3.7	12.11.4		12.11.6			12.11.14			Sub-HAT Vegetation	Road Reserve
			S055	S056	S057	S058	S081	S108	S063	S078	S100	S069	S084	S085	S089	S092	S062	S070	S075		
LAXMANNIACEAE	*Eustrephus latifolius*	LC		2	1			2		2	1	2	3	2	2	2	1	1	2		
LAXMANNIACEAE	*Geitonoplesium cymosum*	LC										1(t)									
LAXMANNIACEAE	*Lomandra confertifolia ssp. pallida*	LC		+													1		2		
LAXMANNIACEAE	*Lomandra longifolia*	LC		+	+						2		2		2	1					
LAXMANNIACEAE	*Lomandra multiflora*	LC					+								1		1(t)				
LAXMANNIACEAE	*Xanthorrhoea johnsonii*	LC			1-2(t)																
LECYTHIDACEAE	*Planchonia careya*	LC	+(t)	2	+(t)				3		1-2			1	2	2	4	1-2(t)	1(t)		
LOGANIACEAE	*Strychnos psilosperma*	LC											'+(t)								
LORANTHACEAE	*Amyema miquellii*	LC		+																	
LORANTHACEAE	*Amylotheca dictyophleba*	LC										+(t)									
LYTHRACEAE	*Ammania multiflora*	LC		1					4(d,t)	2	+(t)										
MALVACEAE	*Hibiscus divaricatus*	LC								2				1		1		1(t)	1-2		
MALVACEAE	*Malvastrum americanum*	*							1					1			+				
MALVACEAE	*Malvastrum coramandelianum*	*					1							2		1					
MALVACEAE	*Sida acuta*	*						+						1(t)							
MALVACEAE	*Sida cordifolia*	LC			1(t)					1						+	1	+			
MALVACEAE	*Sida rhombifolia*	*		1	1				4	1-2				2		1		+			
MALVACEAE	*Sida subspicata*	LC	2		1		1(e)	1	3		2			1	+	1	2	+	1		
MARSILEACEAE	*Marsilea crenata*	LC						+(d,t)	3(d,t)												
MELIACEAE	*Melia azedarach var. azedarach*	LC											'+(t)								
MELIACEAE	*Turraea pubescens*	LC					3	3													

FAMILY	Botanical name	Status	Location – regional ecosystem and assessment sites (refer to Appendix D)																		
			11.3.4				12.2.2		12.3.3		12.3.7	12.11.4		12.11.6			12.11.14			Sub-HAT Vegetation	Road Reserve
			S055	S056	S057	S058	S081	S108	S063	S078	S100	S069	S084	S085	S089	S092	S062	S070	S075		
MENISPERMACEAE	*Hyspera decumbens*	LC										2									
MENISPERMACEAE	*Stephania japonica var. discolor*	LC									1										
MENISPERMACEAE	*Tinospora smilacina*	LC																			
MENYANTHACEAE	*Nymphoides indica*	LC						+(d,t)													
MIMOSACEAE	*Acacia disparrima ssp. disparrima*	LC	4	4-5		3	1(e,t)	4(t)	4	4-5	4	+		1	3	3-4	5		5		
MIMOSACEAE	*Acacia flavescens*	LC		+(t)																	
MIMOSACEAE	*Acacia holosericea*	LC	+(t)																		
MIMOSACEAE	*Acacia julifera*	LC									3				3-4						
MIMOSACEAE	*Acacia leiocalyx ssp. leiocalyx*	LC		1-2					1						3	2-3					
MIMOSACEAE	*Acacia maidenii*	LC																'+(t)			
MIMOSACEAE	*Neptunia gracilis*	LC																+			
MORACEAE	*Ficus hilli*	LC											+								
MORACEAE	*Ficus obliqua*	LC					+														
MORACEAE	*Ficus opposita*	LC									1				+	1					
MORACEAE	*Ficus racemosa*	LC									2(d/l)										
MORACEAE	*Ficus superba var. henneana*	LC											1								
MORACEAE	*Trophis scandens*	LC					3	2				2	3								
MYOPORACEAE	*Eremophila debile*	LC													+				+		
MYOPORACEAE	*Myoporum debile*	LC																1			
MYRSINACEAE	*Myrsine variabilis*	LC					3	3-4													
MYRTACEAE	*Aegiceras corniculatum*	LC																		1	
MYRTACEAE	*Corymbia citriodora ssp.*	LC	1											5	5	5					

FAMILY	Botanical name	Status	Location – regional ecosystem and assessment sites (refer to Appendix D)																			
			11.3.4				12.2.2		12.3.3		12.3.7	12.11.4		12.11.6			12.11.14			Sub-HAT Vegetation	Road Reserve
			S055	S056	S057	S058	S081	S108	S063	S078	S100	S069	S084	S085	S089	S092	S062	S070	S075		
	citriodora																				
MYRTACEAE	*Corymbia clarksoniana*	LC								2				1		+			3		
MYRTACEAE	*Corymbia erythrophloia*	LC											1-3(t)								
MYRTACEAE	*Corymbia intermedia*	LC	2-3	5		4					4						3				
MYRTACEAE	*Corymbia tessellaris*	LC	3		1(t)	4		3	5	+	1-2										
MYRTACEAE	*Eucalyptus crebra*	LC	4	3-4	5	4		5		2		1-5		3-4	3-4	2-3	5	6	5-6		
MYRTACEAE	*Eucalyptus exserta*	LC												+	1		2				
MYRTACEAE	*Eucalyptus tereticornis*	LC	4	4	3	4-5		1	5	6	5					+(d/l)	5		1(t)		
MYRTACEAE	*Lophostemon suaveolens*	LC	5	5	4	3-4			3-4	5	4		1-2(e)								
MYRTACEAE	*Melaleuca nervosa*	LC	5	4	4	5															
MYRTACEAE	*Melaleuca quinquenervia*	LC							1-5(t)												
MYRTACEAE	*Melaleuca viminalis*	LC									'+(t)										
MYRTACEAE	*Osbornia octodonta*	LC																		1	
NYMPHACEAE	*Nymphaea caerulea ssp. zanzibarenisis*	*						1(d,t)													
OLEACEAE	*Jasminum didymum ssp. didymum*	LC					2(t)						2								
OLEACEAE	*Jasminum volubile*	LC					1	3					3						1-2(t)		
OLEACEAE	*Olea paniculata*	LC										+(t)									
ONAGRACEAE	*Ludwigia octovalis*	LC								+											
ONAGRACEAE	*Ludwigia peploides ssp. montevidensis*	LC						1(d,t)													

FAMILY	Botanical name	Status	Location – regional ecosystem and assessment sites (refer to Appendix D)																		
			11.3.4				12.2.2		12.3.3		12.3.7	12.11.4		12.11.6			12.11.14			Sub-HAT Vegetation	Road Reserve
			S055	S056	S057	S058	S081	S108	S063	S078	S100	S069	S084	S085	S089	S092	S062	S070	S075		
ORCHIDACEAE	*Cymbidium canaliculatum*	LC																+			
ORCHIDACEAE	*Durabaculum undulatum*	LC										1(t)									
OXALIDACEAE	*Oxalis perennans*	LC							+					+							
OXALIDACEAE	*Oxalis sp. (n-r)*	LC								2(n-r)											
PASSIFLORACEAE	*Passiflora foetida*	*	+	1	+				+(t)						+						
PASSIFLORACEAE	*Passiflora suberosa*	*					1	3	3	1-3	3-4	2	3	3	2	2-3	1	1	2		
PHILYDRACEAE	*Philydrum lanuginosum*	LC						+(d,t)													
PHYLLANTHACEAE	*Bridelia leichhardtii*	LC																	'+(t)		
PHYLLANTHACEAE	*Phyllanthus virgatus*	LC		1						1	1			2	1	2	2	2	1		
PHYTOLACCAEAE	*Deeringia arborescens*	LC										+									
PHYTOLACCAEAE	*Rivinia humills*	*					1					5									
PICRODENDRACEAE	*Petalostigma pubescens*	LC		+(t)	+(t)	1(t)		4(e)										1	1-2		
PIPERACEAE	*Peperomia blanda var. floribunda*	LC										1(t)									
PITTOSPORACEAE	*Bursaria incana*	LC													+(t)						
PITTOSPORACEAE	*Pittosporum ferrugineum*	LC						2													
PITTOSPORACEAE	*Pittosporum spinescens*	LC																	1(t)		
PLUMBAGINACEAE	*Aegialitis annulata*	LC																		1	
PLUMBAGINACEAE	*Limonium solanderi*	LC																		2	
POACEAE	*Alloteropis semialata*	LC													+						
POACEAE	*Ancistrachne uncinulata*	LC											'+(t)								
POACEAE	*Aristida queenslandica*	LC			+										1		1				

FAMILY	Botanical name	Status	Location – regional ecosystem and assessment sites (refer to Appendix D)																		
			11.3.4				12.2.2		12.3.3		12.3.7	12.11.4		12.11.6			12.11.14			Sub-HAT Vegetation	Road Reserve
			S055	S056	S057	S058	S081	S108	S063	S078	S100	S069	S084	S085	S089	S092	S062	S070	S075		
	var. dissimilis																				
POACEAE	*Aristida queenslandica var. queenslandica*	LC													1			4-5	3		
POACEAE	*Aristida ramosa*	LC																			'+(t)
POACEAE	*Aristida spuria*	LC																'+(t)			
POACEAE	*Arundinella nepalensis*	LC	1	4-5	3	1			1		2				2-4(ck)		1				
POACEAE	*Bothriochloa bladhii ssp. bladhii*	LC				'+(t)			1												
POACEAE	*Bothriochloa decipens var. decipiens*	LC			1			1									1	4-5	1		
POACEAE	*Brachiaria subquadripara*	*					1									2					
POACEAE	*Calyptochloa gracillima*	LC																	1-2		
POACEAE	*Capillipedium spicigerum*	LC		2-3	1										2-3						
POACEAE	*Chloris inflata*	*							2												
POACEAE	*Chloris ventricosa*	LC						+													
POACEAE	*Chrysopogon fallax*	LC			1					1	+					2	2				
POACEAE	*Cymbopogon bombycinus*	LC			'+(t)																
POACEAE	*Cymbopogon refractus*	LC		+	2		1(e)										1	2	2		
POACEAE	*Cynodon dactylon*	*						+(t)	3(d,t)		+										
POACEAE	*Dactyloctenium aegypticum*	*															1(t)				
POACEAE	*Digitaria diffusa*	LC					1		2	2				1	1	2			3		
POACEAE	*Digitaria eriantha*	*							+												
POACEAE	*Digitaria parviflora*	LC								3											

FAMILY	Botanical name	Status	Location – regional ecosystem and assessment sites (refer to Appendix D)																			
			11.3.4				12.2.2		12.3.3		12.3.7	12.11.4		12.11.6			12.11.14			Sub-HAT Vegetation	Road Reserve
			S055	S056	S057	S058	S081	S108	S063	S078	S100	S069	S084	S085	S089	S092	S062	S070	S075		
POACEAE	*Digitaria violascens*	*																			'+(t)
POACEAE	*Enneapogon lindleyanus*	LC			+																
POACEAE	*Eragrostis elongata*	LC																			'+(t)
POACEAE	*Eragrostis leptostachya*	LC			1				1												
POACEAE	*Eragrostis parviflora*	LC																	'+(t)		
POACEAE	*Eragrostis spartinoides*	LC	+(t)	4	2-3					3-4				2			3	4	2		
POACEAE	*Eriochloa procera*	LC							1					2							
POACEAE	*Heteropogon contortus*	LC		3	5			3	3	1	3				3	2	2	3	3		
POACEAE	*Hyparrhenia rufa*	*	6	3	2	6															
POACEAE	*Imperata cylindrica*	LC							1-3(t)	1-2						2-3					
POACEAE	*Leptochloa decipens ssp. decipiens*	LC			1-2			1									4	3-4			
POACEAE	*Leptochloa decipens ssp. peacockii*	LC							1	2						+(d/l)					
POACEAE	*Megathrysus maximus var. pubiglumis*	*	1(t)		1	1-3(t)		3-4			1-2										
POACEAE	*Melinis minutiflora*	*		+(t)																	
POACEAE	*Melinis repens*	*		+			1	2						2		2-3	1-2		2-3		
POACEAE	*Oplismenus aemulus*	LC					3(c)	1(t)		1	3-4	2	2		1	1-3					
POACEAE	*Oplismenus hirtellus ssp. imbecillis*	LC																			
POACEAE	*Ottochloa gracillima*	LC					3	2-3	1-3(t)	2-4							1(t)	+			
POACEAE	*Ottochloa nodosa*	LC								1											

FAMILY	Botanical name	Status	Location – regional ecosystem and assessment sites (refer to Appendix D)																		
			11.3.4				12.2.2		12.3.3		12.3.7	12.11.4		12.11.6			12.11.14			Sub-HAT Vegetation	Road Reserve
			S055	S056	S057	S058	S081	S108	S063	S078	S100	S069	S084	S085	S089	S092	S062	S070	S075		
POACEAE	*Panicum effusum*	LC			2													+			
POACEAE	*Panicum simile*	LC		1											2		1-2	1	1		
POACEAE	*Paspalidium distans*	LC		2					2	3	3			1	1	3		2	1		
POACEAE	*Paspalidium disjunctum*	LC					1														
POACEAE	*Paspalum scrobiculatum*	LC								+	+										
POACEAE	*Sarga nitidum*	LC	1-2			1					2-3				2	+					
POACEAE	*Setaria surgens*	LC					1(e)														
POACEAE	*Sorghum almum*	*							1(t)												
POACEAE	*Sporobolus elongatus*	LC								1											
POACEAE	*Sporobolus laxus*	LC								3-4											
POACEAE	*Sporobolus virginicus*	LC																		1-6	
POACEAE	*Themeda triandra*	LC	+(t)	1	3-4										3-4			1	1		
POACEAE	*Urochloa mosambicensis*	*																			'+(t)
POLYGONACEAE	*Persicaria attenuata*	LC						+(d,t)													
POTAMOGETONACEAE	*Potamogeton tricarinatus*	LC						2(d,t)													
RHAMNACEAE	*Alphitonia excelsa*	LC					1(e,t)	2(e)	1	2-3	3	3	2(e)	+	1		4	2	3-4		
RHAMNACEAE	*Rhamnella vitensis*	LC										+									
RHIZOPHORACEAE	*Bruguiera gymnorhiza*	LC																		1	
RHIZOPHORACEAE	*Ceriops australis*	LC																		2-5	
RHIZOPHORACEAE	*Rhizophora stylosa*	LC																		5-6	
RUBIACEAE	*Aidia racemosa*	LC					2														
RUBIACEAE	*Cyclophyllum coprosmoides*	LC					'+(t)							'+(t)							

FAMILY	Botanical name	Status	Location – regional ecosystem and assessment sites (refer to Appendix D)																		
			11.3.4				12.2.2		12.3.3		12.3.7	12.11.4		12.11.6			12.11.14			Sub-HAT Vegetation	Road Reserve
			S055	S056	S057	S058	S081	S108	S063	S078	S100	S069	S084	S085	S089	S092	S062	S070	S075		
RUBIACEAE	*Pogonolobus reticulatus*	LC			2		1	+(e)		1-2	2				3	1-2	4		3		
RUBIACEAE	*Psydrax odorata forma australiana*	LC					2					+(t)									
RUBIACEAE	*Spermacoce multicaulis*	LC		1						1							1	1			
RUBIACEAE	*Timonius timon*	LC									1-4(d/l)										
RUBIACEAE	*Triflorensia cameronii*	LC					1(t)														
RUTACEAE	*Acronychia laevis*	LC					4	1-2					1								
RUTACEAE	*Citrus x bahiensis*	*										+(t)									
RUTACEAE	*Coatesia paniculata*	LC											'+(t)								
RUTACEAE	*Geijera salicifolia*	LC																	'+(t)		
RUTACEAE	*Micromelum minutum*	LC						3													
SANTALACEAE	*Exocarpus latifolius*	LC					4-5	1				2	1-2								
SAPINDACEAE	*Alectryon connatus*	LC					+(t)					+									
SAPINDACEAE	*Alectryon diversifolius*	LC						2													
SAPINDACEAE	*Alectryon subcinereus*	LC										1									
SAPINDACEAE	*Alectryon tomentosum*	LC					1(e,t)					1									
SAPINDACEAE	*Cupaniopsis anacardioides*	LC					4	2(t)				4	1			+					
SAPINDACEAE	*Cupaniopsis (sp.* indet.)	unknown										1(t)									
SAPINDACEAE	*Cupaniopsis wadsworthii*	LC					+(t)					3									
SAPINDACEAE	*Dodonaea lanceolata*	LC													1			+	1		
SAPINDACEAE	*Elattostachys xylocarpa*	LC											'+(t)								

FAMILY	Botanical name	Status	Location – regional ecosystem and assessment sites (refer to Appendix D)																			
			11.3.4				12.2.2		12.3.3		12.3.7	12.11.4		12.11.6			12.11.14			Sub-HAT Vegetation	Road Reserve
			S055	S056	S057	S058	S081	S108	S063	S078	S100	S069	S084	S085	S089	S092	S062	S070	S075		
SAPINDACEAE	*Harpullia hillii*	LC										'+(t)									
SAPINDACEAE	*Harpullia pendula*	LC										4-5									
SAPINDACEAE	*Jagera pseudorhus*	LC					3				+	3	3						1		
SAPINDACEAE	*Rhysotoechia bifoliata*	LC										2									
SAPOTACEAE	*Pouteria sericea*	LC					4-5					4									
SCROPHULARIACEAE	*Bacopa floribunda*	LC													1(t)						
SCROPHULARIACEAE	*Hygrophila angustifolia*	LC								3											
SCROPHULARIACEAE	*Lindernia crustacea*	LC		+					2(d,t)								+				
SCROPHULARIACEAE	*Scoparia dulcis*	*			+(t)																
SMILACACEAE	*Smilax australis*	LC					1														
SOLANACEAE	*Capsicum frutescens*	*							+(t)												
SOLANACEAE	*Physalis perurviana*	LC								+(t)				1			+(t)				
SOLANACEAE	*Solanum nigrum*	*			+				+	1				1		+					
SOLANACEAE	*Solanum seaforthianum*	*						1				+	3	2							
STERCULIACEAE	*Sterculia quadrifida*	LC					+(t)														
TILIACEAE	*Grewia latifolia*	LC		+	2	1(t)															
TILIACEAE	*Triumfetta rhomboidea*	*							1		1-2			3	1	1(t)					
ULMACEAE	*Celtis paniculata*	LC										1(t)									
VERBENACEAE	*Clerodendrum floribundum*	LC					2					2							1-2(t)		
VERBENACEAE	*Glossocarya hemiderma*	LC					'+(t)														
VERBENACEAE	*Lantana camara var. camara*	* (Class 3)	1-2	1	1		1	2-3	+(t)	1-2		+	1-2								
VERBENACEAE	*Stachytarpheta jamaicensis*	*	1(t)		+																

FAMILY	Botanical name	Status	Location – regional ecosystem and assessment sites (refer to Appendix D)																		
			11.3.4				12.2.2		12.3.3		12.3.7	12.11.4		12.11.6			12.11.14			Sub-HAT Vegetation	Road Reserve
			S055	S056	S057	S058	S081	S108	S063	S078	S100	S069	S084	S085	S089	S092	S062	S070	S075		
VERBENACEAE	*Vitex trifolia var. trifolia*	LC					4(e,t)														
VIOLACEAE	*Hybanthus stellariodes*	LC																	'+(t)		
VITACEAE	*Cissus oblonga*	LC					4	2													
VITACEAE	*Clematocissus opaca*	LC																'+(t)			

Legend

1. "Status" indicates the Queensland conservation status of each taxon under the *Nature Conservation (Wildlife) Regulation 2006*. The codes are Least Concern (LC) and Naturalised Exotic (*). Threatened taxa are described as Endangered (E), Vulnerable (V) or Near Threatened (NT). No species which are afforded a conservation status under the *Environmental Conservation and Biodiversity Conservation Act 1999* were identified in the Study Area.

2. Relative abundance" was based on the Hurst & Allen modification of the Braun-Blanquet technique cover-abundance scale (Hurst and Allen 2007, Mueller-Dombois & Ellenberg 1974, Whittaker 1975) as follows:

- + = one or two individuals only
- 1 = sparse, <5%;
- 2 = any number, <5%;
- 3 = 5 – 24%;
- 4 = 25 – 49%;
- 5 = 50 – 74%;
- 6 = 75 – 100%.

3. The annotation that has been used after some of the relative abundance scores are as follows:

- d = dam
- d/l = drainage line
- e = edge of vegetation community

t = traverse Sub-HAT vegetation refers to species observed below the HAT and therefore strictly outside the scope of this assessment. Records from the road reserve are also included – these are outside of assessment sites (see Appendix D).

Appendix C Fauna Species Observed During Field Surveys

Group	Scientific name	Common name	Status	Location							
				Boatshed point	Curtis Island LNG Facility	Hamilton Point	Tunnel entry shaft & tunnel spoil disposal area	TWAF 8	Mainland within study area	Mainland within 5 km buffer	Curtis Island within 5 km Buffer
Amphibian	*Limnodynastes peronii*	striped marshfrog	Protected						Y		
Amphibian	*Litoria caerulea*	common green treefrog	Protected			Y	Y		Y		Y
Amphibian	*Litoria fallax*	eastern sedgefrog	Protected			Y		Y			
Amphibian	*Litoria gracilenta*	graceful treefrog	Protected						Y		
Amphibian	*Litoria latopalmata*	broad palmed rocketfrog	Protected						Y		
Amphibian	*Litoria nasuta*	striped rocketfrog	Protected						Y		
Amphibian	*Litoria rubella*	ruddy treefrog	Protected						Y	Y	Y
Amphibian	*Platyplectrum ornatum*	ornate burrowing frog	Protected						Y		
Amphibian	*Pseudophryne raveni*		Protected								Y
Amphibian	*Rhinella marina*	cane toad	Exotic	Y	Y	Y		Y	Y	Y	Y
Avian	*Accipiter novaehollandiae*	grey goshawk	NCA NT								Y
Avian	*Aegotheles cristatus*	Australian owlet-nightjar	Protected						Y		Y
Avian	*Alectura lathami*	Australian brush-turkey	Protected		Y				Y		
Avian	*Anas superciliosa*	Pacific black duck	Protected			Y			Y		
Avian	*Aprosmictus erythropterus*	red-winged parrot	Protected						Y		
Avian	*Aquila audax*	wedge-tailed eagle	Protected		Y				Y	Y	Y
Avian	*Ardea alba*	great egret	EPBC M						Y		
Avian	*Ardea pacifica*	white-necked heron	Protected							Y	
Avian	*Artamus leucorynchus*	white-breasted woodswallow	Protected		Y				Y		
Avian	*Aviceda subcristata*	Pacific baza	Protected		Y				Y		
Avian	*Aythya australis*	hardhead	Protected						Y		
Avian	*Burhinus grallarius*	bush stone-curlew	Protected		Y					Y	
Avian	*Butorides striata*	striated heron	Protected				Y		Y		

Group	Scientific name	Common name	Status	Location							
				Boatshed point	Curtis Island LNG Facility	Hamilton Point	Tunnel entry shaft & tunnel spoil disposal area	TWAF 8	Mainland within study area	Mainland within 5 km buffer	Curtis Island within 5 km Buffer
Avian	*Cacomantis flabelliformis*	fan-tailed cuckoo	Protected		Y					Y	
Avian	*Cacomantis variolosus*	brush cuckoo	Protected			Y					
Avian	*Calyptorhynchus banksii*	red-tailed black-cockatoo	Protected		Y	Y		Y		Y	Y
Avian	*Caprimulgus macrurus*	large-tailed nightjar	Protected								Y
Avian	*Carterornis leucotis*	white-eared monarch	Protected								Y
Avian	*Centropus phasianinus*	pheasant coucal	Protected		Y	Y		Y	Y		Y
Avian	*Chalcites lucidus*	shining bronze-cuckoo	Protected							Y	
Avian	*Charadrius mongolus*	lesser sand plover	EPBC M				Y				
Avian	*Charadrius ruficapillus*	red-capped plover	Protected		Y		Y		Y		
Avian	*Chlidonias hybrida*	whiskered tern	Protected						Y		
Avian	*Chroicocephalus novaehollandiae*	silver gull	Protected						Y		
Avian	*Cisticola exilis*	golden-headed cisticola	Protected						Y		
Avian	*Colluricincla harmonica*	grey shrike-thrush	Protected		Y				Y	Y	Y
Avian	*Colluricincla megarhyncha*	little shrike-thrush	Protected	Y							
Avian	*Coracina novaehollandiae*	black-faced cuckoo-shrike	Protected		Y	Y	Y		Y	Y	Y
Avian	*Coracina papuensis*	white-bellied cuckoo-shrike	Protected							Y	
Avian	*Coracina tenuirostris*	cicadabird	Protected						Y	Y	
Avian	*Corcorax melanorhamphos*	white-winged chough	Protected		Y				Y		Y
Avian	*Corvus orru*	Torresian crow	Protected		Y		Y	Y	Y	Y	Y
Avian	*Cracticus nigrogularis*	pied butcherbird	Protected		Y	Y			Y	Y	Y
Avian	*Cracticus tibicen*	Australian magpie	Protected		Y	Y		Y	Y	Y	Y

Group	Scientific name	Common name	Status	Location							
				Boatshed point	Curtis Island LNG Facility	Hamilton Point	Tunnel entry shaft & tunnel spoil disposal area	TWAF 8	Mainland within study area	Mainland within 5 km buffer	Curtis Island within 5 km Buffer
Avian	*Cracticus torquatus*	grey butcherbird	Protected						Y	Y	
Avian	*Dacelo leachii*	blue-winged kookaburra	Protected		Y	Y			Y	Y	Y
Avian	*Dacelo novaeguineae*	laughing kookaburra	Protected	Y	Y	Y	Y	Y	Y	Y	Y
Avian	*Daphoenositta chrysoptera*	varied sittella	Protected								Y
Avian	*Dicaeum hirundinaceum*	mistletoebird	Protected			Y			Y	Y	
Avian	*Dicrurus bracteatus*	spangled drongo	Protected		Y	Y			Y	Y	Y
Avian	*Egretta garzetta*	little egret	Protected				Y		Y		
Avian	*Egretta novaehollandiae*	white-faced heron	Protected	Y	Y						
Avian	*Elanus axillaris*	black-shouldered kite	Protected						Y		
Avian	*Entomyzon cyanotis*	blue-faced honeyeater	Protected						Y		
Avian	*Eolophus roseicapillus*	galah	Protected		Y	Y	Y				
Avian	*Esacus magnirostris*	beach stone-curlew	NCA V						Y		Y
Avian	*Eudynamys orientalis*	eastern koel	Protected				Y	Y			
Avian	*Eurostopodus mystacalis*	white-throated nightjar	Protected								Y
Avian	*Eurystomus orientalis*	dollarbird	Protected						Y		
Avian	*Falco cenchroides*	nankeen kestrel	Protected						Y		
Avian	*Falco peregrinus*	peregrine falcon	Protected	Y						Y	
Avian	*Gallinula tenebrosa*	dusky moorhen	Protected						Y		
Avian	*Geopelia humeralis*	bar-shouldered dove	Protected	Y	Y	Y	Y	Y	Y	Y	Y
Avian	*Geopelia striata*	peaceful dove	Protected			Y	Y	Y	Y	Y	
Avian	*Geophaps scripta scripta*	squatter pigeon (southern subspecies)	EPBC V NCA V							Y	
Avian	*Gerygone levigaster*	mangrove gerygone	Protected						Y	Y	Y

Group	Scientific name	Common name	Status	Location							
				Boatshed point	Curtis Island LNG Facility	Hamilton Point	Tunnel entry shaft & tunnel spoil disposal area	TWAF 8	Mainland within study area	Mainland within 5 km buffer	Curtis Island within 5 km Buffer
Avian	*Gerygone palpebrosa*	fairy gerygone	Protected	Y							
Avian	*Glossopsitta pusilla*	little lorikeet	Protected		Y				Y	Y	Y
Avian	*Haematopus longirostris*	Australian pied oystercatcher	Protected						Y	Y	
Avian	*Haliaeetus leucogaster*	white-bellied sea-eagle	EPBC M	Y		Y			Y		Y
Avian	*Haliastur indus*	brahminy kite	Protected	Y		Y		Y	Y	Y	Y
Avian	*Haliastur sphenurus*	whistling kite	Protected	Y	Y	Y	Y	Y	Y	Y	Y
Avian	*Hieraaetus morphnoides*	little eagle	Protected							Y	
Avian	*Hirundo neoxena*	welcome swallow	Protected		Y	Y	Y		Y		
Avian	*Hydroprogne caspia*	Caspian tern	EPBC M						Y	Y	
Avian	*Lalage leucomela*	varied triller	Protected							Y	Y
Avian	*Lichenostomus chrysops*	yellow-faced honeyeater	Protected		Y				Y	Y	
Avian	*Lichenostomus fasciogularis*	mangrove honeyeater	Protected						Y	Y	
Avian	*Lichmera indistincta*	brown honeyeater	Protected			Y	Y		Y	Y	
Avian	*Limosa lapponica*	bar-tailed godwit	EPBC M						Y	Y	
Avian	*Lophoictinia isura*	square-tailed kite	NCA NT							Y	
Avian	*Malurus melanocephalus*	red-backed fairy-wren	Protected			Y		Y	Y		Y
Avian	*Manorina melanocephala*	noisy miner	Protected							Y	
Avian	*Meliphaga lewinii*	Lewin's honeyeater	Protected						Y	Y	
Avian	*Melithreptus albogularis*	white-throated honeyeater	Protected		Y	Y		Y	Y	Y	Y
Avian	*Melithreptus lunatus*	white-naped honeyeater	Protected						Y		
Avian	*Merops ornatus*	rainbow bee-eater	EPBC M		Y	Y	Y	Y	Y	Y	Y
Avian	*Microcarbo melanoleucos*	little pied cormorant	Protected						Y		

Group	Scientific name	Common name	Status	Location							
				Boatshed point	Curtis Island LNG Facility	Hamilton Point	Tunnel entry shaft & tunnel spoil disposal area	TWAF 8	Mainland within study area	Mainland within 5 km buffer	Curtis Island within 5 km Buffer
Avian	*Milvus migrans*	black kite	Protected						Y		
Avian	*Myiagra rubecula*	leaden flycatcher	Protected	Y	Y	Y			Y	Y	Y
Avian	*Myzomela sanguinolenta*	scarlet honeyeater	Protected		Y	Y	Y		Y	Y	Y
Avian	*Ninox boobook*	southern boobook	Protected		Y	Y				Y	Y
Avian	*Ninox connivens*	barking owl	Protected		Y	Y				Y	
Avian	*Ninox strenua*	powerful owl	NCA V								Y
Avian	*Numenius madagascariensis*	eastern curlew	EPBC M NCA NT			Y			Y	Y	
Avian	*Numenius phaeopus*	whimbrel	EPBC M						Y	Y	Y
Avian	*Ocyphaps lophotes*	crested pigeon	Protected						Y		
Avian	*Oriolus sagittatus*	olive-backed oriole	Protected		Y	Y				Y	Y
Avian	*Pachycephala pectoralis*	golden whistler	Protected							Y	
Avian	*Pachycephala rufiventris*	rufous whistler	Protected		Y	Y			Y	Y	Y
Avian	*Pardalotus punctatus*	spotted pardalote	Protected		Y						Y
Avian	*Pardalotus striatus*	striated pardalote	Protected		Y	Y	Y	Y	Y	Y	Y
Avian	*Pelecanus conspicillatus*	Australian pelican	Protected						Y		
Avian	*Petrochelidon ariel*	fairy martin	Protected			Y			Y	Y	
Avian	*Petrochelidon nigricans*	tree martin	Protected						Y		
Avian	*Phalacrocorax varius*	pied cormorant	Protected			Y				Y	
Avian	*Philemon citreogularis*	little friarbird	Protected		Y				Y	Y	Y
Avian	*Philemon corniculatus*	noisy friarbird	Protected		Y	Y	Y	Y	Y	Y	Y
Avian	*Platycercus adscitus*	pale-headed rosella	Protected		Y				Y		Y
Avian	*Podargus strigoides*	tawny frogmouth	Protected			Y				Y	Y

Group	Scientific name	Common name	Status	Location							
				Boatshed point	Curtis Island LNG Facility	Hamilton Point	Tunnel entry shaft & tunnel spoil disposal area	TWAF 8	Mainland within study area	Mainland within 5 km buffer	Curtis Island within 5 km Buffer
Avian	*Pomatostomus temporalis*	grey-crowned babbler	Protected							Y	
Avian	*Ptilinopus regina*	rose-crowned fruit-dove	Protected	Y						Y	
Avian	*Rhipidura albiscapa*	grey fantail	Protected		Y				Y	Y	Y
Avian	*Rhipidura leucophrys*	willie wagtail	Protected		Y				Y	Y	Y
Avian	*Rhipidura rufifrons*	rufous fantail	EPBC M			Y				Y	
Avian	*Scythrops novaehollandiae*	channel-billed cuckoo	Protected			Y		Y			
Avian	*Sphecotheres vieilloti*	Australasian figbird	Protected					Y	Y	Y	
Avian	*Strepera graculina*	pied currawong	Protected							Y	Y
Avian	*Tachybaptus novaehollandiae*	Australasian grebe	Protected						Y		
Avian	*Taeniopygia bichenovii*	double-barred finch	Protected				Y	Y	Y		
Avian	*Thalasseus bergii*	crested tern	Protected								Y
Avian	*Threskiornis molucca*	Australian white ibis	Protected						Y		
Avian	*Todiramphus chloris*	collared kingfisher	Protected						Y		
Avian	*Todiramphus macleayii*	forest kingfisher	Protected		Y				Y		Y
Avian	*Todiramphus sanctus*	sacred kingfisher	Protected			Y			Y		Y
Avian	*Trichoglossus chlorolepidotus*	scaly-breasted lorikeet	Protected				Y		Y	Y	
Avian	*Trichoglossus haematodus moluccanus*	rainbow lorikeet	Protected	Y	Y	Y		Y	Y	Y	Y
Avian	*Vanellus miles*	masked lapwing	Protected		Y		Y		Y	Y	Y
Avian	*Zosterops lateralis*	silvereye	Protected		Y	Y				Y	Y
Avian	*Pandion haliaetus*	eastern osprey	EPBC M			Y				Y	Y
Mammal	*Aepyprymnus rufescens*	rufous bettong	Protected						Y		

Group	Scientific name	Common name	Status	Location							
				Boatshed point	Curtis Island LNG Facility	Hamilton Point	Tunnel entry shaft & tunnel spoil disposal area	TWAF 8	Mainland within study area	Mainland within 5 km buffer	Curtis Island within 5 km Buffer
Mammal	*Austronomus australis*	white-striped freetail bat	Protected	Y	Y					Y	Y
Mammal	*Canis familiaris*	dog	Exotic				Y		Y	Y	Y
Mammal	*Chalinolobus gouldii*	gould's wattled bat	Protected	Y							
Mammal	*Equus caballus*	horse	Exotic		Y						
Mammal	*Hydromys chrysogaster*	water rat	Protected						Y		
Mammal	*Isoodon macrourus*	northern brown bandicoot	Protected						Y		
Mammal	*Lepus capensis*	brown hare	Exotic						Y		
Mammal	*Macropus agilis*	agile wallaby	Protected							Y	
Mammal	*Macropus giganteus*	eastern grey kangaroo	Protected		Y	Y		Y	Y		
Mammal	*Macropus parryi*	whiptail wallaby	Protected							Y	
Mammal	*Miniopterus australis*	little bent-wing bat	Protected		Y					Y	Y
Mammal	*Miniopterus orianae oceanensis*	eastern bent-wing bat	Protected	Y							
Mammal	*Petauroides volans*	greater glider	Protected						Y	Y	Y
Mammal	*Petaurus australis australis*	yellow-bellied glider (southern subspecies)	Protected							Y	
Mammal	*Petaurus breviceps*	sugar glider	Protected							Y	Y
Mammal	*Pteropus alecto*	black flying-fox	Protected							Y	
Mammal	*Pteropus poliocephalus*	grey-headed flying-fox	EPBC V							Y	Y
Mammal	*Rattus rattus*	black rat	Exotic								Y
Mammal	*Tachyglossus aculeatus*	short-beaked echidna	Protected	Y							
Mammal	*Trichosurus vulpecula*	common brushtail possum	Protected		Y	Y			Y	Y	Y

Group	Scientific name	Common name	Status	Location							
				Boatshed point	Curtis Island LNG Facility	Hamilton Point	Tunnel entry shaft & tunnel spoil disposal area	TWAF 8	Mainland within study area	Mainland within 5 km buffer	Curtis Island within 5 km Buffer
Mammal	*Vulpes vulpes*	red fox	Exotic								Y
Mammal	*Wallabia bicolor*	swamp wallaby	Protected							Y	
Reptile	*Boiga irregularis*	brown tree snake	Protected								Y
Reptile	*Carlia foliorum*		Protected		Y				Y		Y
Reptile	*Carlia vivax*		Protected						Y		Y
Reptile	*Cryptoblepharus virgatus sensu lato*	wall skink	Protected		Y	Y			Y	Y	Y
Reptile	*Ctenotus taeniolatus*		Protected		Y						
Reptile	*Dendrelaphis punctulata*	common tree snake	Protected	Y						Y	
Reptile	*Eulamprus tenuis*		Protected							Y	
Reptile	*Furina diadema*		Protected							Y	Y
Reptile	*Glaphyromorphus punctulatus*		Protected							Y	
Reptile	*Heteronotia binoei*		Protected	Y	Y	Y			Y	Y	Y
Reptile	*Lampropholis delicata*		Protected								Y
Reptile	*Morelia spilota*	carpet python	Protected								Y
Reptile	*Oedura rhombifer*	zig-zag gecko	Protected			Y					Y
Reptile	*Pogona barbata*	bearded dragon	Protected			Y					
Reptile	*Varanus tristis*	black-tailed monitor	Protected			Y					Y

Y denotes confirmed record during field surveys for the Arrow LNG Plant.

Status refers to legislative status under the NCA or EPBC. All native species are considered 'Protected under the NCA. M= 'Migratory', V= 'Vulnerable', NT= 'Near Threatened'

Appendix D
Vegetation Assessment Sites

Vegetation Assessment Sites - Preliminary Field Investigation (Dry Season)

Date:	14th to 16th December 2009
Datum:	WGS84
Device:	Garmin *etrex* Vista HCx

Waypoint	UTM grid	Assessment site	Regional ecosystem	Remnant status	Comments
1	56 K 320299 7369905	Q001	12.11.14	Remnant	
2	56 K 320104 7369873	Q002	12.11.14	Remnant	
4	56 K 319361 7369892	Q003	12.11.6	Remnant	Drainage line, braided sinuous channel representative of incised geology - NOT alluvium
5	56 K 319219 7369861	Q004	12.11.6	Remnant	Drainage line, braided sinuous channel representative of incised geology - NOT alluvium
8	56 K 320088 7369560	Q005	12.11.14	Remnant	Drainage line, braided sinuous channel representative of incised geology - NOT alluvium
11	56 K 319681 7368518	Q006	12.11.14 or 12.3.6	Remnant	Small patch size
12	56 K 319490 7367945	Q007	12.11.7	Remnant	Small patch of mid-stratum
14	56 K 319566 7367792	Q008	12.1.3	Remnant	*R.stylosa* dominant
15	56 K 319857 7367673	Q009	12.11.4	Remnant	Good quality, potential habitat
17	56 K 319727 7368578	Q010	12.11.4 (with elements of 12.3.6)	Remnant	Currently mapped as 12.2.2 (holocene dunes not readily evident and 'beach scrub' generally lacking (occasional isolated individuals or small clumps of VF generalists)
18	56 K 320026 7368331	Q011	12.11.14	Remnant	Lower slope variant
19	56 K 318964 7369182	Q012	12.11.14	Remnant	Lower slope variant
23	56 K 317853 7368112	Q013	12.2.2	Remnant	Much restricted in size compared with RE map
44	56 K 311848 7364731	Q015	12.3.7	Remnant	Narrow creekline with broad overflow terrace generally lacking woody vegetative cover but with overflow billabong to north
47	56 K 311797 7364986	Q016	12.3.3	Non-remnant	Mid-mature regrowth woodland

Waypoint	UTM grid	Assessment site	Regional ecosystem	Remnant status	Comments
48	56 K 311964 7366576	Q017	12.3.3/11.3.29	Remnant	Site at ecotone of community
49	56 K 311159 7369340	Q018	12.3.3	Borderline	
51	56 K 310262 7369298	Q019	11.3.29	Borderline	

Vegetation Assessment Sites – Detailed Flora Survey (Late Wet/Early Dry Season)

Date:	12th to 22nd July 2010
Datum:	GDA94
Device:	Garmin *etrex* Vista HCx

Project area	Assessment type	Waypoint	Zone	Easting	Northing	Assessment site	DERM mapped regional ecosystem	Field-validated regional ecosystem	Remnant status	Vegetation management status
Mainland	Secondary	418	56 K	311887	7366459	S055	11.3.29	11.3.4	Remnant	'Of Concern'
Mainland	Secondary	419	56 K	311770	7365956	S056	11.3.29	11.3.4	Remnant	'Of Concern'
Mainland	Secondary	420	56 K	312628	7364087	S057	11.3.29	11.3.4	Remnant	'Of Concern'
Mainland	Secondary	423	56 K	313020	7363716	S058	11.3.29/12.3.3	11.3.4	Remnant	'Of Concern'
Mainland	Quaternary Sites	426	56 K	311675	7364405	Q059	12.11.6/12.11.14 (60/40)	12.11.14	Remnant	'Least Concern'
Curtis Island	Secondary	93	56 K	318973	7368434	S062	12.11.6/12.11.14 (85/15)	12.11.14	Remnant	'Of Concern'
Curtis Island	Secondary	94	56 K	319658	7368718	S063	12.3.7/12.3.11 (70/30)	12.3.3	Remnant	'Endangered'
Curtis Island	Secondary	123	56 K	319838	7367704	S069	12.11.4	12.11.4	Remnant	'Of Concern'
Curtis Island	Secondary	124	56 K	319851	7367990	S070	12.11.6	12.11.14	Remnant	'Of Concern'
Curtis Island	Secondary	131	56 K	320594	7368950	S075	12.11.6/12.11.4 (70/30)	12.11.14	Remnant	'Of Concern'
Curtis Island	Secondary	137	56 K	320123	7369383	S078	12.3.11/12.11.6/12.11.14 (60/30/10)	12.3.3	Remnant	'Endangered'
Curtis Island	Secondary	176	56 K	319109	7367202	S081	12.11.4	12.2.2	Remnant	'Of Concern'
Curtis Island	Tertiary Sites	92	56 K	319118	7368328	T061	12.11.6	12.11.14	Remnant	'Of Concern'

Project area	Assessment type	Waypoint	Zone	Easting	Northing	Assessment site	DERM mapped regional ecosystem	Field-validated regional ecosystem	Remnant status	Vegetation management status
Curtis Island	Tertiary Sites	95	56 K	319770	7368849	T064	12.11.6/12.11.14 (85/15)	12.3.3	Remnant	'Endangered'
Curtis Island	Tertiary Sites	116	56 K	319538	7368725	T065	12.11.6/12.11.14 (85/15)	12.11.14	Remnant	'Of Concern'
Curtis Island	Tertiary Sites	118	56 K	319930	7367549	T067	12.11.4	12.11.4	Remnant	'Of Concern'
Curtis Island	Tertiary Sites	122	56 K	320027	7367450	T068	12.11.4	12.11.4	Remnant	'Of Concern'
Curtis Island	Tertiary Sites	126	56 K	319900	7368614	T071	12.11.6	12.11.14	Remnant	'Of Concern'
Curtis Island	Tertiary Sites	127	56 K	320016	7368764	T072	12.11.6	12.11.6	Remnant	'Least Concern'
Curtis Island	Tertiary Sites	129	56 K	320106	7368965	T073	12.3.11/12.11.6/12.11.14 (60/30/10)	12.11.14	Remnant	'Of Concern'
Curtis Island	Tertiary Sites	135	56 K	320367	7369397	T076	12.11.6	12.11.14	Remnant	'Of Concern'
Curtis Island	Tertiary Sites	136	56 K	320542	7369467	T077	12.11.14/12.3.3 (70/30)	12.11.14	Remnant	'Of Concern'
Curtis Island	Tertiary Sites	154	56 K	318905	7367769	T079	12.11.6	12.3.6	Remnant	'Of Concern'
Curtis Island	Tertiary Sites	174	56 K	319081	7367090	T080	12.11.4	12.11.14/12.11.4 (80/20)	Remnant	'Of Concern'
Curtis Island	Tertiary Sites	191	56 K	319064	7367407	T082	12.11.6	12.11.4	Remnant	'Of Concern'
Curtis Island	Tertiary Sites	427	56 K	319647	7369256	T094	n-r (OC - HVR)	n-r (12.3.3)	High value regrowth	'Endangered'
Curtis Island	Tertiary Sites	428	56 K	319523	7369590	T095	12.11.6/12.11.14 (85/15)	12.3.3	Remnant	'Endangered'
Curtis Island	Tertiary Sites	429	56 K	319407	7369562	T096	12.3.7/12.3.11 (70/30)	12.3.7	Remnant	'Least Concern'

Vegetation Assessment Sites – Supplementary Survey (Wet Season)

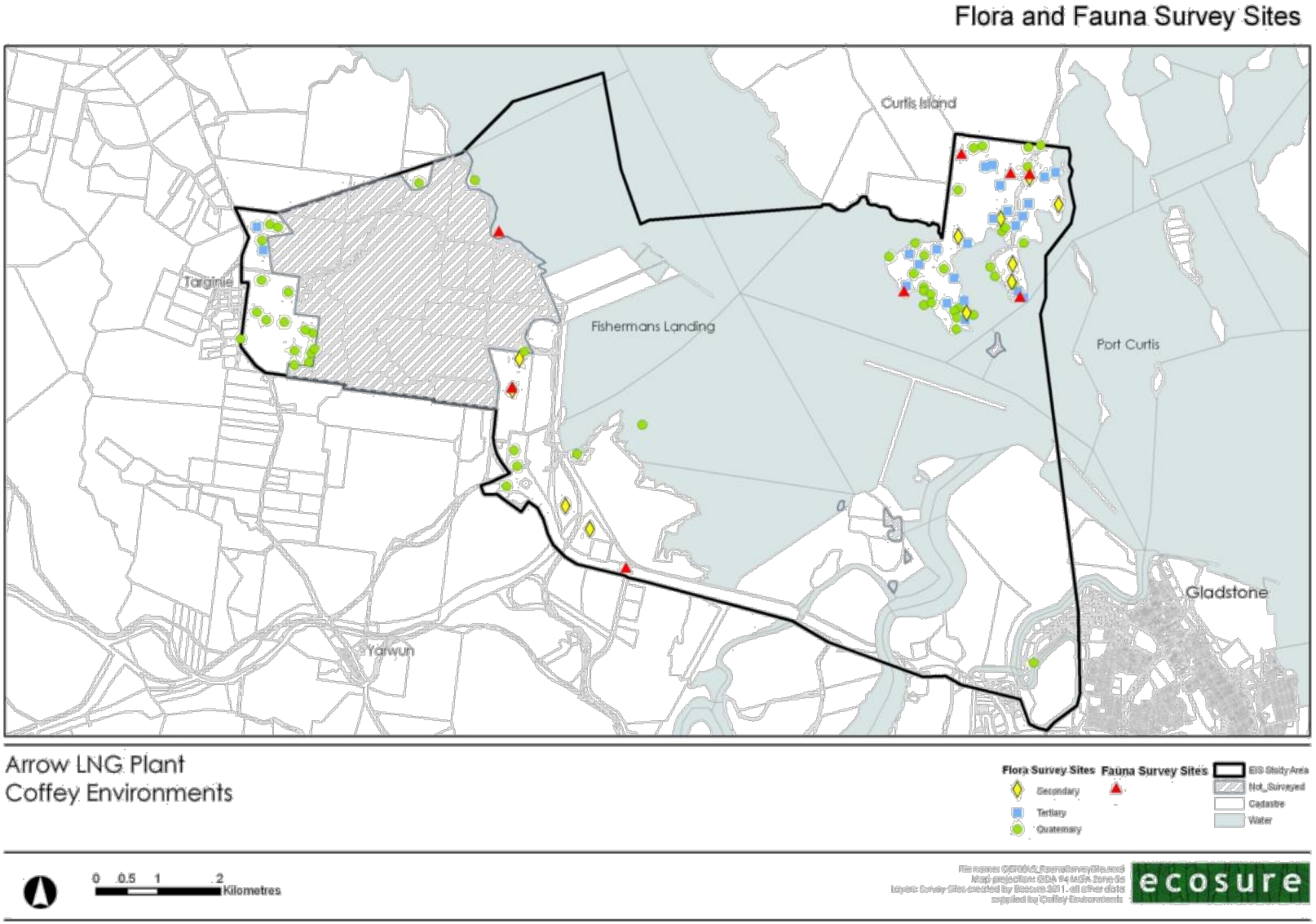
Date:	19th to 20th February 2011
Datum:	GDA94
Device:	Garmin *etrex* Vista HCx

Survey date	Project area	Assessment type	Waypoint	Zone	Easting	Northing	Assessment site	DERM mapped regional ecosystem	Field-validated regional ecosystem	Remnant status	Vegetation management status
2011	Mainland Tunnel Entry Shaft and Tunnel Spoil Disposal Area	Quaternary Sites	1	56 K	313864	7365399	Q001	12.1.3	12.1.3	Remnant	'Least Concern'
2011	Curtis Island	Quaternary Sites	2	56 K	319216	7367172	Q002	12.1.3	12.1.3	Remnant	'Least Concern'
2011	Curtis Island	Quaternary Sites	3	56 K	318413	7367328	Q003	12.1.3	12.1.3	Remnant	'Least Concern'
2011	Curtis Island	Quaternary Sites	5	56 K	318276	7368324	Q005	12.1.3	12.1.3	Remnant	'Least Concern'
2011	Curtis Island	Quaternary Sites	15	56 K	318737	7367915	Q007	12.11.6	12.11.14/12.11.6 (boundary of veg types)	Remnant	'Of Concern'/ 'Least Concern'
2011	Curtis Island	Quaternary Sites	28	56 K	318419	7368127	Q008	12.11.6	12.11.14/12.11.6 (boundary of veg types)	Remnant	'Of Concern'/ 'Least Concern'
2011	Curtis Island	Quaternary Sites	79	56 K	318251	7367835	Q011	12.11.6	12.11.14/12.11.6 (boundary of veg types)	Remnant	'Of Concern'/ 'Least Concern'
2011	Curtis Island	Quaternary Sites	91	56 K	318415	7367622	Q012	12.11.6	12.11.14/12.11.6 (boundary of veg types)	Remnant	'Of Concern'/ 'Least Concern'
2011	Curtis Island	Quaternary Sites	107	56 K	318413	7367557	Q013	12.1.3	12.1.3	Remnant	'Least Concern'
2011	Curtis Island	Quaternary Sites	106	56 K	318530	7367503	Q014	12.11.6	12.11.14	Remnant	'Least Concern'
2011	Curtis Island	Quaternary Sites	108	56 K	318538	7367364	Q015	12.1.3	12.1.3	Remnant	'Least Concern'
2011	Curtis Island	Quaternary Sites	131	56 K	318981	7367281	Q017	Non-remnant	Non-remnant	Non-remnant	n/a

Survey date	Project area	Assessment type	Waypoint	Zone	Easting	Northing	Assessment site	DERM mapped regional ecosystem	Field-validated regional ecosystem	Remnant status	Vegetation management status
2011	Curtis Island	Quaternary Sites	136	56 K	318903	7367234	Q018	12.11.6	12.11.14/12.11.6 (boundary of veg types)	Remnant	'Of Concern' / 'Least Concern'
2011	Curtis Island	Quaternary Sites	142	56 K	318950	7367125	Q019	12.11.6	12.11.14/12.11.6 (boundary of veg types)	Remnant	'Of Concern'/ 'Least Concern'
2011	Curtis Island	Quaternary Sites	148	56 K	318937	7366939	Q020	12.11.6	12.11.14/12.11.6 (boundary of veg types)	Remnant	'Of Concern'/ 'Least Concern'
2011	TWAF 7	Quaternary Sites	154	56 K	320186	7361560	Q021	Non-remnant	Non-remnant	Non-remnant	n/a
2011	TWAF 8	Quaternary Sites	157	56 K	307849	7368627	Q023	11.3.4	11.3.4	Remnant	'Of Concern'
2011	TWAF 8	Quaternary Sites	158	56 K	307987	7368588	Q024	11.3.4	11.3.4	Remnant	'Of Concern'
2011	TWAF 8	Quaternary Sites	159	56 K	307724	7368369	Q025	11.3.4	11.3.4	Remnant	'Of Concern'
2011	TWAF 8(S)	Quaternary Sites	164	56 K	308244	7366364	Q027	12.11.6/12.11.17	12.11.14	Remnant	'Of Concern'
2011	TWAF 8(S)	Quaternary Sites	168	56 K	308481	7366409	Q028	12.11.6/12.11.17	11.11.15	Remnant	'Least Concern'
2011	TWAF 8(S)	Quaternary Sites	169	56 K	308521	7366552	Q029	12.11.6/12.11.17	11.11.15	Remnant	'Least Concern'
2011	TWAF 8(S)	Quaternary Sites	170	56 K	308568	7366620	Q030	11.11.18/11.11.15	11.11.18	Remnant	'Endangered'
2011	TWAF 8(S)	Quaternary Sites	173	56 K	308541	7366879	Q031	11.11.18/11.11.15	11.11.15	Remnant	'Least Concern'
2011	TWAF 8(S)	Quaternary Sites	174	56 K	308422	7366928	Q032	12.11.6/12.11.17	11.11.15/12.11.14 (boundary)	Remnant	'Least Concern'/ 'Of Concern'
2011	TWAF 8(S)	Quaternary Sites	181	56 K	308255	7366592	Q033	HVR (OC Sub-dom)	12.11.14	High value regrowth	'Of Concern'
2011	TWAF 8(S)	Quaternary Sites	182	56 K	308150	7367536	Q034	HVR (OC)	11.3.4	High value regrowth	'Of Concern'

Survey date	Project area	Assessment type	Waypoint	Zone	Easting	Northing	Assessment site	DERM mapped regional ecosystem	Field-validated regional ecosystem	Remnant status	Vegetation management status
2011	TWAF 8(S)	Quaternary Sites	183	56 K	308087	7367055	Q035	HVR (OC)	11.3.4	High value regrowth	'Of Concern'
2011	TWAF 8(S)	Quaternary Sites	184	56 K	307797	7367084	Q036	HVR (OC)	11.3.4	High value regrowth	'Of Concern'
2011	TWAF 8(S)	Quaternary Sites	186	56 K	307645	7367211	Q037	HVR (OC)	11.3.4	High value regrowth	'Of Concern'
2011	TWAF 8(S)	Quaternary Sites	189	56 K	307381	7366779	Q038	HVR (OC)	12.11.14	High value regrowth	'Of Concern'
2011	TWAF 8(S)	Quaternary Sites	190	56 K	307720	7367725	Q039	HVR (OC)	11.3.4	High value regrowth	'Of Concern'
2011	Mainland Tunnel Entry Shaft and Tunnel Spoil Disposal Area	Quaternary Sites	191	56 K	312814	7364925	Q040	12.1.2	12.1.2	Remnant	'Least Concern'
2011	Curtis Island	Tertiary Sites	6	56 K	318626	7368232	T006	12.11.6	12.11.14	Remnant	'Of Concern'
2011	Curtis Island	Tertiary Sites	42	56 K	318177	7368155	T009	12.11.6	12.11.14	Remnant	'Of Concern'
2011	Curtis Island	Tertiary Sites	68	56 K	318136	7367642	T010	12.11.6	12.11.14	Remnant	'Of Concern'
2011	Curtis Island	Tertiary Sites	109	56 K	318786	7367360	T016	12.11.6	12.11.6	Remnant	'Least Concern'
2011	TWAF 8	Tertiary Sites	155	56 K	307644	7368594	T022			Remnant	
2011	TWAF 8	Tertiary Sites	161	56 K	307742	7368215	T026	11.3.4	11.3.4 (potentially 12.3.7)	Remnant	'Of Concern' ('Least Concern')
2011	Curtis Island	Tertiary Sites	83	56 K	318339	7367987	T041	12.11.6	12.11.6	Remnant	'Least Concern'

Appendix E Flora and Fauna Survey Sites



Appendix F Regional Ecosystem Information

Regional ecosystems (REs) are vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil type. REs are designated and reviewed (every two years) by the Queensland Herbarium (DERM) and are based on satellite imagery provided by the Statewide Land and Tree Study and comparison with pre-clearing vegetation maps.

Vegetation management status: the statutory status of an RE as defined under Section 22 of the *Vegetation Management Act 1999* is 'Endangered', 'Of Concern' or 'Least Concern'. This status is based on an assessment of the pre-clearing and remnant extent of a RE and is listed in the Vegetation Management Regulation 2000. The vegetation management status only applies to remnant vegetation. The status of each RE is defined as:

'Endangered' if:

- less than 10 per cent of the pre-clearing extent remains, or
- 10–30 per cent of the pre-clearing extent remains and the area of remnant RE remaining is less than 10 000 hectares.

'Of Concern' if:

- 10–30 per cent of the pre-clearing extent remains, or
- more than 30 per cent of the pre-clearing extent remains and the area of remnant RE remaining is less than 10 000 hectares.

'Least Concern' if:

- more than 30 per cent of the pre-clearing extent remains, and the area of remnant RE remaining is more than 10 000 hectares.

Vegetation is mapped as remnant if the predominant (ecologically dominant) layer:

- covers at least 50%of the undisturbed canopy;
- is at least 70% of the height of the undisturbed height; and,
- includes similar floristic species that exists if the vegetation community is undisturbed.

Remnant vegetation includes vegetation that has been cleared in the past but now meets the above criteria.

Biodiversity status: the non-statutory status of an RE as defined by DERM is 'Endangered', 'Of concern' or not 'Of Concern' at present. This status is based on assessment of the condition of remnant vegetation in addition to the pre-clearing and remnant extent of an RE. Although not of statutory significance, the biodiversity status of an RE should be used as a guide for decision making.

For biodiversity planning purposes, DERM classifies an RE as possessing a biodiversity status of:

'Endangered' if:

- Less than 10% of its pre-clearing extent remains unaffected by severe degradation

and/or biodiversity loss[1]; or

- 10-30% of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss and the remnant vegetation is less than 10,000 hectares; or
- It is a rare[2] RE subject to a threatening process[3].

'Of Concern' if:

- 10-30% of its pre-clearing extent remains unaffected by moderate degradation and/or biodiversity loss[4].

'No Concern at present' if:

- The degradation criteria listed above for 'Endangered' or 'Of Concern' regional ecosystems are not met.

Definitions (from Neldner *et al.* 2005)

[1] Severe degradation and/or biodiversity loss is defined as:

- floristic and/or faunal diversity is greatly reduced but unlikely to recover within the next 50 years even with the removal of threatening processes; or
- soil surface is severely degraded, for example, by loss of A horizon, surface expression of salinity, surface compaction, loss of organic matter or sheet erosion.

[2] Rare regional ecosystem:

- pre-clearing extent (1000 ha); or
- patch size (100 ha and of limited total extent across its range)

[3] Threatening processes are those that are reducing or will reduce the biodiversity and ecological integrity of a regional ecosystem. For example, clearing (clearing includes cultivation of non-woody natural vegetation), weed invasion, fragmentation, inappropriate fire regime or grazing pressure, or infrastructure development.

[4] Moderate degradation and/or biodiversity loss is defined as:

- floristic and/or faunal diversity is greatly reduced but unlikely to recover within the next 20 years even with the removal of threatening processes; or
- soil surface is moderately degraded.

The moratorium on the clearing of regulated regrowth was lifted on the 7th October 2009 and was replaced with a code and mapping. The mapping includes high value regrowth and regrowth watercourse vegetation which are collectively known as 'regulated regrowth'. The mapping appears similar to the remnant mapping in that it defines areas of 'high value regrowth' by RE status of 'Endangered' (pink), 'Of Concern' (orange) and 'Least Concern' (green) regrowth and has an essential habitat overlay (blue hatch). 'Regrowth watercourse vegetation' is specifically located within the catchment of the Great Barrier Reef and these watercourses are indicated by a maroon line on the applicable mapping. All other

watercourses are noted and are assigned stream orders.

The assessment system relies on self-assessment and notification, rather than a permitting system. Following satisfaction of the *Regrowth vegetation code: on freehold and indigenous land and leasehold land for agriculture and grazing – Version 1.0* (DERM, 2009a) and delivery of formal notification to DERM clearing can be undertaken. The code is split into three main sections - high value regrowth, regrowth watercourse vegetation and exchange (or offset) areas.

Appendix G - Projects Considered in the Cumulative Impact Assessment (from Coffey Environments, 2011c)

Name of Project	Proponent(s)	Criteria	Status	Description
Queensland Curtis LNG Project	QGC Pty Limited (BG Group business)		· EIS and Supplementary EIS complete. · Project approved with conditions by the Queensland Coordinator-General (CG). · Project approved with conditions by Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPC). · Financial Investment Decision taken 31 October 2010.	· Development of coal seam gas (CSG) resources in the Surat Basin. · Construction of gas pipeline from the gas fields to Gladstone. · Development of a liquefied natural gas (LNG) facility (12 million tonnes per annum (Mtpa)) and export terminal on Curtis Island.
GLNG Project	Santos Limited (and partners Petronas, Total and KOGAS)		· EIS and Supplementary EIS complete. · Project approved with conditions by the CG. · Project approved with conditions by DSEWPC. · Financial Investment Decision taken 13 January 2011.	· Development of CSG resources in the Surat Basin. · Construction of gas pipeline from the gas fields to Gladstone. · Development of a 10 Mtpa LNG facility and export terminal on Curtis Island.
Yarwun Alumina Refinery Expansion Project	Rio Tinto		· EIS approved in 2007. · Under construction.	· Expansion of Yarwun Alumina Refinery, increasing output by 2 Mtpa to 3.4 Mtpa by 2011.
Australia Pacific LNG Project	Australia Pacific LNG (ConocoPhillips and Origin Energy)	1, 2a	· EIS complete. · Project approved with conditions from the CG.	· Development of CSG resources in the Walloon gas fields in the Surat Basin. · Construction of gas pipeline from gas fields to Gladstone. · Development of an 18 Mpta LNG facility and export terminal on Curtis Island.
Western Basin Strategic Dredging and Disposal Project	Gladstone Ports Corporation Limited	1, 2a	· EIS and Supplementary EIS complete. · Project approved with conditions by the CG. · Project approved with conditions by DSEWPC.	· Dredging associated with the deepening and widening of existing channels, swing basins and berth pockets in the Port of Gladstone. · Dredged material will be placed into reclamation areas near Fisherman's Landing to create a land reserve.
Fishermans Landing Northern Expansion Project	Gladstone Ports Corporation Limited	1, 2a	· EIS and Supplementary EIS complete. · Project approved with conditions from the CG.	· Expansion of Fishermans Landing by reclamation. · Reclamation will provide for the containment of dredge material from future maintenance and capital dredge programs.
Arrow Surat Pipeline Project (formerly Surat Gladstone Pipeline Project)	Arrow Energy Ltd	1, 2b	· EIS complete. · EIS assessment report received.	· Construction of a high-pressure gas pipeline to transport CSG from Dalby to Gladstone.

Name of Project	Proponent(s)	Criteria	Status	Description
Central Queensland Pipeline Project	Enertrade (AGL Energy and Arrow Energy)	1, 2a	· EIS and Supplementary EIS complete. · Project approved with conditions by the CG. · Project approved with conditions by DSEWPC.	· Construction of a high pressure gas transmission pipeline from Moranbah to Gladstone.
Wiggins Island Coal Terminal Project	Central Queensland Ports Authority and Queensland Rail	1, 2a	· EIS and Supplementary EIS complete. · Project approved with conditions by the CG.	· Development of a coal terminal (25 Mtpa initially and an upgrade capability to a nominal 70 Mtpa in later stages) and associated infrastructure in the Port of Gladstone. · Dredging and reclamation.
Gladstone Nickel Project	Gladstone Pacific Nickel Limited	1, 2a	· EIS and Supplementary EIS complete. · Project approved with conditions by the CG.	· Development of a greenfield high pressure acid leach (HPAL) refinery in the Gladstsone State Development Area. · Development of slurry and water pipelines between Marlborough and the plant site. · Development of a tailings storage facility in the GSDA and ore importing facilities at the Port of Gladstone.
Gladstone Steel Plant Project	Boulder Steel Limited	1, 2a	· Initial Advice Statement complete. · EIS in progress. ·	· Development of an integrated steel making plant (2.1 Mtpa initially and increasing to 5 Mtpa in later stages) at a site in the GSDA Aldoga Precinct.
Moura Link-Aldoga Rail Project	Queensland Rail Ltd	1, 2a	· EIS complete. · No supplementary required. · Project approved with conditions by the CG.	· Development of a new rail line via the Moura Short Line to the existing North Coast Line. · Development of a rolling stock maintenance yard at Aldoga in the GSDA. · Quadruplication of the North Coast Line from the new yard to east of Yarwun.
Gladstone-Fitzroy Pipeline Project	Gladstone Area Water Board	1, 2a	· EIS and Supplementary EIS complete. · Project approved with conditions by the CG. · Pending approval with conditions from DSEWPC.	· Development of an underground pipeline to connect existing infrastructure from Laurel Bank to Yarwun. · Development of an intake and pump station, water treatment plant, booster pump station and a reservoir.
Hummock Hill Island Community Project	Eaton Place Pty Limited	1, 2a	· EIS and Supplementary EIS complete. · Pending approval with conditions by the CG and DSEWPC.	· Development of a residential and tourism community, including education facilities and a golf course, to accommodate the population of approximately 4000 on Hummock Hill Island.
Boyne Island Aluminium Smelter Extension of Reduction Lines Project	Rio Tinto Aluminium	1, 2a	· EIS and Supplementary EIS complete. · Project approved with conditions by the CG. · Works deferred until global market for aluminium improves.	· Expansion of the existing smelter to increase the annual capacity to 733, 000 tonnes of aluminium product.
Gladstone LNG Project	Gladstone LNG Pty Ltd	1, 2b	· EIS and Supplementary EIS complete. · Project approved with conditions by DERM.	· Development of a 1.6 Mtpa (initial) LNG facility and export terminal at Fisherman's Landing. · Environmental Authority issued 7 May 2010.

Appendix H Known Locations of EPBC Act Threatened Flora Species- Cupaniopsis sp.indet

Figure waypoint	Easting[1]	Northing	Species	Assessment site	Vegetation type (RE)	<1m	1 - 2m	2 - 4m	4 - 6m	>6m	Total number	Flowers	Fruit[2]	Vegetative material
Curtis Island Population (Lot 2 on RP602284) - Hamilton Point population														
86	7366854	318987	*Cupaniopsis sp. indet*	S081	12.2.2			3			3	X	X, X(s)	X
Curtis Island Population (Lot 1 on RP602284) - Boatshed Point population														
87	7367421	319998	*Cupaniopsis sp. indet*	T067, T068, S069	12.11.4			4	1		5			X
88	7367438	319994	*Cupaniopsis sp. indet*				1	3			4			
89	7367443	319983	*Cupaniopsis sp. indet*				8	11	1		20			
90	7367460	319981	*Cupaniopsis sp. indet*				1	2	1		4			
91	7367475	319973	*Cupaniopsis sp. indet*					1			1			
92	7367491	319973	*Cupaniopsis sp. indet*			1	1	2			4			
93	7367503	319976	*Cupaniopsis sp. indet*				3				3			
94	7367493	319981	*Cupaniopsis sp. indet*				4	4			8			
95	7367478	319984	*Cupaniopsis sp. indet*					9	2	2	13			
96	7367469	319991	*Cupaniopsis sp. indet*			1	1	2			4			
97	7367456	319998	*Cupaniopsis sp. indet*			1	2	2			5			
98	7367497	319926	*Cupaniopsis sp. indet*					3			3		X	X
99	7367498	319946	*Cupaniopsis sp. indet*			4	3	2			9	X(s)	X, X(s)	X
100	7367485	319953	*Cupaniopsis sp. indet*			1		4			5			
101	7367477	319948	*Cupaniopsis sp. indet*			1	5	3			9			
102	7367432	319948	*Cupaniopsis sp. indet*				1	1			2			
103	7367705	319843	*Cupaniopsis sp. indet*				1	2			3			
104	7367700	319831	*Cupaniopsis sp. indet*			10	5	4			19			
105	7367691	319850	*Cupaniopsis sp. indet*				1	8			9			
106	7367676	319834	*Cupaniopsis sp. indet*			1					1			

Figure waypoint	Easting[1]	Northing	Species	Assessment site	Vegetation type (RE)	<1m	1 - 2m	2 - 4m	4 - 6m	>6m	Total number	Flowers	Fruit[2]	Vegetative material
107	7367638	319858	*Cupaniopsis sp. indet*			1					1			
108	7367639	319876	*Cupaniopsis sp. indet*			1	4	3			8			
109	7367705	319858	*Cupaniopsis sp. indet*			1	2	4			7			
110	7367717	319848	*Cupaniopsis sp. indet*			1	1	3			5			
111	7367722	319860	*Cupaniopsis sp. indet*			4	6	1			11		X	X
112	7367412	319988	*Cupaniopsis sp. indet*				1				1			
Mainland Population (Lot 45 on RP894211)														
1	7370100	302856	*Cupaniopsis sp. indet*	S039	11.11.18			1				X	X(s)	X
2	7370097	302867	*Cupaniopsis sp. indet*				3	4	3		10		X, X(s)	X
3	7370090	302855	*Cupaniopsis sp. indet*					5	1		6			
4	7370060	302843	*Cupaniopsis sp. indet*					1			1	X	X(s)	X
5	7370040	302806	*Cupaniopsis sp. indet*			1	1	1			3			
6	7370044	302830	*Cupaniopsis sp. indet*					3			3			
7	7370056	302854	*Cupaniopsis sp. indet*						1		1			
8	7370068	302856	*Cupaniopsis sp. indet*					1			1			
9	7370087	302870	*Cupaniopsis sp. indet*			1	1	5			7			
10	7370087	302881	*Cupaniopsis sp. indet*				1	1	1		3			
11	7370065	302879	*Cupaniopsis sp. indet*					1			1			
12	7370017	302812	*Cupaniopsis sp. indet*					1			1			
13	7370112	302844	*Cupaniopsis sp. indet*				1				1	X	X	X
14	7370110	302768	*Cupaniopsis sp. indet*					3			3	X, X(s)		X
Mainland Population (Lot 45 on RP894211)														
15	7369956	302008	*Cupaniopsis sp. indet*	S042	11.11.18	5	6	1	1		13		X, X(s)	X(2)

Figure waypoint	Easting[1]	Northing	Species	Assessment site	Vegetation type (RE)	<1m	1 - 2m	2 - 4m	4 - 6m	>6m	Total number	Flowers	Fruit[2]	Vegetative material
16	7369994	301993	*Cupaniopsis sp. indet*			7	3	5	1		16			
17	7370006	301973	*Cupaniopsis sp. indet*			1	1	6	3		11			
18	7370033	301967	*Cupaniopsis sp. indet*					1			1			
19	7370081	301970	*Cupaniopsis sp. indet*					1			1			
20	7369856	301877	*Cupaniopsis sp. indet*				1	2			3			
79	7369640	301932	*Cupaniopsis sp. indet*			1	1				2			
Mainland Population (Lot 45 on RP894211) - southern population in regrowth patches fringing cleared drainage line														
80	7369528	301899	*Cupaniopsis sp. indet*	east of S045	non-remnant 11.11.18	18	16				34			
81	7369541	301907	*Cupaniopsis sp. indet*			13	11	1			25			
Mainland Population (Lot 45 on RP894211) - southern population in regrowth vegetation														
82	7369065	301229	*Cupaniopsis sp. indet*	east of S047	non-remnant 11.11.18	4	3	1			8			
83	7369048	301255	*Cupaniopsis sp. indet*				4	2			6			
84	7369040	301235	*Cupaniopsis sp. indet*				6	3			9		X	X
85	7369020	301253	*Cupaniopsis sp. indet*				1				1			X

1 – Datum used was GDA94.

2 - 'X(s)' denotes that the material was collected and preserved in spirit, 'X' denotes that the material was collected and pressed.

Appendix I
Threatened Fauna Records Observed During Field Surveys

Group	Scientific name	Common name	Status	Location		Number observed	Comment
				Easting	Northing		
Avian	*Accipiter novaehollandiae*	grey goshawk	NCA NT	317606	7371532	1	
				317778	7371669	1	
Avian	*Ardea alba*	great egret	EPBC M	311553	7368520	1	Foraging in freshwater watercourse, draining onto mudflat north of Fishermans Landing.
Avian	*Charadrius mongolus*	lesser sand plover	EPBC M	313603	7363097	11	Several foraging on stagnant mudflat adjacent to Rio Tinto smelter.
Avian	*Esacus magnirostris*	beach stone-curlew	NCA V	311193	7369329	2	Pair seen foraging on mudflat.
				313781	7372961	1	
Avian	*Geophaps scripta scripta*	squatter pigeon (southern subspecies)	EPBC V NCA V	302676	7370534	1	
				308281	7371801	1	
				309082	7372564	1	
Avian	*Haliaeetus leucogaster*	white-bellied sea-eagle	EPBC M	311193	7369329	1	Observed perching in stag adjacent to mudflat.
				311553	7368520	1	
				313781	7372961	3	Two adults and one juvenile seen in transit over the rocky shoreline at the tip of Boatshed Point, Curtis Island.
				318094	7367554	1	
				318568	7367658	1	
				319869	7367361	3	Two adults and one juvenile seen in transit over the rocky shoreline at the tip of Boatshed Point, Curtis Island.
				319983	7367442	1	One in transit over vine thicket on the crest of Boatshed Point, Curtis Island.
				320613	7370812	1	One seen in transit over mudflat approximately 600 m north of the LNG plant site boundary (outside the study area).
				320707	7371057	1	
Avian	*Hydroprogne caspia*	Caspian tern	EPBC M	310920	7369955	2	Seen foraging over water from survey point.
				311522	7368874	1	Foraging over water.
				311553	7368520	3	Foraging over water. One landed feeding on small fish.
Avian	*Limosa lapponica*	bar-tailed godwit	EPBC M	310920	7369955	>1	Several recorded foraging on mudflat from survey point.
				311553	7368520	1	
Avian	*Lophoictinia isura*	square-tailed kite	NCA NT	306209	7371211	1	

Group	Scientific name	Common name	Status	Location		Number observed	Comment
				Easting	Northing		
Avian	*Merops ornatus*	rainbow bee-eater	EPBC M	302663	7370539	1	
				302971	7370486	1	
				303780	7371524	1	
				304943	7372082	1	
				306656	7371699	1	
				307643	7368578	1	
				307902	7371706	1	
				310561	7368627	1	Observed in Targinie State Forest, along Forest Road.
				311553	7368520	1	
				311760	7365999	1	Heard/seen in woodland.
				312670	7365496	1	
				312809	7364834	1	Foraging on edge of mudflat, south of Fisherman's Landing.
				314512	7372554	1	
				314990	7372788	1	
				315306	7372880	1	
				317606	7371532	1	
				317699	7371609	1	
				318094	7367554	1	Seen foraging in thick vegetation along a dry watercourse on the western side of Hamilton Point, Curtis Island.
				318189	7368349	1	
				318390	7367583	1	
				318512	7367362	1	
				319025	7369776	1	
				319090	7368684	4	Foraging over small dam near Farmhouse, Curtis Island.
				319737	7369795	1	Heard in open-forest on LNG Plant site, Curtis Island.
				319815	7369462	1	One heard in open-forest on LNG Plant site, Curtis Island.
				320027	7369106	1	Heard in open-forest, southern section of study area, Curtis Island.
				320096	7369555	1	One seen near existing track, north of Boatshed Point.
				320278	7369900	1	One seen foraging over open-forest near mudflat, Curtis Island.
Avian	*Ninox strenua*	powerful owl	NCA V	316389	7372817	1	
Avian	*Numenius madagascariensis*	eastern curlew	EPBC M NCA NT	310813	7369811	1	Mudflat adjacent to Targinie State Forest, behind coastal mangroves, foraging at low tide.
				310920	7369955	2	Landing, foraging at low tide. Seen 150 m north of survey point.

Group	Scientific name	Common name	Status	Location		Number observed	Comment
				Easting	Northing		
				311400	7368700	1	Recorded foraging behind mangroves, on mudflat north of Fishermans Landing.
				311464	7368735	2	Recorded behind mangroves, foraging in intertidal area.
				311553	7368520	4	Recorded regularly at diurnal bird survey site, on mudflat north of Fishermans Landing.
				318987	7366854	1	One seen foraging on eastern of Hamilton Point.
Avian	*Numenius phaeopus*	whimbrel	EPBC M	310920	7369955	6	Several recorded foraging on mudflat from survey point.
				311553	7368520	9	Observed foraging.
				316043	7373637	1	
Avian	*Rhipidura rufifrons*	rufous fantail	EPBC M	302663	7370539	1	Observed in vine thicket at the top of the ridge on the property off Cullens road.
				318094	7367554	1	Seen foraging in thick vegetation along a dry watercourse on the western side of Hamilton Point, Curtis Island.
Avian	*Pandion haliaetus*	eastern osprey	EPBC M	315101	7372864	1	
				319006	7366854	1	One seen in transit at the southern tip of Hamilton Point, Curtis Island.
				322725	7364747	1	On pylons out from the Gladstone Marina
Mammal	*Pteropus poliocephalus*	grey-headed flying-fox	EPBC V	302857	7370082	1	Foraging in flowering *Eucalyptus tereticornis*
				306717	7371730	1	
				307802	7372621	1	
				307902	7371706	1	
				315914	7372971	1	
				321917	7362744	>1	Seen roosting in flying fox camp adjacent to Gladstone Marina.

Status refers to legislative status under the NCA or EPBC. M= 'Migratory', V= 'Vulnerable', NT= 'Near Threatened'

Revision History

Revision number	Revision date	Details	Prepared by	Reviewed by	Approved by
00	10/03/2010	Draft One/ Working Draft (Flora)	Chris Hansen Flora Ecologist Nick Murray Senior Ecologist	Not reviewed	Not approved
01	27/04/2011	Draft One Terrestrial Ecology (Flora and Fauna)	Chris Hansen Flora Ecologist Jesse Rowland Ecologist Beth Kramer Principal Environmental Scientist Phil Shaw Director	Christy Englezakis Senior Environmental Scientist	Phil Shaw Director
02	29.05/2011	Draft Two Terrestrial Ecology (Flora and Fauna) – including response to comments on Draft One	Beth Kramer Principal Environmental Scientist	Phil Shaw Director	Phil Shaw Director
03	06/07/2011	Draft Three Terrestrial Ecology (Flora and Fauna) – including response to comments on Draft Two	Beth Kramer Principal Environmental Scientist	Phil Shaw Director	Phil Shaw Director
04	11/08/2011	FINAL Terrestrial Ecology (Flora and Fauna) – including comments on Draft Three	Beth Kramer Principal Environmental Scientist	Phil Shaw Director	Phil Shaw Director
05	23/08/2011	Final Terrestrial Ecology (Flora and Fauna) (revision 1)	Beth Kramer Principal Environmental Scientist	Phil Shaw Director	Phil Shaw Director
06	21/09/2011	Final Terrestrial Ecology (Flora and Fauna) (revision 2)	Beth Kramer Principal Environmental Scientist	Phil Shaw Director	Phil Shaw Director
07	27/09/2011	Final Terrestrial Ecology (Flara and Fauna (revision 3)	Phil Shaw Director	Phil Shaw Director	Phil Shaw Director
08	7/10/2011	Final Terrestrial Ecology (Flara and Fauna (revision 4)	Beth Kramer Principal Environmental Scientist	Phil Shaw Director	Phil Shaw Director

09	13/10/2011	Final Terrestrial Ecology (Flora and Fauna) (revision 5)	Phil Shaw Director	Phil Shaw Director	Phil Shaw Diredtor

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